VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

CONTENTS

VOLUME-IA PART-I CHAPTER-I
PROJECT INFORMATION
2X660 MW UDANGUDI THERMAL POWER STATION

UDANGUDI SUPERCRITICAL TPS UNITS- 1 & 2 [2 x 660 MW] is being set up by **TAMILNADU GENERATION AND DISTRIBUTION CORPORATION** at a site in Kallamoli village of Tiruchendur Taluk, Tuticorin District., Tamilnadu, India. The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

1.1	Project Title	:	2 x 660 MW Udangudi
1.2	Plant capacity	:	660 MW
1.3	Type of project	:	Green Field
1.4	Owner	:	Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO)
1.5	Plant site location	:	Kallamoli - 628203, Tiruchendur Taluk, Tuticorin District., Tamil Nadu.
1.7	Nearest Village	:	Udangudi
1.8	Nearest Town & City	:	Tuticorin at 41 KM
1.9	State Capital	:	Chennai (655 Km)
1.10	Nearest Railway Station	:	Thiruchendhur at 8 KM
1.11	Nearest Airport	:	Domestic airport at Tuticorin (41 KM)
1.12	Nearest Seaport	:	Tuticorin Port (45 KM)
1.13	Nearest Road access	:	ECR Connecting Tuticorin and Kanyakumai – state highway -176
2.0	Meteorological Condition		
2.1	Climate	:	Tropical, very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind
2.2	Site Elevation	:	(+)2.8Meter above Mean Sea Level
2.3	Ambient Temperature		
a.	Annual Maximum Mean Temperature	:	41°C

b.	Annual Minimum Mean Temperature	:	22.3°C
c.	Dry bulb Temperature(DBT) for Design Purpose	:	Max 41°C & Min 17°C
2.4	Relative Humidity for Design purpose		Max 84% & Min 62%
2.5	Annual Rainfall		
	Average	:	Max 718.2mm & Min 384.4mm
2.6	Basic Design Wind Pressure	:	Design wind speed is 39 m/sec as per IS: 875 Part III Mean Wind Speed (max): 20.6 km/h as per IS: 875 (Latest Edition)
2.7	Seismic zone	:	Zone: II as defined in IS:1893-2002
2.8	High Flood Level		High Flood Level for site: RL 2.450 m

VOLUME-IA PART-I CHAPTER-II
SCOPE OF WORKS

1.2.1 The scope of works covers Balance Civil & architectural works of the Coal Handling Plant area for Unit 1 & 2 – (Package 1), including other miscellaneous works at 2X660 MW Udangudi Super Critical Thermal Power Project site, including supply of all materials (excluding the materials supplied by BHEL free of cost), labour & mobilization of tools and plants.

1.2.2 The scope of works are as mentioned below. However, the scope of work is indicative only, but not limited to the given below,

AREAS OF WORK

Balance Civil & Architectural works of

i) Coal shed (Part 1) as per the instructions of BHEL Engineer in charge at site
ii) Stock Pile - 2 Nos
iii) Stacker cum Reclaimer 1 (SCR 1) (SCR 1 is located in the area of Belt Conveyor 4)
iv) Yard & Retaining Wall for SCR 1
v) Barricading – SCR 1
vi) Crusher House
vii) Belt Conveyors - 2A, 2B
viii) Belt Conveyor 4
ix) Belt Conveyor 6A, 6B
x) Belt Conveyor 7A, 7B (part) (Between JNT 5 & JNT 6)
xi) Belt Conveyor 9 A, 9B
xii) Belt Conveyor 10A, 10B
xiii) Belt Conveyor 11A, 11B
xiv) Belt Conveyor 12A, 12B
xv) Belt Conveyor 13A, 13B
xvi) Junction Tower – 5, 6, 7, 8, 9, 10
xvii) CHP MCC 1
xviii) Cable Rack (respective part)
xix) Roads & drains (respective part)
xx) Levelling & Micro grading (respective Part)
xxi) Any other structures required for completion of CHP

Note: The above provided list is indicative only for the bidder's guideline. Any other structure / foundation not mentioned above, but required for completion of the scope of work – "CHP Civil & architectural works" in total, deemed to have been included in the bidder scope under this contract. Such work will be executed

under this contract by bidder as per the direction of Engineer in charge. If any item of work not available in the rate schedule of this contract, the rate will be fixed in line with clause 2.15.7 of GCC.

1.2.3 BHEL shall provide Cement and reinforcement steel, Structural steel for civil and structural works only for incorporation in the permanent works as free supply.

Though Major scope of Structural fabrication and erection works is in BHEL's scope, depending upon requirement at site, bidder may be required to carry out minor structural fabrication & erection works i.e. supporting structure for false ceiling etc., Structural steel for such works shall be supplied by BHEL as a free issue and fabrication & erection of the same may be operated under the relevant items of BOQ and as per tender terms & conditions.

Embedment's /inserts required 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 for embedment's/inserts from scraps (if available), payment shall be made as per corresponding item in BOQ. If BHEL provides fabricated embedment's/ inserts as supplied by BHEL manufacturing units, payment for fixing of those shall be made as per corresponding item in BOQ.

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

1.2.5 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials removed shall be burnt or otherwise disposed of as directed by the Engineer-in-Charge. No separate payment for these operations shall be made. The cost of all these operations shall be deemed to have been included in the unit rates derived for the different items under bill of quantities.

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

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

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

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

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

1.2.11 Bidder shall visit site for better clarification against present status of civil works in various area for proper assessment of pending works. The work covered under scope of works shall be taken up on AS IS WHERE IS basis, as applicable in site as per the instructions of BHEL Engineer in charge. For information on status of works, annexure –A to this chapter shall be referred.

1.2.12 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 pandemic measures published vide government order time to time will be liable to be proceeded for legal action as per the government order. Following shall be observed in work place:

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

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

1.2.16 Contractor shall sanitize their work place between shifts and to ensure vaccination to the workers as per the Govt Guide lines.

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

1.2.18 Government order (state/ center) being issued time to time for protective measures of COVID 19 pandemic shall be complied with strictly untill government (state/ center) declares end of pandemic.

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

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 encouraged.
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 pandemic patients, should be identified and list should be available at work place all the times.

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

Annexure A to VOLUME-IA PART – I CHAPTER – II - SCOPE OF WORKS
STATUS OF BALANCE WORKS – As on 10.01.2022

Structure	Current Status	Executed RCC Qty
JNT 5	Excavation started (only 1 m excavation completed from NGL)	
JNT 6	Excavation, PCC, Raft & Pedestal 1st lift & 2nd lift completed. Pedestal Bolt lift with Plinth Beam balance	421/479 cum RCC foundation works completed
JNT 7	Excavation, Raft PCC & RCC completed	922/1099 cum RCC foundation works completed
JNT 9	Foundation Completed, Handed Over on 29.07.2021	879/879 cum RCC Foundation works completed
JNT 10	work not started	
BCN 4	work not started	
BCN 7 AB	work not started	
BCN 11 AB	work not started	
BCN 12 AB	RCC works with pedestal Bolt lift completed	380/380 cum RCC foundation works completed
BCN 13 AB	work not started	
MCC 1	Excavation and PCC works in progress, 24/60 raft PCC, 22/60 raft RCC completed	108/1200 CUM RCC COMPLETED
SCR 01	23/448 no's raft RCC completed till date, Pedestal works yet to be taken up. Excavation for 04/16 modules completed	108/3370 cum RCC foundation works completed
SCR 01 END SEGMENT	work not started	
STOCK PILE 01	work not started	
SCR 01 RETAINING WALL	work not started	

Structure	Current Status	Executed RCC Qty
SCR 01 BARRICADING (WIND BARRIER)	work not started	
Crusher House	08/27 PCC completed, 07/27 raft RCC works completed	277.2/1509 cum RCC completed
COAL SHED	work not started	
JNT 08	work not started	
CABLE RACK	work not started	
ROAD & DRAINS	work not started	
BCN 2 AB	work not started	
BCN 9AB	work not started	
BCN 10 AB	work not started	
LEVELLING & MICRO GRADING	work not started	

Notes:

i. Above list and the status is indicative and bidder shall visit the site to know the actual status of the works under the scope of the tender.

ii. Bidder has to execute all the associated works for completion of above list of balance works and handing over as required and as per the instructions of engineer in charge.

iii. The bidder shall be responsible for the entire scope of works including the works, which are partly/ fully completed / under execution by the earlier agency but to be continued by the bidder for further scope of works.

VOLUME-IA PART-I CHAPTER-III

FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR / BHEL

(SCOPE MATRIX)

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.1.0	**ESTABLISHMENT**			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		
B	Open space for storage	Yes		
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	
D	Bidder's all office equipment's, office / store / canteen consumables		Yes	
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	
1.3.1.1.2	FOR LIVING PURPOSES OF THE BIDDER			
A	Open space		Yes	
B	Living accommodation		Yes	
1.3.1.2.0	**ELECTRICITY**			
1.3.1.2.1	Electricity For construction purposes	Yes		Chargeable as per TANGEDCO prevailing tariff
1.3.1.2.1.1	Single point source	Yes		

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	
1.3.1.2.2	Electricity for the office, stores, canteen, & labour colony 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	Demobilization of the facilities after completion of works		Yes	
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc on the above lines. (in case BHEL provides this facility, the scope should be given without ambiguity)		Yes	
1.3.1.3.0	**WATER SUPPLY**			
1.3.1.3.1	For construction purposes:		Yes	
1.3.1.3.1.1	Making the water available at single point		Yes	
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	
1.3.1.3.2	Water supply for bidder's office, stores, canteen, and labour colony etc.		Yes	
1.3.1.3.2.1	Making the water available at single point		Yes	

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.3.2.1	Further distribution as per the requirement of work including supply of materials and execution		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	
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) At office storage area At the preassembly area At the construction site /area		Yes	
1.3.1.5.0	**COMMUNICATION FACILITIES for site operations of the bidder**	**-**		
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc		Yes	

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

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

1.3.3 **OPEN SPACE**

1.3.3.1 Open space as made available by customer will be provided at free of charges to the contractor, for construction of temporary office shed, fabrication yard and storage area at the job site, contractor’s stores shed(s). 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, office, storage area etc. for construction purpose shall be provided as per availability free of cost. The contractor will be responsible for handing over 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 his cost. The contractor to construct labour colony 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. Suitable paved area to be provided in the labour colony. The Contractor shall provide adequate arrangements for electricity requirements for labour colony.

1.3.4 **ELECTRICITY**

1.3.4.1 In Construction power will be provided to the contractor at one single point within the plant area by BHEL on chargeable basis as per the prevailing rates of TANGEDCO under LT tariff VI at the nearest substation.

1.3.4.2 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.

1.3.4.3 The TANGEDCO tariff and tax may vary from time to time and the same is applicable for the bidder. The required digital Energy meter for measuring the consumption and MD shall be provided and installed by the contractor. Any dispute regarding consumption, the BHEL engineer's decision is final. The contractor shall make his own arrangement for further distribution (as required within plant boundary and outside plant boundary) with necessary isolator / LCB etc.

1.3.4.4 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.

1.3.4.5 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. Any duty, deposit involved in getting the Electricity for contractors use i.e. Office shed, labour colony etc shall be borne by the bidder.

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 Construction Water required for construction purposes to be arranged by the bidder at bidder's cost. 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 Contractor has to make his own arrangements for his water requirement for his labour colony at his cost.

1.3.5.3 Drinking Water shall be arranged by the bidder at his cost

1.3.6 **MATERIAL SUPPLY**

1.3.6.1 Supply / providing aggregate and all other materials required for the work are in the scope of the contractor.

BHEL shall provide Cement, reinforcement steel for civil works only for incorporation in the permanent work AS FREE SUPPLY. BHEL shall provide structural steel as specified in clause no 1.2.3.

1.3.6.2 Fine aggregate source shall be manufactured crushed stone or rock sand (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.

The amount of fine particles as ascertained by the laboratory sedimentation method shall not exceed 10% for crushed stone sand. The amount of material passing a 75 micron sieve (IS test sieve) shall not exceed the following limits:-

a) Crushed stone sand concrete subject to abrasion 1% by weight

b) All other concrete 3% by weight.

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

1.3.6.3 Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum each of 100MT capacity per 30 Cum batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the No of cement silos shall be increased based on the site requirement. Carrying out design mix required for the scope of work providing all materials except cement is in the scope of bidder. Only cement for the design mix shall be provided by BHEL free of cost. On advance request of the bidder, the cement shall be supplied in Bags for other

than RCC works like masonry, flooring works etc. Advance request for supply of cement in bags shall be minimum two months.

1.3.6.4 The reinforcement 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.

1.3.6.5 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.

1.3.6.6 Bidder to note that steel materials required for Embedment's, inserts, MS Grating, Galvanized Grating, GI Handrail, Stainless Steel Handrail, Stop Lock Gate, Stationery Screen, fasteners like MS/HT/HSFG bolts/nuts, lock nuts, washers and foundation bolts other than those supplied by BHEL, shall be supplied by the bidder. However, Bidder shall use the scrap materials available with BHEL or with the respective bidders, for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities, if taken from BHEL and shall be accounted for monthly reconciliation, if it belongs to the bidder's scrap materials.

1.3.7 CONSUMABLES

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

In the event of failure of contractor to bring necessary and sufficient consumables, BHEL may arrange for the same at the risk and cost of the contractor. The entire cost towards this along-with overhead shall be paid by the contractor or deducted from the contractor's bills.

1.3.8 LIGHTING FACILITY

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

1.3.9 CONTRACTOR'S OBLIGATION ON COMPLETION

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

1.3.10 BLASTING

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

1.3.11 DEWATERING

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

1.3.12 BID DRAWINGS

Plot plan drawing enclosed for information and this may get revised during execution.

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

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

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

Sr No	**Major T&P**	**Mobilizing time from the date of start of work**
C1	2 nos. excavator equivalent to capacity of Pocklain CK90	1 no. within 20 days, 1 no. within 45 days
C2.a	1 nos. automatic concrete batching plant with printing facility (60 Cum/Hr) – with DG backup. With minimum 2 Nos of silo (100MT each)	1 no. within 30 days.
C2.b	1 nos. automatic concrete batching plant with printing facility (30 Cum/Hr) – with DG backup. With minimum 2 Nos of silo (100MT each)	1 no. within 60 days.
C3	1 Nos Truck mounted concrete mixer cum pump along with placing boom minimum 42 m high i.e. Concrete boom placer (42m)	1 no. within 30 days
C4	8 nos. transit mixer (5/6 M3 capacity) including standby 1 nos.	2 nos. within 30 days. Balance progressively as per site requirement.
C5	1 No 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 mutually agreed between bidder and Engineer In-Charge of BHEL
Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
C6	2 nos. Back hoe loader like JCB	1 no. within 30 days and bal. as per site requirement.
C7	3 nos. dumper (Min 15 cum each)	2 nos. within 20 days. Balance as per site requirement.
C8	2 nos. diesel driven Mixer machine of 0.5 cum capacity	As per site requirement.

C9	2 nos. self-priming dewatering pump 20 HP (diesel)	As per site requirement.
C10	10 nos. self-priming dewatering pump 5 HP (electric)	As per site requirement.
C11	5 nos. reinforcement bending machine	2 nos. within 20 days, balance progressively as per site requirement
C12	5 nos. reinforcement cutting machine	3 nos. within 20 days, balance progressively as per site requirement
C13	MS scaffolding pipe	As per site requirement.
C14	2 nos. power driven earth rammer (Roller Type 1/2 T)	As per site requirement.
C15	2 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	Within 60 days.
C16	1 no. vibro earth compactor or Vibromax or equivalent	as per site requirement.
C17	Civil laboratory equipment's as per list IN Sl 1.4.4.2 with temporary building one AC lab size 4.5mtrx6mtr and 1 non AC lab 4.5 mtrx4.5 mtr.	Within 45 days.
C18	2 no. total station with adequate arrangement for Surveyors.	As per site requirement.
C19	3 nos. auto level & staff + 2 nos. as required	As per site requirement.
C20	200 nos. concrete cube moulds	100 nos. within 30 days balance as per site requirement.
C21	Adequate no. of small trucks 2T/5T for shifting of reinforcement/ cement/ shuttering etc. within site	As per site requirement.
C22	2 nos. drinking water tank – 5000 lit.	As per site requirement.
C23	2 nos. mobile toilet blocks for labour use.	As per site requirement.
C24	1 nos. truck mounted 125 KVA DG set	1 no. within 45 days
C25	Construction power cable	As per site Requirement
C26	Construction water Pipeline	As per site Requirement

C27	Minimum 10 nos Concrete vibrator with adequate needle (diesel/power)	5 Nos (at least 3 nos. diesel driven) within 45 Days. Balance as per site requirement.
C28	Portable fire extinguishers as below: Soda acid – 5 sets. Dry chemical powder – 5 sets CO2 – 5 sets. Water & sand bucket (4 buckets in one stand) – 5 sets. Fire hose with nozzle (50 M length) – 5 sets.	25% of each type within 30 days and balance progressively within 90 days.
C29	1 no. compression testing machine (200 T cap)	1 no. within 30 days

Note:

1) T&P and the mobilization schedule shown in the above mentioned list is tentative requirement considering parallel working. However, Mobilization schedule and quantity/ numbers of T & Ps, and period of deployment 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-mobilization 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:

   Case 1: 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.

Case 2: BHEL provides hired T&P: In all cases other than that specified in Sl No. 1 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. 1.6.1.1. 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.

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

1.4.4.2 Field and laboratory testing procedures for materials follow Indian Standard Specifications with necessary equipment 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			
1	Liquid limit test	Liquid limit apparatus	Standard	IS 2720
2	Core Cutter test	core cutter apparatus	Rammer, 6 no's of std. core cutter mould, dolly	IS 2720
3	Proctor density test	Std proctor Compaction apparatus	Standard	IS 2720
4	Moisture Content	Rapid moisture meter	Standard, at least 04 no's	IS 2720

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

1.4.6 In construction projects of this magnitude, all the areas / approaches may not be ready. In such cases consolidation of ground and arrangement of sleeper's / 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.

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

1.4.8 The age of contractor deployed cranes upto 150T 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 BHEL Engineer.

1.4.9 In case, cement is issued through bulkers being supplied from manufacturer/ stockiest, the same shall be emptied in cement silos of batching plant and necessary unloading arrangements shall be provided by contractor. Contractor to note that batching plant being established at site shall have cement silos of 100 MT capacities each as mentioned in clause 4.2.B- list of Tools & Plants to be deployed by the contractor.

1.4.10 **CRANE OPERATOR FOR CRANES PROVIDED BY CONTRACTOR**

1.4.10.1 Must be capable of independently operating hydraulic/ mechanical crawler/ tyre mounted cranes of respective categories.

1.4.10.2 Must have minimum 2 years' experience in operation of hydraulic/ mechanical crawler/ tyre mounted cranes in respective categories & hold valid HMV/ TRANS license. Should be able to read and interpret the operation and

maintenance manual, boom load chart, boom angle and other indicating devices.

1.4.10.3 Operator shall have latest physician's certification for their physical fitness in vision with/ without lenses & adequate hearing with or without hearing aid.

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

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

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

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

VOLUME-IA PART-I CHAPTER-VI
TIME SCHEDULE

1.6.1 TIME SCHEDULE

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

1.6.1.2 The entire scope of work of Civil and Architectural works for the package as detailed in the Tender Specification shall be completed **within 19 (Nineteen) months** from the date of commencement of work.

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

1.6.1.4 The contractor is required to refer Form 15 provided at Chapter-9 in Part II Volume IA Technical Conditions of Contract for all the instructions to be taken immediately after receipt of LOI.

1.6.2 MOBILISATION

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

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

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

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.

1.6.3 SUBMISSION OF L3 SCHEDULE

The contractor shall submit and a detailed area/ structure wise L3 schedule within 7 days in consultation with BHEL based on the tentative schedule provided as per the clause 1.6.5. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects to meet the agreed project schedule covering various mile stone activities and their split up details such as construction, procurement of materials, execution

activities. 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.

1.6.4 GUARANTEE PERIOD FOR THE PACKAGE

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

1.6.5 CIVIL WORKS SCHEDULE FOR CHP – Part-1 at 2X660MW UDANGUDI POWER PROJECT

Tentative schedule for the scope of works is as given below.

Sl. No	Area	Completion from the date of commencementof work
1	Foundation of JTs 5,6,7– Clearance to structural agency for erection	Progressively by 4th Month
2	Foundation ofJTs 8,10- Clearance to structural agency for erection	Progressively by 5th Month
3	Foundations of SCR 1	Progressively by 6th Month
4	Foundation for Crusher House	Progressively by 4th Month
5	Foundation for other structures – Clearance to structural agency for erection	Progressively by 5th Month
6	SCR -1, Yard & retaining wall for SCR -1	Progressively by 8th Month
7	Coal shed 1	- Design completion and approval by 3rd month - Coal shed foundation completion progressively by 8th month - Completion of supply and erection by 15th Month
8	CHP MCC 1	Progressively by 11th Month
9	Roads & drains (respective part)	Progressively by17th Month

10	Miscellaneous structures and complete readiness of above structures	Progressively by 17th Month
11	Material Reconciliation and Balance Finishing works	18th Month
12	Contract Closure & Final bill submission	19th Month

1.6.6 **Intermediate Milestones**

Sl. No.	Description	Completion month from the contractual date of start of work	Intermediate Milestone
1.	Foundation for Crusher House	4th month	M1
2.	SCR -1, Yard & retaining wall for SCR -1	8th month	M2

1.6.6.1 **Penalty for Intermediate Milestones**

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

1.6.6.1.2 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.

1.6.6.1.3 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.

1.6.6.1.4 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.

1.6.6.1.5 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.

1.6.6.1.6 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.

1.6.6.1.7 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.

1.6.6.1.8 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.

1.6.7 The above schedule is tentative. In case the activities in the schedule are to be advanced, the related civil/ structural activities in the scope of the contractor are to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

1.6.8 The above schedule is for entire completion and handing over the structure/ Building to BHEL. The foundations, pedestals, floors, etc, required for the mechanical equipment erection/ structural erection shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement.

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

1.6.10 The bidder must submit a detail schedule (area wise) for completion of work to meet the work schedule given in clause no. 1.6.5 within 15 days from the date of issue of LOI.

1.6.11 **RECORDS TO BE MAINTAINED AT SITE**

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

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

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

VOLUME-IA PART-I CHAPTER-VII
TERMS OF PAYMENT

1.7.0 TERMS OF PAYMENT

1.7.1 Secured Advance

Not applicable

1.7.2 Advance for Mobilization

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

1.7.2.2 2% of contract value after receipt of initial Security Deposit as per relevant clauses in the GCC/TCC along with unqualified acceptance of detailed letter of intent.

1.7.2.3 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below in line with Chapter IV of this TCC 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– 2 Nos.
2) Batching Plant – 60 cum/hr. capacity – 1 No. with 2 Nos of silo (100MT each).
3) Transit mixers (5/6 M3 capacity) – 3 Nos.
4) Concrete boom placer (42m high) – 1 No.

1.7.2.4 1.5% of contract value on completion of site mobilization of Machinery & T&P as given below in line with Chapter IV of this TCC, in addition to the above, and on certification by site in-charge for compliance.

1) Transit mixer (5/6 M^3 capacity) – 3 Nos.
2) Concrete pumps (60 CUM/ hr min capacity & lift 90M) – 1 No.

   Note: Concrete pump can be replaced by concrete boom placer in addition to those mentioned above in Sl. No. (4) in Clause 1.7.2.3 with due approval of Engineer In- Charge.
3) Back hoe loader like JCB – 2 Nos.
4) Dumper – 3 Nos.

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

1.7.3 Interim Payment

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

1.7.3.2 95% item rate shall be released after completion of works certification by Engineer in charge.

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

1.7.3.4 Retention amount applicable be as per GCC.

1.7.3.5 BHEL Site Engineer, at discretion, may operate the part rate of the items in line with the BHEL GCC clause 2.23.1.V

1.7.4 Royalty/ seigniorage charges

Royalty/ seigniorage charges for excavation, inside/outside the plant boundary, as applicable as per Govt of Tamilnadu for earth work shall be payable by the bidder at bidder's cost and proof of payment shall be submitted to BHEL along each RAB. The above royalty/ seigniorage charges shall be inclusive within the quoted rate. No extra payment shall be applicable to the vendor.

1.7.5 METHOD OF MEASUREMENT

Mode of measurement shall be as per relevant clauses of IS 1200 in conjunction of IS code 3385 shall beadopted. 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.

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

1.7.7 Bidder to refer General Conditions of Contract Volume IC Book II regarding PVC, ORC, Retention Amount and Sl. No. 6 of Chapter 1 of Part II of Technical Conditions of Contract (Volume-IA Book-I) for Base Date of PVC.

VOLUME-IA PART – I CHAPTER-VIII

TAXES AND DUTIES

1.8.1 Goods and Service Tax (GST) & Cess

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

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

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

BHEL GSTN : 33AAACB4146P2ZL

NAME : BHARAT HEAVY ELECTRICALS LIMITED

ADDRESS : BHEL PSSR SITE OFFICE
2X660 Udangudi Thermal Power Project
Kallamoli village, Tiruchendur Taluk,
Tuticorin District, Tamil Nadu- 628203, India

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
BILL OF QUANTITY

1.9.1 Bill of Quantities

As mentioned in the Volume II, Price bid

VOLUME-IA PART-I CHAPTER-X GENERAL

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.10.3.2 **PROVIDENT FUND**

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

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

1.10.3.3 **OTHER STATUTORY REQUIREMENTS**

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

1.10.3.3.2 The 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.

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

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

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

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

1.10.3.4 DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN

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

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

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

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

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

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

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

c) **Compensation in respect of each of the victims:**
In the event of death or permanent disability resulting from Loss of both limbs: Rs. 10,00,000/- (Rs. Ten Lakh)
In the event of other permanent disability: Rs. 7,00,000/- (Rs. Seven Lakh)

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

1.10.4 **GENERAL**

1.10.4.1 **Site Visit by the Bidder**

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

1.10.4.2 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.

1.10.4.3 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.

1.10.4.4 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.

1.10.4.5 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.

1.10.4.6 The work covered under this specification is of highly sophisticated nature, requiring the best quality workmanship, engineering and construction management. The contractor must have adequate quantity of tools, construction aids, equipments etc., in his possession. He must also have on his rolls adequate trained, qualified and experienced supervisory staff and skilled personnel.

1.10.4.7 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.

1.10.4.8 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.

1.10.4.9 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.

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

1.10.4.11 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.

1.10.4.12 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.

1.10.4.13 Wherever Construction sequences are furnished by BHEL, the contractor shall follow the same sequence. Contractor shall execute the supply and works as per sequence prescribed by BHEL at site engineer. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of execution of similar job in any other site or for any reasons whatsoever.

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

1.10.4.15 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.

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

1.10.4.17 The contractor at his cost shall arrange necessary security measures for adequate protection of his machinery, equipment, tools, materials etc. BHEL shall not be responsible for any loss or damage to the contractor's construction equipment and materials. The contractor may consult the Engineer-in-Charge on the arrangements made for general site security for protection of his machinery equipment tools etc.

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

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

1.10.4.20 The contractor must obtain the signature and permission of the security personnel of the customer / BHEL for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside. Surplus materials including steel item brought at site by the contractors with proper documentation and Gate pass, shall be allowed to taken out of the project premises after completion of relevant works, on certification by BHEL in charge.

1.10.4.21 Contractor shall remove all scrap materials periodically generated from his working area and collect the same at one place earmarked for the same. Load of scraps is to be shifted to a place earmarked by BHEL. Failure to collect the scrap is likely to lead to accidents and as such BHEL reserves the right to collect and remove the scrap at contractor's risk and cost if there is any failure on the part of contractor in this respect.

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

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

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

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

1.10.4.26 Sometimes, it may be required to re-schedule the activities to enable other agencies to commence/ continue the work so as to keep the overall project schedule.

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

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

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

1.10.4.30 It is the responsibility of the contractor to do the checking, testing etc. if necessary, repeatedly to satisfy BHEL Engineer with all the necessary tools and tackles, manpower etc. without any extra cost. The testing will be completed only when jointly certified so, by the BHEL Engineer.

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

1.10.4.32 The contractor's work shall not hinder other work, either underground or over ground, such as electrical, phone lines, water or sewage lines, etc. In areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities

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

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

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

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

1.10.4.36 RECORDS TO BE MAINTAINED AT SITE:

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

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

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

1.10.4.37 SITE INSPECTION

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

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

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

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

1.10.4.37.4 Field Quality Assurance (FQA) Formats:-

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

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

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

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

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

1.11 PROGRESS AND MONITORING OF WORK

1.11.1 Refer forms F -14 and F-15 furnished in Volume 1A, Part II, Chapters 8 & 9 as well as to forms F-16, F-17, F-18 of volume I D (Forms & Procedure) of Volume - I Book-II. Plan and review will be done as per the formats.

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

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

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

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

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

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

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

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

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

f) Availability report of cranes/T&Ps

g) Safety implementation report in the format

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

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

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

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

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

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

VOLUME-IA PART-I CHAPTER-XII
MATERIAL HANDLING

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

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

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

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

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

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

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

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

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

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

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

VOLUME-IA PART –I CHAPTER –XIII
ACCOUNTING OF MATERIALS ISSUE

1.13 ACCOUNTING OF MATERIALS ISSUE

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

1.13.1 CEMENT

1.13.1.1 ISSUE OF CEMENT

1.13.1.1.1 Cement as received from the manufacturer / stockiest will be issued **free of cost** to the contractor. The cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos cement silo of 100 MT each per 30 CUM batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement of silos and the number of cement silos shall be increased based on the site requirement. Unloading arrangements shall be provided by the bidder.

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

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

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

1.13.1.1.5 Bidder is responsible for sampling and testing of cement as per Indian

Standard / Specification / approved quality plan in the testing laboratory established by the bidder.

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

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

Sl. No.	ISSUE OF MATERIALS	MAX. QUANTITY IN CONTRACTOR'S STORE
1.	Cement	Requirement of one month

1.13.1.2 **RETURN OF CEMENT**

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

1.13.1.2.2 Cement unloaded in the silos shall be returned on weighment basis, only when the cement is unloaded in the silo 30 days before.

1.13.1.2.3 Sweep cement will not be taken back by BHEL.

1.13.1.3 **CEMENT CONSUMPTION AND WASTAGE**

The theoretical consumption of cement shall be based on the following.

i. For design mix concrete as per approved design mix.
ii. For nominal mix concrete work, as per minimum cement as specified or as approved by Engineer-in-charge. No extra payment is payable to the vendor.

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

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

1.13.1.4 **CEMENT WASTAGE**

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

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

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

1.13.2 STEEL MATERIAL

1.13.2.1 **ISSUE OF STEEL**

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

Sl. No.	Description	Basis
(a)	Structural Steel	Weighment basis (Unit – MT)
(b)	Reinforcement Steel and Earthing rod (MS round)	Weighment basis (Unit – MT)

1.13.2.1.2 All the steel (structural scrap, reinforcement, earthing MS rod,) issued by BHEL shall be properly accounted for. The total quantity of steel required for the work will be calculated from the approved Bar Bending schedule, 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

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

1.13.2.1.3 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.

1.13.2.1.4 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.

1.13.2.1.5 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.

1.13.2.1.6 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 (as specified in clause 1.2.3)	Requirement of one month

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.

1.13.2.1.7 Bidder to note that steel materials required for embedments, inserts, GI Handrail, Stainless Steel Handrail, fasteners like MS/HT/HSFG bolts/nuts, lock nuts, washers and foundation bolts other than those supplied by BHEL, shall be supplied by the bidder. However, Bidder shall use the scrap materials 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

All surplus steel and all wastage materials will be taken back on weighment basis. Surplus, unused and untampered steel shall be sorted section-wise and

returned separately to a place directed by BHEL / Engineer within the project area. Return of such materials will not be entitled to any handling and incidental charges.

All wastage / scrap (including melting scrap, wastage, unusable 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.

1.13.3.1 **SCRAP & SERVICEABLE MATERAILS:**

a) 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.
b) 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.
c) 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.
d) 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.

1.13.4 STEEL CONSUMPTION AND WASTAGE

1.13.4.1 **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.

i) Surplus = Un-tampered, unused. uncut quantity of steel and serviceable materials as stipulated under clause “Scrap and Serviceable Materials (Refer Clause 1.13.3.1 above)” returned by the contractor to BHEL store along with relevant documents.

ii) Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE:

ALLOWABLE WASTAGE: (+3%) (Three percent) 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.

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

1.13.4.2 **STRUCTURAL STEEL, (ROLLED SECTION, PLATES ETC.) CONSUMPTION & WASTAGE (as specified in Clause 1.2.3):**

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 1.13.3.1 above)” returned by the contractor to BHEL store along with relevant documents.

iii) 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.

Sl.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

1.13.4.3 **RECONCILIATION OF MATERIALS**

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

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

c) 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.

d) 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 approved by BHEL.

1.13.5 RECOVERY OF MATERIAL

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

a) If wastage exceeds the specified limit

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

c) For not returning the surplus serviceable materials

1.13.6 PENAL RATE OF MATERIALS

A	**REINFORCEMENT STEEL** Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod MS round	**Rs. 64,785/- per MT** + GST or other taxes & duties
B	**STRUCTURAL STEEL – Long Products** Rolled steel Beams, channels, and angles etc in sizes and lengths as available	**Rs. 69,347/- per MT** + GST or other taxes & duties
C	**STRUCTURAL STEEL – Flat Products** MS plates, MS flats, MS pipes, Chequered Plates, etc in sizes and lengths as available	**Rs. 81,428/- per MT** + GST or other taxes & duties
D	**CEMENT (OPC)**	**Rs. 5,907/- per MT** + GST 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.

Clause 4.2.2.9 alone is revised as below.
In construction projects of this magnitude it is possible that all the areas/ approaches may not be ready. In such cases backfilling of approaches where ever necessary, 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.

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 Rev 01) 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

EARNEST MONEY DEPOSIT

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

Void (Explanation: EARNEST MONEY DEPOSIT is not applicable for this tender).

Bid Security Declaration: Bidders to submit Bid Security Declaration as per format provided in NIT.

Sl No. 5

The following clause is added under clause 1.10 Security Deposit in General Conditions of Contract (Volume I Book II):

1.10.8 Bidder agrees to submit security deposit required for execution of the contract within the time period mentioned. In case of delay in submission of security deposit, enhanced security deposit which would include interest (Base rate of SBI + 6%) for the delayed period, shall be submitted by the bidder. Further, if security deposit is not submitted till such time the first bill becomes due, the amount of security deposit due shall be recovered as per terms defined in NIT / contract, from the bills along with due interest

Sl No.: 6

PRICE VARIATION COMPENSATION (PVC)

Clause 2.17.5 under The PRICE VARIATION COMPENSATION (PVC) clause 2.17 published in General Conditions of Contract (Volume IC Book-II) is revised as under.

"Base date shall be calendar month of the scheduled completion date (i.e. actual start date + scheduled contractual completion period as per letter of intent/ award and/or work order)".

Sl. No.: 7

Clause 2.14.1 in GCC regarding Quantity Variation in General Conditions of Contract (GCC), Volume-1C, Book- II is revised as under:

"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.: 8

Procedure 2.3 that forms the part of Forms and Procedures is published as Chapter 12 in Volume IA Part II of this booklet (Volume-I Book-I).

Sl No.: 9

The chapter Reverse auction procedure published in 'Forms and Procedures' of Volume I Book-II stands deleted. 'Guidelines for Reverse Auction-2021' available in the website http://www.bhel.com -> Supplier Registration, shall be applicable**.**

Sl No.: 10

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-10, Part-II of Volume-IA Technical Conditions of Contract.

Sl No.: 11

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.: 12

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

Sl No.: 13

Existing format for Integrity Pact, as available in Volume ID Forms and procedure stands Deleted. Refer revised format for Integrity Pact provided in Annexure – 7 of Notice Inviting Tender (NIT).

VOLUME-IA PART – II

CHAPTER 2 to 11

Chapter 2 to 11 in next 1287 pages as below

Chapter 2	Technical Specifications	1099 pages
Chapter 3	Bore log data	63 pages
Chapter 4	Tentative details (Drawings) for Coal Shed	2 pages
Chapter 5	Plot Plan	1 page
Chapter 6	T&P Hire Charges	12 pages
Chapter 7	"HSE Plan for Site Operations by Subcontractor" (Document No. HSEP: 14 Rev01)	82 pages
Chapter 8	Format for Form no.: F-14 (Rev 01); Monthly Plan and Review with Contractors	6 pages
Chapter 9	Format for Form no.: F-15 (Rev 03); Monthly Performance Evaluation of contractor	8 pages
Chapter 10	Proforma of Bank Guarantee (in lieu of Security Deposit)-Form WAM 22	3 pages
Chapter 11	Procedure 2.3-Procedure for Conduct of Conciliation Proceedings	11 pages

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION. LTD.

2x660 MW UDANGUDI T.P.P. STAGE-I
UDANGUDI, TAMIL NADU

SPECIFICATION NO. PE-TS-435-600-C001

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

Project Title	2x660 MW UDANGUDI T.P.P. STAGE-I :
Job no.	435
Document No.	PE-TS-435-600-C001
Subject	TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS FOR 2 x 660 MW UDANGUDI T.P.P. STAGE-I

Rev No.	Particulars	Prepared by	Checked by	Approved by	Remarks
	Name	Prayank	DKM	AKS	
0	Sign	-sd-	-sd-	-sd-	
	Date	07/02/2018	12/02/2018	13/02/2018	

PREAMBLE

This Document /specification has been subdivided into following sections:

Section-A: Scope of work

Section-B: Project Information

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

Section-D: This section comprises of technical specification.

Applicable scope of work and specifications to be referred as per the Vol.1A - TCC - Chapter 2. Scope of work.

Note: In case of any conflict between section–C and section-D, Section C of the specification prevails.

SECTION – D comprises of sub-sections as mentioned below:

Sub-section D1: Earthwork in excavation and backfilling

Sub-section D2: Cement concrete (Plain and reinforced) and formwork

Sub-section D3: Carpentry and joinery

Sub-section D4: Roof and underground structures water proofing, insulation and allied works

Sub-section D5: Metal doors, windows, ventilators, louvers etc.

Sub-section D6: Glass and Glazing

Sub-section D7: Rolling Steel Shutter and Grills

Sub-section D8: Miscellaneous Metal

Sub-section D9: Masonry and allied works

Sub-section D10: Finish to masonry and concrete

Sub-section D11: Painting, Whitewashing, polishing

Sub-section D12: Floor finish and allied works

Sub-section D13: Sheet work in roof and siding

Sub-section D14: Suspended ceiling

Sub-section D15: Water supply, drainage & sanitation

Sub-section D16: Road & drainage

Sub-section D17: Fabrication of structural steelwork

Sub-section D18: Erection of structural steelwork

Sub-section D19: Roof decking

Sub-section D20: False flooring

~~**Sub-section D21: Bored cast-in-situ RCC piles**~~

Sub-section D22: Site levelling & grading works

Sub-section D23: Anti-termite treatment

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION. LTD.

2x660 MW UDANGUDI T.P.P. STAGE-I
UDANGUDI, TAMIL NADU

SECTION - A

SCOPE OF WORK

SPECIFICATION NO. PE-TS-435-600-C001

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

The works covered in this section consists of collection of all site related data, conducting topographical surveying if necessary, site investigations, design, preparation of all construction drawings, supply of all materials, construction, fabrication, erection and testing where necessary, of all structures required for housing all equipment and civil works for all services required for the Power Plant defined in the specification document. The Civil works shall include those required for Installation, Commissioning, testing, operation and maintenance of the Power Plant. The scope of work includes (but not limited to) following civil, structural and architectural works in conformity with approved mechanical/ electrical layout: -

1.0 GRADING, LEVELLING, BOUNDARY WALL, ROAD AND DRAIN ETC.

(a) Topographic survey & Geotechnical Investigation work.

(b) Site Development Work & Site clearance works, Site grading, levelling (within main plant area) & dressing as required.

(c) Approach road to the main entry of the plant from State Highway

(d) Plant road network including patrol roads, approach roads to all the buildings /structures / services.

(e) Plant storm water drainage system for the entire plant.

(f) Boundary wall with fencing.

(g) Plant storm water drainage system for the entire plant up to terminal point excluding storm water diversion channel/drain.

2.0 CONSTRUCTION ENABLING WORKS

(a) Site office & Site Stores Complex

(b) Temporary Workshop and Garage

(c) Fabrication Yard

(d) Quality Control Laboratory

(e) Fuel Storage Area

(f) Staff Welfare Facilities

3.0 TURBINE AND AUXILIARIES, BOILER, WATER SYSTEM, CHEMICAL PLANT

(a) Main Power House building consisting of TG bay, Electrical bay, including its substructures with STG, Boiler Feed pumps and all other major / minor equipment foundations, service and maintenance bays.
(b) Central Control room building
(c) Mill and Bunker building with steel coal bins including sub-structures with foundations and mill foundations, mill reject handling system with mill reject silo.
(d) Foundations for Steam generator (Boiler) supporting structures and its auxiliaries along with boiler elevator foundation and interconnection to bunker building and power house building.
(e) Foundations for ESP structures and its auxiliaries along with fans, duct supports, etc. including sub-structure.
(f) ESP switchgear & Control Room building & Boiler Area Paving.
(g) Transformer yard civil works including transformer foundations, oil soak pits, burnt oil pit, cable ducts, cable trenches with covers, fire protection walls, roads, drainage, fencing, oil drainage to sump pit and oil recovery, jacking pads, transformer rail tracks (up to maintenance bay of Power House Building) along with foundation, oil test lab and Transformer Oil Filter Plant Building.
(h) Civil, structural and architectural works for Fuel Handling Area including Fuel Oil pump house.
(i) CW pump house including Cooling Water channel, CW fore bay, CW piping, CW Inlet and Outlet Conduits etc.
(j) Civil, structural and architectural works for Desalination and Water Treatment Plant.
(k) Pipe and cable racks, pipe pedestals etc.
(l) Effluent treatment plant including Guard pond.
(m) Sewage network and treatment plant.
(n) Electro Chlorination Building
(o) Miscellaneous Plant Buildings-Plant Air Compressor Building and Air Washer Room,
(p) DG building
(q) Chemical / Hazardous Store.
(r) Hydrogen Generation Building
(s) Maintenance Office Cum Stores
(t) Reinforced concrete chimney
(u) Natural draught cooling towers.

(v) Id,FD,PA & Seal Air Fans with duct supporting structures

(w) Sea water intake system and outfall system including related Bathymetric survey and land /marine geotechnical investigations.

4.0 OTHER STRUCTURES/FACILITIES/WORKS

(a) Condensate storage tank foundation.
(b) Pipe Trenches & Duct Banks
(c) Service and Potable Water Overhead Tanks
(d) Horticulture and Landscaping Works and Green Belt Development
(e) Rain Water Harvesting
(f) Plumbing & sanitary works
(g) Anti-weed treatment in Transformer yard and Switchyard.
(h) Anti-termite treatment for all buildings.
(i) Painting of all Architectural, Civil and Structural works

5.0 NON PLANT BUILDINGS/STRUCTURES

(a) Service Building

(b) Weigh Bridge and Control Room

(c) Workshop Building

(d) Canteen

(e) Gate house with parking facilities.

(f) Time office cum security office.

(g) Car & Scooter stand.

(h) Fire Station

(i) Administration Building

(j) Canteens and Dormitory.

(k) Fencing & gates wherever required

(l) Dispensary

(m) Bank Extension Counter and Post Office

(n) Permanent Store with paving & a Security building.

(o) Canteen (near Fire Station)

(p) Weigh bridge & control room

It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant are deemed to be included in the scope. All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detailed specification.

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION. LTD.

2X660 MW UDANGUDI T.P.P. STAGE-I
UDANGUDI, TAMIL NADU

SECTION - B

SITE INFORMATION

SPECIFICATION NO. PE-TS-435-600-C001

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

Site Location	2x660 MW coal based STPP at Udangudi plant site is about 12 KM from Tiruchendur railway station in Thoothukudi District, Tamil Nadu, India. The proposed site is located about 60 KM from Vaagaikulam Airport and about 650 KM south of Chennai city. The nearest sea port is Tuticorin which is about 45 KM away from the proposed site. Next big cities to site: Thoothukudi (approx.45 kms from site) Road access: East Coast Road – State high way (176)
Grade level	Finished Graded Level (FGL) shall be kept as following:- RL (+) 3.3m above M.S.L– Main plant area
Soil Condition and Ground Water Level	Type of foundation, depth, safe bearing capacity, ground water table etc., shall be as per the approved Geotechnical report.
Seismic Condition	Seismic Intensity: As per IS: 1893 Latest Zone: II Intensity : As per IS:1893-Latest
Wind Speed	Design wind speed is 39 m/sec as per IS: 875 Part III Mean Wind Speed (max): 20.6 km/h Wind direction : North, North East, North West, East
Reference Level	All elevations shall be marked with reference to Finished Ground Floor elevation of Power House building as EL (±) 0.000m which corresponds to RL (+)3.3m.
Temperature	Ambient Air Temperature Maximum dry bulb temperature: 41°C Minimum dry bulb temperature : 17°C
Rainfall	Annual rainfall (Maximum): 718.2 mm Annual Rain fall (Minimum): 384.1 mm Twenty four (24) Hour max : 138.2 mm

Tide Levels

The recorded tide levels with respect to the Chart Datum (CD) near the identified intake point are as follows:

Mean high water-Spring	CD + 0.99 m
Mean high Water-Neap	CD + 0.71 m
Mean low Water-Neap	CD + 0.55 m
Mean low water-Spring	CD + 0.29m
Mean sea level	CD + 0.64 m
Highest High Tide Level	CD+ 1.026 m
Lowest Low Tide Level	CD + 0.110 m

High Flood Level High Flood Level for site: RL 2.450 m

Relative Humidity

Mean Maximum humidity(summer) :84%

Mean Minimum Humidity (Summer): : 62%

Maximum Humidity(Monsoon): 97%

Minimum Humidity(Monsoon): 45%

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION. LTD.

2X660 MW UDANGUDI T.P.P. STAGE-I
UDANGUDI, TAMIL NADU

SECTION - C

TECHNICAL SPECIFICATIONS

SPECIFICATION NO. PE-TS-435-600-C001

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

C 0 N T E N T

TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION. LTD.

2X660 MW UDANGUDI T.P.P. STAGE-I
UDANGUDI, TAMIL NADU

SECTION – C SUB-SECTION-C1

SPECIFIC TECHNICAL REQUIREMNTS FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

Bharat Heavy Electricals Limited

Project Engineering Management
Power Sector, BHEL

CONTENTS

PART-I

GENERAL CIVIL REQUIREMENT

1. GENERAL

Two Volumes-Section C & Section D of this specification cover site survey, soil investigation, site development works, design and construction of Civil, Structural and Architectural works. The scope of works covers complete Civil, Structural and Architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the packages. This Part-I of Section-C Lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. **If there is any ambiguity and/or contradiction between Section C and Section D, the provisions / requirements laid in Section C shall prevail. In case of ambiguity between BOQ and Part C former shall prevail**.

(Contractor shall read the parts of the specification relevant to the contract and shall ignore the other parts of the specification. Relevant clauses of this section as applicable for respective package to be followed.)

2. 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:

2.1. Earthwork

a) IS-1498: Classification and identification of soils for General Engineering purposes.
b) IS-3764: Safety Code for excavation work.
c) IS-7293: Safety Code for working with construction machinery.
d) IS-4701: Code of practice for earth work on canals.
e) IS-9759: Guide lines for dewatering during construction.
f) IS-10379: Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

2.2. 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: (Part I & II) 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-457: Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
g) IS-460: Test Sieves (all parts).
h) IS-516: Methods of test for strength of concrete.
i) IS-1199: Methods of sampling and analysis of concrete.
j) IS-1566: Hard drawn steel wire fabric for concrete Reinforcement.
k) IS-1786: High strength deformed steel bars and wires for concrete Reinforcement.
l) IS-1791: General requirement for batch type concrete mixers.
m) IS-1834: Hot applied sealing compounds for joints in concrete.
n) IS-1838: Preformed fillers for expansion joints in concrete pavement and structures.

o) IS-2386: (Part I-VIII) Methods of test for aggregates for concrete (all parts).

p) IS-2438:	Specification for roller pan mixers.
q) IS-2502:	Code of practice for bending and fixing of bars for concrete Reinforcement.
r) IS-2505:	Concrete vibrators - immersion type.
s) IS-2506:	General requirements for screed board concrete vibrators.
t) IS-2722:	Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
u) IS-2750:	Steel scaffoldings.
v) IS-2751:	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
w) IS-3150:	Hexagonal wire netting for general purposes.
x) IS-3366:	Specification for pan vibrators.
y) IS-3370: (Part I-IV)	Code of practice for concrete structures for storage of liquids (all parts).
z) IS-3414:	Code of practice for design and installation of joints in buildings.
aa) IS-3558:	Code of practice for use of immersion vibrators for consolidating concrete.
bb) IS-4014: (Part I & II)	Code of practice for steel tubular scaffolding.
cc) IS-4656:	Form vibrators for concrete.
dd) IS-4925:	Concrete batching and mixing plant.
ee) IS-4948:	Welded steel wire fabrics for general use.
ff) IS-4990:	Plywood for concrete shuttering work.
gg) IS-5256:	Code of practice for sealing expansion joints in concrete lining on canals.
hh) IS-6452:	High Alumina Cement for Structural use.
ii) IS-6461:	Glossary of terms relating to cement concrete.
jj) IS-6494:	Code of practice for water proofing of underground reservoir and swimming pools.
kk) IS-6509:	Code of practice for installation of joints in concrete pavements.
ll) IS-7320:	Concrete slump test apparatus.
mm) IS-7861: (Part I & II)	Code of practice for extreme weather concreting.
nn) IS-8041:	Rapid Hardening Portland Cement.
oo) IS-8112:	High strength ordinary Portland Cement.
pp) IS-9012:	Recommended practice for shotcreting.
qq) IS-9103:	Admixtures for concrete.
rr) IS-9417:	Recommendations for welding cold worked bars for reinforced concrete construction.
ss) IS-10262:	Recommended guidelines for concrete mix design.
tt) IS-458:	Specification for precast concrete pipes.
uu) IS-3935:	Code of practice for composite construction.
vv) IS-4995:	Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials.
ww) IS-5525:	Recommendation for detailing of reinforced concrete works.
xx) IS-11384:	Code of practice for composite construction in structural steel and concrete.
yy) IS-11682:	Criteria for design of RCC staging for overhead water tanks.
zz) IS:12118:	Two parts polysulphide based sealants.
aaa) IS:12200:	Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
bbb) IS:13311:	Non-destructive testing of concrete - methods of test.
Part I -	Ultrasonic pulse velocity.
Part II -	Rebound hammer.
ccc) IS-13920:	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
ddd) SP-16:	Design codes for reinforced concrete to IS:456-1978.
eee) SP-23:	Hand book of concrete mixes.
fff) SP-24:	Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS: 456)

ggg) SP-34: Hand book on concrete reinforcement and detailing.
hhh) ACI-318: American Concrete Institute code for structural concrete.
iii) IS-280: Mild steel wire for general engineering purpose.
jjj) IS-10297: Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
kkk) IS-10505: Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
lll) IS-15658: Pre-cast concrete block for paving.

2.3. Foundations

a) IS-1080: Code of practice for Design and Construction of shallow foundations on soils (other than raft, ring and shell)
b) IS-1904: Code of practice for Design and Construction of foundations in soils: General Requirements
c) IS-2314: Steel sheet piling sections.
d) IS-2911: Code of practice for Design and Construction of Pile foundations (all parts).
e) IS-2950: Code of practice for design and construction of raft foundations.
f) IS-2974: Code of practice for design and construction of machine foundations.
g) IS-4091: Code of practice for Design and Construction of foundations for transmission line towers and poles
h) IS-6403: Code of practice for determination of Bearing capacity of Shallow foundations.
i) IS-8009: Code of practice for calculation of settlement of foundations: (all parts)
j) IS-9556: Code of practice for Design and Construction of diaphragm walls.
k) IS-11089: Code of practice for Design and Construction of ring foundation.
l) IS-12070: Code of practice for design and construction of shallow foundations on rocks.
m) IS-13301: Guidelines for vibration isolation for machine foundation.
n) ISO 10816: Criteria for assessing mechanical vibrations of machines.
o) ISO 1940: Criteria for assessing the st of balance of rotating rigid bodies.
p) DIN: EN13906-1: Helical compression spring made of round wire and rod: calculation and design of compression.
q) DIN: 2096 Helical compression spring out of round wire and rod: Quality requirements for hot formed compression spring.
r) DIN: 4024 Flexible supporting structures for machine with rotating machines.

2.4. Loading

a) IS-875: Code of practice for Structural safety of buildings - loading standards.
b) IS-1911: Schedule of unit weights of building materials.
c) IRC-6: Standard specifications & Code of practice for road bridges.

2.5.Masonry

a) IS-712: Building limes.
b) IS-1077: Common Burnt Clay Building Bricks.

c) IS-1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.
d) IS-1528: Methods of sampling and physical tests for refractory materials.

e) IS-1597: Code of practice for construction of stone masonry (all parts).
f) IS-2212: Code of practice for brickwork.
g) IS-2116: Sand for masonry mortars
h) IS-2185: Concrete masonry units. (all parts - Hollow and Solid concrete blocks).

i) IS-2250: Code of practice for preparation and use of masonry mortars.
j) IS-2572: Code of practice for construction of hollow concrete block masonry.

k) IS-2691: Burnt clay facing bricks.
l) IS-3414: Code of practice for design and installation of joints in buildings.
m) IS-3495: Methods of tests of burnt clay building bricks.
n) IS-4441: Code of practice for use of Silicate type chemical resistant mortars.
o) IS-4860: Acid Resistant Bricks.
p) IS-1905: Code of practice for structural use of unreinforced masonry.
q) IS-10440: Code of practice for construction of reinforced brick and reinforced brick concrete floors and roofs.
r) SP-20: Hand book on masonry design and construction.
s) IS-1489: Portland-pozzolana cement.
t) IS-1542: Sand for Plaster.
u) IS-12269: 53 grade ordinary Portland cement.
v) IS-12894: Specification for fly ash lime bricks.
w) IS-13757: Burnt clay fly ash building bricks.

2.6.Doors, Windows and Ventilators

a) IS-399: Classification of commercial timbers and their zonal distribution.
b) IS-883: Code of practice for design of structural timber in building.
c) IS-1003: Timber panelled 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.
r) IS-208: Door Handles.
s) IS:281: Mild steel sliding door bolts for use with padlocks.
t) IS-362: Parliament Hinges.
u) IS-419: Putty, for use on window frames.
v) IS-451: Technical supply conditions for wood screws.
w) IS-733: Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
x) IS-1285: Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
y) IS-1341: Steel butt hinges.
z) IS-1823: Floor door stoppers.
aa) IS-1868: Anodic coatings on Aluminium and its alloys.

bb) IS-2209: Mortice locks (vertical type)
cc) IS-2553: Safety glass.
dd) IS-3564: Door closers (Hydraulically regulated).
ee) IS-5187: Flush bolts.

ff) IS-5437: Figured, rolled and wired glass.
gg) IS-6315: Specification for floor springs (Hydraulically regulated) for heavy doors.

hh) IS-7196: Hold fast.
ii) IS-7452: Hot rolled steel sections for doors, windows and ventilators.
jj) IS-10019: Mild steel stays and fasteners.
kk) IS-10451: Steel sliding shutters (top hung type)
ll) IS-12823: Prelaminated particle boards.

2.7.Roof and 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 R.C. 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.

2.8.Waterproofing

a) IS-1322: Bitumen felts for waterproofing and damp proofing.
b) IS-1346: Code of practice for waterproofing of roofs with bitumen felts.
c) IS-1609: Code of practice for laying damp proof treatment using bituminous felts.
d) IS-3036: Code of practice for laying lime concrete for a waterproofed 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.
i) IS-5318: Code of practice for laying of flexible PVC sheet and tile flooring.
j) IS-8042: White Portland cement.
k) IS-13755: Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
l) IS-13801: Chequered cement concrete tiles.

2.9.Soil Engineering

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

2.10. Water Supply, Drainage and Sewerage

a) IS-404: Lead pipes
b) IS-458: Concrete pipes
c) IS-651: Salt glazed stoneware pipes and fittings.

d) IS-771: Glazed fire-clay sanitary appliances (all parts).
e) IS-774: Flushing cisterns for water closets and urinals other than plastic cisterns.

f) IS-783:	Code of practice for laying of concrete pipes.
g) IS-1172:	Code of basic requirements for water supply, drainage and sanitation.
h) IS-1626:	Asbestos cement building pipes, gutters and fittings (all parts).
i) IS-1742:	Code of practice for building drainage.
j) IS-2064:	Code of practice for selection, installation and maintenance of sanitary appliances.
k) IS-2065:	Code of practice for water supply in buildings.
l) IS-2470:	Code of practice for installation of septic tanks (all parts).
m) IS-3114:	Code of practice for laying of Cast Iron pipes.
n) IS-4127:	Code of practice for laying of glazed stoneware pipes.
o) IS-12251:	Code of practice for Drainage of Building Basement.
p) IS-1200:	Method of measurement: Laying of water and [Part- XVI] sewer lines including appurtenant items.
q) IS-1536:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r) IS-1537:	Vertically cast iron pressure pipe for water, gas and sewage.
s) IS-3486:	Cast iron spigot and socket drain pipes.
t) IS-5329:	Code of practice for sanitary pipe work above ground for buildings.
u) IS-3076:	Low density polyethylene pipes for potable water supplies.
v) IS-1538:	Cast iron fittings for pressure pipes for water, gas and sewage.
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:	Prestressed 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 enamelled cast iron sanitary appliances.
dd) IS-775:	Cast iron brackets and supports for wash basins and sinks.
ee) IS-777:	Glazed earthenware wall tiles.
ff) IS-2548:	Plastic water closet seats and covers (all parts).
gg) IS-2527:	Code of practice for fixing rainwater gutters and downpipes for roof drainage.
hh) IS-554:	Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
ii) IS-778:	Copper alloy gate, globe and check valves for water works purposes.
jj) IS-781:	Cast copper alloy screw down bib taps & stop valves for water services.
kk) IS-782:	Caulking lead.
ll) IS-1703:	Copper alloy float valve for water supply fitting.
mm) IS-2326:	Automatic flushing cisterns for urinals.
nn) IS-2556:	Vitreous sanitary appliances (vitreous china).
oo) IS-3311:	Waste plug and its accessories for sinks and wash basins.
pp) IS-3438:	Silvered glass mirrors for general purposes.
qq) IS-3589:	Steel pipe for water and sewage (168.3 to 2540mm outside diameter)
rr) IS-3989:	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
ss) IS-4111: (Part I to V)	Code of practice for ancillary structure in sewerage system.
tt) IS-4733:	Methods of sampling and testing sewage effluents.
uu) IS-4764:	Tolerance limits for sewage effluents discharged into inland surface waters.
vv) IS-1068:	Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
ww) IS-5382:	Rubber sealing rings for gas mains, water mains and sewer

xx) IS-5822: Code of practice for laying of electrically welded steel pipes for water supply.
yy) IS-7740: Code of practice for construction and maintenance of road gullies.
zz) IS-8931: Copper alloy fancy single taps combination tap assembly and stop valves for water services.
aaa) IS-9762: Polyethylene floats for float valves.
bbb) IS-10592: Industrial emergency showers, eye and face fountains and combination units.
ccc) IS-12592: Specification for precast concrete manhole covers and frames.
ddd) IS-12701: Rotational moulded polyethylene water storage tanks.
eee) IS-13983: Stainless steel sinks for domestic purposes.
fff) SP-35: Hand book on water supply and drainage with special emphasis on plumbing.

2.11. Paving and 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: Practice followed by Indian Road Congress (all parts).

2.12. 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.

~~2.13. Chimney~~

~~a) IS-4998: Criteria for Design of R.C. Chimneys (all parts).~~
~~b) IS-6533: Code of practice for design and construction of steel chimneys~~
~~c) ACI-307: Specification for the design and construction of reinforced concrete chimneys~~
~~d) BS-4076: Specification for steel chimneys~~
~~e) CICIND: Model Code for concrete chimneys / Model code for steel chimneys~~

~~2.14. Cooling Tower~~

~~a) BS-4485: Structural design of cooling towers.~~
(Part 4)

2.15. Structural Steelwork

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 (All Parts).
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 of symbols for welding.
f) IS-814: Covered electrodes for manual metal arc welding of 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 ironwork.
p) IS-1239: Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q) IS-1363: Black hexagonal bolts, nuts and locknuts (Dia. 6 to 39 mm) and black hexagon screws (Dia.6 to 24 mm). [all parts]
r) IS-1364: Precision and semi-precision hexagon bolts, screws, nuts and locknuts (Dia. range 6 to 39 mm). [all parts]
s) IS-1365: Slotted counter sunk head screws (Dia. range 1.6 to 20 mm).
t) IS-1367: Technical supply conditions for threaded steel fasteners. (Part 1 to 18)
u) IS-1443: Code of practice for laying and finishing of cement concrete flooring tiles.
v) IS-1608: Method for 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 tests for wire-flux combinations for submerged-arc welding of structural steels.
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 sub-merged arc welding of structural steels.
mm) IS-7318: (Part-I) Approval test for welders when welding procedure approval is not required.

nn) IS-8500: Structural steel - micro alloyed (medium and high strength qualities).
oo) IS-9595: Recommendation for metal arc welding of carbon and carbon manganese steels.
pp) AWS D.1.1 Structural Welding Code.
qq) IS-8640: Recommendations for dimensional parameters for industrial building.
rr) IS-9178: Criteria for design of steel bins for storage of bulk material (all parts).
ss) IS-12843: Tolerances for erection of steel structures.

tt) IS-1181: Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).
uu) IS-2595: Code of practice for Radiographic testing
vv) IS-2629: Hot dip galvanising of iron and steel
ww) IS-3502: Steel chequered plate.

xx) IS-3658: Code of practice for liquid penetrant flaw detection.

yy) IS-4353: Sub merged arc welding of mild steel and low alloy steel Recommendation.

zz) IS-5369: General requirements for plain washers and lock washer.
aaa) IS-6623: High strength structural nuts.
bbb) IS-6649: Hardened and tampered washers for high strength structural bolts & nuts.

ccc) IS-6911: Stainless steel plate, sheet and strip.
ddd) IS-7205: Safety code for erection of structural steel.
eee) IS-7307: Approved test for welding procedures
(Part I) Fusion welding of Steel
fff) IS-7310: Approval test for welders working to approval welding procedure.
(Part I) Fusion welding of Steel
ggg) SP-6: IS Handbook for structural engineers.

2.16. 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: Code of practice for painting of ferrous metal in buildings.
(Part I & II)
e) IS-2338: Code of practice for finishing of wood and wood based materials.
(Part I & II)
f) IS-2339: Specification for Aluminium Paints for general purposes in dual containers.
g) IS-2395: Code of practice for painting concrete, masonry and plaster surface.
h) IS-2932: Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.
i) IS-2933: Specification for enamel, exterior - a) undercoating, b) finishing.
j) IS-5410: Specification for cement paint.
k) IS-162: Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
l) IS-1650: Specification for colours for building and decorative materials.
m) IS-2395: Code of practice for painting concrete, masonry and plaster surfaces.
(Part I) Operations and Workmanship.
(Part II) Schedule.
n) IS-2524: Code of practice for painting of nonferrous metals in buildings.
(Part I) Pre-treatment.
(Part II) Painting.
o) IS-15489: Plastic emulsion paint.
p) IS-6278: Code of practice for white washing and Colour washing.
q) IS-10403: Glossary of term related to building finish.

r) IS-12027: Silicone based water repellent.
s) IS-13238: Epoxy based zinc phosphate primer (2 pack).
t) IS-13239: Epoxy surface (2 pack).
u) IS-13467: Chlorinated rubber for paints
v) IS-14209: Epoxy enamel, two component glossy.
w) BS-5493: Code of practice for protective coating of iron and steel structures against corrosion.

2.17. Sheeting

a) IS-277: Galvanised steel sheets (Plan & corrugated).
b) IS-513: Cold-rolled low carbon steel sheets & strips.
c) IS-730: Hook bolts for corrugated sheet roofing.
d) IS-801: Code of practice for use of cold formed light gauge steel structural members in

general building construction.

e) IS-7178: Technical supply condition for tapping screw.

f) IS-8183: Bonded mineral wool.
g) IS-8869: Washers for corrugated sheet roofing.
h) IS-12093: Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanized steel sheets.
i) IS-12436: Preformed rigid Polyurethane (PUR) and Polyisocyanurate (PIR) foams for thermal insulation.
j) IS-12866: Plastic translucent sheets made from thermosetting polyester resin (glass fiber reinforced).
k) IS-14246: Continuously pre-painted galvanized steel sheets and coils.
l) BS-5950: (Part VI) Code of practice for design of light gauge profiled steel sheeting

2.18. Plastering

a) IS-1661: Code of practice for application of cement and cement lime plaster finishes.
b) IS-2402: Code of practice for external rendered finishes.
c) IS-2547: Gypsum building plaster.

2.19. Acid / Alkali Resistant Tiling

a) IS-158: Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
b) IS-412: Expanded metal steel sheets for general purpose.
c) IS-4443: Code of practice for use of resin type chemical resistant mortars.
d) IS-4456: (Part I & II) Method of Test for chemical resistant tiles.
e) IS-4457: Ceramic unglazed vitreous acid resisting tiles.
f) IS-4832: Specification for chemical resistant mortars.
(Part I) Silicon Type
(Part II) Resin Type
(Part III) Sulphur Type
g) IS-9510: Bitumastic acid resisting grade.

2.20. Safety

a) IS-1641: Code of practice for fire safety of buildings - General principles of fire grading and classification.
b) IS-1642: Code of practice for fire safety of buildings - Details of construction.
c) IS-3696: (Part I & II) Safety code for scaffolds and ladders.
d) IS-4081: Safety code for blasting and related drilling operations.
e) IS-4130: Demolition of buildings - code of safety.

f) IS-5121: Safety code for piling and other deep foundations.

g) IS-5916: Safety code for construction involving use of hot bituminous materials.
h) IS-7205: Safety code for erection of structural steel work.
i) IS-7969: Safety code for handling and storage of building materials.

2.21. Architectural Design of Buildings

a) SP-7: National Building Code of India.
b) SP-41: Hand book on functional requirements of buildings (other than industrial buildings).

2.22. Other

a) Indian Road Congress (IRC) Bridge Codes
b) Indian Railway Standard Bridge Rules

3. GENERAL

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

4. LAYOUT

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. **If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall coordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks.** If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and bench
mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the opinion of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderer’s shall take into account the cost of these in quoting their price.

5. WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye laws

of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or

licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

6. TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

7. INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

8. SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all important items of work.

9. CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanized from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, porcelains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All handling of materials shall be with cranes.

Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydraulically controlled grouting equipment.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed.

Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

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SECTION - C

SUB-SECTION – C2

SPECIFIC TECHNICAL REQUIREMENTS

SPECIFICATION NO. PE-TS-435-600-C001

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

C 0 N T E N T

Civil Structural & Architectural Work

The Scope will cover but not limited to Architectural, Civil and Structural works of the following buildings / structure / systems / facilities.

1. ~~Topographic survey~~
2. ~~Geotechnical Investigation~~
3. Site Development Work
    - Site clearance works
    - Site grading
    - Fencing
    - Approach road to the main entry of the plant from State Highway
    - Plant road network including patrol roads, approach roads to all the buildings / structures / services.
    - Plant storm water drainage system for the entire plant, sump, pump houses, drainage channels, drainage pump house, etc.
    - Boundary walls
    - Security Gate Complex
    - Watch Towers
    - Storm Water Diversion Channels
4. Construction Enabling Works
    - Site office
    - Site Store Complex
    - Temporary Workshop and Garage
    - Fabrication Yard
    - Quality Control Laboratory
    - Fuel Storage Area
    - Staff Welfare Facilities
5. ~~Main Power House building consisting of TG bay, Electrical bay, including its substructures with STG, Boiler Feed pumps and all other major / minor equipment foundations, service and maintenance bays.~~
6. ~~Central Control room building~~
7. ~~Mill and Bunker building with steel coal bins including sub-structures with foundations and mill foundations, mill reject handling system with mill reject silo.~~
8. ~~Foundations for Steam generator (Boiler) supporting structures and its auxiliaries along with boiler elevator foundation and interconnection to bunker building and power house building.~~
9. ~~Foundations for ESP structures and its auxiliaries along with fans, duct supports, etc., including sub-structure.~~
10. ~~ESP switchgear & Control Room building~~
11. ~~Boiler Area Paving~~
12. ~~Transformer yard civil works including transformer foundations, reactor foundation, oil soak pits, burnt oil pit/oil separating pits, cable ducts, cable trenches with covers, fire protection walls, roads, drainage, fencing, oil drainage to sump pit and oil recovery, jacking pads, transformer rail tracks (upto maintenance bay of Power House Building) along with foundation, oil test lab and Transformer Oil Filter Plant Building, etc.~~
13. ~~Switchyard comprising of indoor Gas Insulated Switchgear (GIS) building, Switchyard control building and outdoor equipment such as towers, gantries, lighting poles,~~

lightning masts, equipment support etc. cable trenches, fencing, internal roads, drains, etc.

14. Civil, structural and architectural works for Coal handling systems.
15. Civil, structural and architectural works for Ash handling systems
16. Civil, structural and architectural works for Fuel handling Area including Fuel Oil pump house
17. Cooling Water channel, CW fore bay, CW piping etc.
18. CW pump house
19. Chemical House and Chlorination Building
20. CW Inlet and Outlet Conduits
21. Civil, structural and architectural works for Desalination and Water Treatment Plant
22. Pipe and cable racks, pipe pedestals etc.
23. Effluent treatment plant
24. Sewage network and treatment plant.
25. Miscellaneous Plant Buildings
    - Plant Air Compressor Building and Air Washer Room
    - DG House
    - Chemical / Hazardous Store
    - Hydrogen Generation Building
    - Maintenance Office Cum Stores
26. Non-Plant Buildings
    - Service Building
    - Weigh Bridge and Control Room
    - Workshop
    - Fire Station
    - Administration Building
    - Canteens and Dormitory
    - Dispensary
    - Parking
    - Bank Extension Counter and Post Office
27. Other Structures and Facilities
    - Condensate storage tank foundation
    - Pipe Trenches & Duct Banks
    - Service Water Overhead Tank
    - Horticulture and Landscaping Works and Green Belt Development
    - Rain Water Harvesting
28. Sea water intake system and outfall system including related Bathymetric survey and land / marine geotechnical investigations
29. Reinforced concrete chimney
30. Natural draught cooling towers.
31. Ash pond
32. Paving

Any other buildings, structures and works necessary and not specifically mentioned here but required for construction, operation and maintenance of the power plant for system engineering conforming to other sections of this tender document are deemed to be included in the scope of the Contractor.

2.4.0 Civil

Sl.No.	Description	Terminal Point	Remarks
1.0	**Storm water drains**		
a	Storm water drains -final discharge	Complete storm water drain system will be in the scope of EPC package.	
b	Drains from Owner's non-plant buildings (those which are not in EPC contractor scope)	At 1 m distance from each Non Plant building (those which are not in EPC contractor scope) terminating at the garland drain around the building. Interconnection to main storm water network is in EPC scope.	
2.0	**Approach Roads**		
	Plant Approach Roads	Upto State Highway	
3.0	**Construction Water**		
a	Construction Water	Shall be arranged by EPC Contractor	

Note: In this specification if there is any contradiction between two or more clauses in stating a requirement, then the Bidder shall bring out to notice such contradictions and get it cleared during the bidding stage itself. If contractor brings to notice of the same in later stage after the award of contract then the final decision about that requirement shall lie with the Owner which the contractor shall comply.

4.0.0 PROVISIONS BY THE OWNER

Following are the provisions / supplies by the Owner:

- Land within the property line limits as indicated in the plot plan.
- TANGEDCO will provide power supply for construction power at one location near boundary, on chargeable basis at commercial tariff rate. HT tariff VI commercial as per TNERC norms will be leived as per the usage. Further caution deposit and statutory levis as per TNERC / TANGEDCO will be applicable. The power at 33 kV level shall be terminated at pole. The contractor shall receive the same and establish 33 kV Construction Power Substation and distribute 33 kV supply to various distribution substations in the plant and further step down to 415 V supply to provide construction power for various locations. The Owner may not be able to guarantee on the reliability of the power supply and it is the responsibility of the contractor to make alternative arrangement during not availability of power supply. The Owner shall not be responsible for the delay in the project execution due to non-availability of power supply. Required number of Diesel generators shall be arranged & utilized by the contractor for the construction power requirement, if the Owner's power supply is temporarily unavailable.
- Contractor shall arrange construction water.
- 400 kV Transmission lines
- Any requirements of LDC to be provided at 400kV receiving end substations (outside power project)
- All utilities/services up to the limits of supply and conditions of supply as specified in above section.
- Captive Jetty and its related facilities for receiving coal
- External Coal Handling System up to Junction tower-1. Complete Junction tower-1 is in Owner's scope except of the equipments/requirements mentioned in the specification.
- Township / Colony

Tamil Nadu Generation and Distribution Corporation Ltd.

2 X 660 MW Udangudi Supercritical Thermal Power Project – Stage - 1

TENDER ENQUIRY DOCUMENT
FOR
EPC CONTRACT

[BID Specification No. SE/C/UP/EE/E/OT No. 01/2015-16]

VOLUME - II

SECTION – 5

DETAILED TECHNICAL SPECIFICATION -
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

FICHTNER Consulting Engineers (India) Private Limited
Chennai, India

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VOLUME – II

SECTION – 5

DETAILED TECHNICAL SPECIFICATION – CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

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SECTION 5.1

GENERAL

TABLE OF CONTENTS

5.1.1 GENERAL

This specification covers design, preparation of general arrangement, construction fabrication drawings and supply of all labours, materials and construction of all civil, structural and architectural works complete.

On ENGINEERING PROCUREMENT CONSTRUCTION (EPC) basis for all buildings and structures described in the specification as mentioned in Mechanical, Electrical, instrumentation, ventilation etc all complete as per scope of work.

The Civil, Architectural and Structural Steel work to be performed under this contract consists of design, engineering and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, 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 including revisions and amendments thereto as may be required during the execution of work.

The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the Civil Works.

The work shall be carried out according to the design / drawings (Architectural, Civil and Structural) to be developed by the Contractor and approved by the Owner / Owner's Engineer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Contractor keeping in view the statutory and functional requirements and providing enough space and access for operation, use and 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 and facilities and providing enough space and access for operation and maintenance as per the best prevailing practices and to the complete satisfaction of the Owner.

All works shall conform to Indian Standards and Codes and all local and state regulations. Where requirements are at variance, the more stringent of them shall govern.

All equipments and materials including cement, reinforcement steel, structural steel etc. shall be arranged / procured by the Contractor.

The Contractor's work shall cover complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Owner / Owner's Engineer.

The Contractor shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Govt. dept. as per the directions of the Owner / Owner's Engineer. The Contractor shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Owner / Owner's Engineer for general checking of the correctness of the civil works.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to.

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

In case of any conflict between stipulations in various provisions of the specification, the most stringent stipulation would be applicable for implementation by the Contractor without any extra cost or time to the Owner.

Contractor shall obtain approval of Civil / Architectural drawings from concerned authorities before taking up the construction work.

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 and other statutory requirements unless stipulated otherwise in detail specification.

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

Contractor shall rectify defects for all civil works for a period of five years from the date of handing over of the entire plant.

5.1.2 SCOPE OF WORKS

The Scope will cover but not limited to Architectural, Civil and Structural works of the following buildings / structure / systems / facilities.

1. ~~Topographic survey~~
2. ~~Geotechnical Investigation~~
3. Site Development Work
   - Site clearance works
   - Site grading
   - Fencing and Gates
   - Approach road to the main entry of the plant from State Highway
   - Plant road network including patrol roads, approach roads to all the buildings / structures / services.
   - Plant storm water drainage system for the entire plant, sump, pump houses, drainage channels, drainage pump house, etc.
   - Boundary walls
   - Security Gate Complex
   - Watch Towers
   - Storm Water Diversion Channels
4. Construction Enabling Works
   - Site office
   - Site Store Complex
   - Temporary Workshop and Garage
   - Fabrication Yard
   - Quality Control Laboratory
   - Fuel Storage Area
   - Staff Welfare Facilities

5. Main Power House building consisting of TG bay, Electrical bay, including its substructures with STG, Boiler Feed pumps and all other major / minor equipment foundations, service and maintenance bays.
6. Central Control room building
7. Mill and Bunker building with steel coal bins including sub-structures with foundations and mill foundations, mill reject handling system with mill reject silo.
8. Foundations for Steam generator (Boiler) supporting structures and its auxiliaries along with boiler elevator foundation and interconnection to bunker building and power house building.
9. Foundations for ESP structures and its auxiliaries along with fans, duct supports, etc., including sub-structure.
10. ESP switchgear & Control Room building
11. Boiler Area Paving
12. Transformer yard civil works including transformer foundations, oil soak pits, Burnt oil pit, cable ducts, cable trenches with covers, fire protection walls, roads, drainage, fencing, oil drainage to sump pit and oil recovery, jacking pads, transformer rail tracks (upto maintenance bay of Power House Building) along with foundation, oil test lab and Transformer Oil Filter Plant Building, etc.
13. Switchyard comprising of indoor Gas Insulated Switchgear (GIS) building, Switchyard control building and structures and foundations for outdoor equipments such as towers, gantries, lighting poles, lightning masts, CT, CVT, Lightning arrestors, equipment support etc. cable trenches, fencing, internal roads, drains, etc.
14. Civil, structural and architectural works for Coal handling systems.
15. Civil, structural and architectural works for Ash handling systems
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    - Plant Air Compressor Building and Air Washer Room
    - DG House
    - Chemical / Hazardous Store

- ~~Hydrogen Generation Building~~
- ~~Maintenance Office Cum Stores~~

26. ~~Non-Plant Buildings~~
    - ~~Service Building~~
    - ~~Weigh Bridge and Control Room~~
    - ~~Workshop and Permanent Store~~
    - ~~Fire Station~~
    - ~~Administration Building~~
    - ~~Canteens and Dormitory~~
    - ~~Dispensary~~
    - ~~Parking~~
    - ~~Bank Extension Counter and Post Office~~
27. ~~Other Structures and Facilities~~
    - ~~Condensate storage tank foundation~~
    - ~~Pipe Trenches & Duct Banks~~
    - ~~Service and Potable Water Overhead Tanks~~
    - ~~Horticulture and Landscaping Works and Green Belt Development~~
    - Rain Water Harvesting
28. ~~Sea water intake system and outfall system including related Bathymetric survey and land / marine geotechnical investigations~~
29. ~~Reinforced concrete chimney~~
30. ~~Natural draught cooling towers.~~
31. ~~Ash pond~~
32. Paving

Any other buildings, structures and works necessary and not specifically mentioned here but required for construction, operation and maintenance of the power plant for system engineering conforming to other sections of this tender document are deemed to be included in the scope of the Contractor.

The work also includes :

- Design and preparation of working drawings (Architectural, Civil and Structural), fabrication drawings, excavation drawings, shuttering drawings, bar bending schedule drawing and construction of all structures.

- Preparation of as built drawings of all structures and facilities to reflect as built status of construction AutoCAD latest version in CD / DVD and hard copies

- Plumbing & sanitary works

- Painting of all Architectural, Civil and Structural works

- Anti weed treatment in Transformer yard and Switchyard.

- Anti termite treatment for all buildings.

- Handing over of complete plant facilities to the satisfaction of Owner.

- All temporary roads and approach roads inside the graded plant area necessary for construction purpose and for conveying main plant equipments with adequate parking area for heavy vehicles and all permanent roads for the power plant to be constructed including formation over the graded site. The road gradient shall not be steeper than 1 in 33 at any location with necessary culverts.

- Fixing of inserts, bolts and other embedments specifically for equipment foundations, tanks, structures, etc as required.

- Fabrication and installation of full plant model in a suitable scale such that it can be accommodated in the model room of Administration Building.

- All statutory clearances / NOC required for implementation of the project from various departments/agencies like PWD, Highways, local bodies etc, shall be obtained by the Contractor.

- The Contractor shall fill or excavate or blast the areas to the required formation levels as indicated in the plot plan and dispose the excavated materials as directed by the Owner.

General Requirements

All buildings / structures / areas shall be provided the following as applicable.

Plastering, painting, plumbing, sanitation, water supply, electrification, lighting, air conditioning, fire fighting, anti termite treatment, plinth protection, damp proof course, garland drains, septic tanks, rain water harvesting, furniture, doors, windows, rolling shutters, ventilators, approach roads, colour and white washing, sunshades, false ceiling, false flooring, flooring, under deck insulation, water proofing, roof treatment, rain water down take pipes, stair case, lift, cranes and monorails, porch, potable water tanks, fans, etc.

5.1.3 TOPOGRAPHICAL SURVEY

The Owner has carried out a preliminary survey of the area and drawings indicating the survey detail are enclosed. This should be treated as for reference only. It is the responsibility of the Bidder to verify the various features on his own before submission of bid. The Owner does not take any responsibility for correctness of various features / contour shown on the drawing.

It is the responsibility of the successful Bidder to carryout detail topographical survey of the proposed power plant area. The Contractor is not eligible for any extra cost or any extension of time if the results from his detailed survey and actual conditions at site are at variance to any extent.

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 of 0.25 meter intervals.

A specialized firm approved by the Owner shall carry out the site survey. Before commencing the works, approval for sub vendor may be obtained from Owner.

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 400mm 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 proposed numbers, locations, co-ordinates, and levels of the reference points and bench marks shall be plotted on drawings and approved by the Owner 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.

Safeguard of Survey Points

The survey points shall not be removed from their position without the permission of the Owner. 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.

Surveying During The Progress of Work

The Contractor shall assist the Owner's Consultant at any time when checking survey points, setting out, checking construction items and erection parts. The Contractor shall provide and arrange the following:

- Provision and maintenance of survey instruments and accessories
- Provision of skilled personnel
- Supply of all material required for the survey
- Exposing covered survey points
- Shifting of any machinery used for construction out of the sight lines
- Stopping all drilling, blasting, driving, and any other works causing soil vibrations and stopping during instrument observations
- Removing all obstructive accumulation of water
- Taking all necessary safety precautions
- Furnishing any marking material requested by the Owner in connection with control surveys
- Providing additional survey points.

5.1.4 SITE LEVELING

The formed levels of the site are available as a separate Annexure to this specification for information and guidance purpose. Necessary additional filling shall be carried out by the Contractor to raise the level to FGL as indicated elsewhere in this specification.

The site is already graded by Owner up to the levels indicated in the Topographical survey drawing within the respective blocks and balance area is ungraded. Balance leveling inside these blocks and in ungraded areas are to be done by the Contractor

5.1.5 GEOTECHNICAL INVESTIGATION

5.1.5.1 Preliminary Geotechnical Investigation

Owner has carried out preliminary geotechnical Investigation in the proposed power plant area. The preliminary soil investigation report made by Owner is enclosed with the specification. The correct assessment and understanding of the existing sub-soil condition is to be done by the Contractor.

Based on the borehole data, it is observed that the site predominantly consists of silty clay with lime at top from 0 to 3m followed by silty clay with limestone of 1.5m thick. Calcarieous sand stone layer exists from 4.5m to 18.5m.

5.1.5.2 Final Geotechnical Investigation

Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit. The Contractor has to carryout detailed geo technical investigation at no extra cost to the Owner after the award of contract, through some approved/reputed agency and submit geotechnical investigation report with recommendations for Owner's review and approval. The recommendation given in approved final report becomes binding on the Contractor. Before commencing the works, approval for sub vendor shall be obtained from Owner.

The Contractor is not eligible to increase his cost or demand any extension of time if the final report is in variance from preliminary report furnished by Owner. Owner is not responsible for any variation of result between preliminary soil investigation report furnished to bidders and final soil investigation to be carried out by the bidder.

The Contractor shall carry out geotechnical investigation to obtain sufficient information on the sub-soil conditions for the detailed design of foundations and structures under this Contract.

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. The Contractor shall obtain approval for the field and laboratory testing scheme proposed by him from the Owner before commencement of geotechnical investigation works. 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. The investigation shall cover sufficient numbers of bore holes in each area to get the longitudinal of the soil profile as required. If required, additional investigations shall be carried out during work progress at the Contractor's expense in order to obtain additional information.

5.1.5.2.1 Standards

Unless otherwise specified, the following standards shall apply to the works covered by this chapter.

IS:1498 Classification and identification of soils for general engineering purposes.

IS:1888 Method of load tests on soils.

IS:1892 Code of practice for sub-surface investigation for foundations.

IS:2131 Method of Standard penetration test for soils.

IS:2132 Code of practice for thin-walled tube sampling of soils.

IS:2720 Methods of test for soils (All Parts).

IS:2809 Glossary of terms and symbols relating to soil engineering.

IS:2810 Glossary of terms and symbols relating to soil dynamics.

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:4968 Method of sub-surface sounding for soils (All Parts)

IS:5249 Method of test for determination of dynamic properties of soils

IS:5529 Code of practice for in-situ permeability tests (All Parts)

IS:9214 Method of determination of modulus of subgrade reaction (K-value) of soils in field

IS:10060 Code of practice for subsurface investigation for power house sites

ASTM D 4428 Cross bore shear wave test

5.1.5.2.2 In-situ Testing

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.

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.

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

The diameter of boreholes shall be minimum 150mm in soil and 76 mm in rock.

5.1.5.2.3 Borings in Soil

Drilling and sampling shall be performed in accordance with IS Standards. Disturbed samples shall be taken in all materials at 1 meter intervals and at changes of strata and shall be contained in airtight containers. Undisturbed samples shall be taken in cohesive material or weak cemented granular material where possible at 1 meter intervals and at changes of strata. Samples shall be sealed so that no changes in water content or soil structure occur. Cores of cemented material shall be packed in core boxes immediately on removal from the core barrel.

5.1.5.2.4 Rock Drilling

During boring operation, once the rock strata is encountered, drilling operation shall be resorted to for determining depth and nature of rock strata.

Rotary core drilling technique with continuous core recovery using double tube core barrel with diamond bit attachment should be adopted for drilling through rock. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each borehole the Contractor shall record the rate of sinking of drill rods, ground water table elevations if any, nature, type and sequence of rock drilled. The recovered rock cores shall be properly indexed & stored as per stipulations of IS:4078. From the recovered cores, the Contractor shall determine nature of fractures and degree of weathering of the rock for each borehole. The Contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each borehole. The Contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stage of core advance and for all the boreholes.

The drilling operation shall be terminated either 3 metres in hard rock or 95% of core recovery whichever is later.

5.1.5.2.5 Field tests

Field tests but not limited to the following shall be conducted as per relevant standards:

- 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
- Earth Resistivity Tests
- Pressure meter tests
- Percolation test
- Block vibration tests
- CBR tests
- Seismic refraction tests

5.1.5.2.6 Standard Penetration Test (S.P.T.)

The standard penetration test shall be performed in all boreholes at 1.5 meter intervals and at change of soil strata. The blow count shall be recorded. If the blow count exceeds 75 or if the penetration is less than 25mm per 50 blows, the test shall be stopped. The standard penetration test shall comply with IS: 2131. Eeven 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.

5.1.5.2.7 Shallow Trial Pits

Trial pits shall be carried out to a depth of 3 meters minimum below ground level and plan area of 10 square meters to examine the in-situ condition of the upper soil strata. After logging, sampling and testing the trial pits shall be backfilled and compacted.

5.1.5.2.8 Laboratory tests

The laboratory tests shall be conducted on soil, rock & water samples collected during field investigations in sufficient numbers as approved by Owner, but shall not be limited to the following. The laboratory tests shall be carried as per relevant standards.

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for

- Grain Size Analysis
- Hydrometer Analysis
- Atterberg Limits (Liquid limit, plastic limit, plasticity index, shrinkage limit, shrinkage ratio).
- Triaxial Shear Tests (UU, CU and CD)
- Natural Moisture Content
- Specific Gravity, Bulk and Dry Unit Weight, Water Content, Soil classification, relative density.
- Consolidation Tests
- Unconfined Compression Test
- Free Swell Index
- Swell Pressure Test
- Chemical Analysis test on soil and water samples to determine the carbonates, Sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.
- Modified proctor density
- Relative density
- CBR Test
- Permeability test

Laboratory tests on rock samples shall be carried out for

- Hardness
- Specific Gravity
- Unit Weight
- Uni-axial Compressive Strength (in-situ & saturated)
- Water absorption test.

On completion of all field and laboratory work, the Contractor shall submit a Geotechnical investigation report for Owner / Owner's Engineer approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field and laboratory observations/ data/ records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all areas of work. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Generally, the geotechnical investigation report shall include, but not be limited to, the following:

a) Plot plan showing the locations and reduced levels of all field tests.

b) Geological information of the area.

c) A true cross section of all individual boreholes and trial pits with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, results of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with.

d) A set of longitudinal and transverse soil/ rock profiles connecting various boreholes.

e) Detailed bore log Plots of Standard Penetration Tests with depths, ground water level, classification, SPT blow count.

f) Results of all laboratory tests summarised (i) for each Borehole along with (ii) a consolidated table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores and trial pits shall be furnished.

g) For pressure meter tests, the following shall be furnished

- Field pressure meter, creep air calibration curves indicating Po, Pf and Pl. Corrected pressure meter and creep curves indicating Po, Pf, Pl. along with sample calculation for the corrections.
- Pressure meter modulus, shear modulus and coefficient of sub grade reaction along with sample calculation.

h) All field test results.

i) All laboratory test results.

j) Earth resistivity of subsoil based on electrical resistance tests including electrode spacing Vs cumulative resistivity curve.

k) Suitability of the sub soil for construction of roads / embankments and their stable slopes for embankment and shallow and deep excavations, values of earth pressures coefficient for active / passive / at rest conditions and modulus of elasticity as a function of depth for the design of underground structures.

l) Suitability of locally available soils at site for filling and back filling purposes.

m) If expansive soil is met with, any special treatment, viz. Soil replacement/lime treatment, etc., required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished.

n) Protective measures based on chemical nature of soil and ground water with due regard to potential deleterious effects on concrete, steel and other building materials, etc. Remedial measures for sulphate attack, chloride attack and acidity shall be dealt in detail. Susceptibility of soil to termite action and remedial measures for the same.

o) Identification of any other potential geotechnical problems & their remedial measures.

p) Description of measures required for erosion control.

q) Identification of corrective measures required for the improvement of sub-surface conditions such as removal of poor sub soil / material, in-situ densification. If ground improvement is recommended then its detailed specifications, specification for materials to be used, construction method, equipments to be deployed etc. shall be furnished.

r) Recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total / differential settlement permissible for structures and equipments, minimum depth and width of foundation. Recommended dynamic properties of soil, modulus of subgrade reaction.

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

t) If Pile Foundations are necessary, type of piles recommended with reasons for the same, length, diameter, allowable capacity (lateral, pullout and vertical) of individual and groups of piles, negative skin friction if any and magnitude of estimated negative skin friction, structural design etc.

u) 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.

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

Geotechnical investigation work shall be got executed by the Contractor through reputed agency after approval of by the Owner / Owner's Engineer:

The detailed Geotechnical Investigation report, Foundation system, founding level to be adopted including the allowable bearing capacities, measures to be adopted as mentioned in the specification shall be submitted to the Owner / Owner's Engineer for approval.

5.1.6 DATA TO BE FURNISHED BY BIDDER AT THE TIME OF BID

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.

General arrangement / architectural drawings for all buildings and structures showing dimension, levels plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs types of finishes, construction methodology, design criteria etc.

All deviations from bid document shall be furnished by bidder.

List of equipment to be deployed by the bidder and by other subcontractors to be associated with him-in is to be furnished.

List of software proposed to be used against various areas, for analysis, design, construction etc, their source and along with validation report for the software.
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 needs 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 building / structure / area wise shall be submitted for design / drawing activity indicating.

- A level-1 part showing the start and completion date of all civil construction activities.

- A level-2 part showing the time required for preparation of design criteria, for approval of design criteria by Owner after checking and clearance given by the Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner after checking and clearance given by the Owner. This part shall take into account the construction schedule (Level-1 part).

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

List of all sub-contractors 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-contractors approved by Owner shall be engaged by the Contractor on the job.

5.1.7 INSPECTION OF SITE BY BIDDER

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, subsoil conditions, natural drainage etc, ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.

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

5.1.8 CONSTRUCTION TOOLS AND MATERIALS SUPPLIED BY Contractor

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 covered under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expense. No claim shall be entertained for mobilizing additional equipment and / or personnel to complete the work within the stipulated time.

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.

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.

The Contractor shall ensure continuous supply of coarse and fine aggregate conforming to the specification for the duration of the contract period and extended period if any. Adequate stocks are to be ensured before the on-set of monsoon, because the approaches to the quarries becomes difficult during monsoon.

Adequate stocks of material shall be ensured such that there are no interruption of works due to shortage of material at any point of time during the contract period and extended periods, if any.

All materials supplied by 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.

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.

The Owner reserves the right to test any construction material supplied by the Contractor in an established testing laboratory at Contractor's cost.

The Owner reserves the right to instruct the Contractor to remove all materials which do not meet the specification requirements.

5.1.9 WORK EXECUTION AND SUPERVISION

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 works.

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.

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.

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 accident. He shall also report such accidents to all the competent authorities wherever such reports are required by them as mandated by statutory laws.

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

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.

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.

Should the work be suspended by reasons of strikes / riot 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 expense any damage arising from any other than these causes. No compensation, whatsoever, will be given by the Owner.

During the course of Contractor's works, other works either by the Owner or by other Contractors or by the Owner or by other 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.

A quality control laboratory shall be set up with all required testing equipments. The quality control laboratory shall be handed over to the Owner and laboratory shall be under the Owner control. However testing of all materials has to be carried out by the Contractor. The bidders have to re-calibrate the testing equipments brought to site by competent authorities from time to time to maintain the accuracy.

Bidder should furnish the list of equipments that will be provided in the laboratory.

The Contractor shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth which is hazardous and detrimental to health and affect safety of the work place.

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

5.1.10 SUBMISSION OF DOCUMENTS TO THE OWNER AFTER AWARD OF CONTRACT

The Contractor shall commence soil investigation only after obtaining and incorporating the comments given by the Owner on the project-specific specification for soil investigation submitted by Contractor.

After completion of soil investigation, Contractor shall submit a detailed soil investigation report to the Owner, after vetting by reputed third party institutions like IIT or NIT , within three months from award of contract, giving all data from tests conducted, conclusions there from, safe allowable bearing pressures, level of ground water, presence of aggressive chemicals to concrete etc., The Contractor shall incorporate all changes suggested by the Owner at no extra cost to the Owner and with no extension of time.

The Contractor shall begin further works like preparation of design criteria only after obtaining approval of the report.

Detailed design calculations / drawings shall be commenced by Contractor only after approval is obtained from the Owner on the basic design criteria for building / structure / areas to be submitted by the Contractor. No later deviation from the approved design criteria shall be permitted unless specifically approved by the Owner in writing, prior to its adoption.

Civil assignment drawings showing all details such as equipment loads, live loads, erection and maintenance loads, cutouts, crane capacity and wheel loads and wheel spacing, point loads due to piping / pipe hangers, ventilation duct, cable trays etc. shall be submitted for information. Vertical bracing, brick wall location, etc shall be based on approved general arrangement (GA) drawings of the equipment, piping / cable tray / ventilation duct layout drawings and shall be submitted by the Contractor for Owner's approval. Interferences shall be indicated in civil GA drawings, Civil GA drawings submitted without prior approval of relevant GA drawings for equipment piping / cable tray / ventilation duct layout shall not be considered for review and approval.

The Contractor shall freeze all loadings applicable for the main plant building within a maximum period of six months from the award of contract.

Design calculations and drawings and other documents shall be submitted sequentially after obtaining approval in a phased manner as per approved L2 schedule. Contractor shall ensure that design calculations / drawings for several structures are not submitted at one time. For this purpose, design / drawing submission schedule furnished during bidding stage and agreed upon by Owner shall be followed. Owner will review and furnish comments / approval, if any, to the designs and drawings. The Contractor shall resubmit the design documents and drawings within a maximum period of three weeks from the date of receipt of comments by the Contractor. Timely submission of designs / drawings to the Owner for review / approval is the sole responsibility of the Contractor and postal or other delays as reasons for late / non-submission shall not be entertained

by the Owner.

Should there be a requirement for preparation of separate drawings to show enlarged details to facilitate construction / erection, then such drawings shall also be prepared by the Contractor at no extra cost.

Design drawings shall indicate structural arrangements, member sizes, member forces, splice location, details of base plate, anchor bolts details of moment connection, construction joints, waterstops, loadings etc., so that the drawings indicate clearly all the necessary information brought out in relevant design calculations. Proposed bracing patterns shall be subject to approval by Owner. In framing plan of TG and Mill Building and other misc buildings, end shear of all secondary beams and end shear and end moment of frame beams are to be furnished in a tabular form.

Design drawings showing typical connection details conforming to design assumptions shall be submitted for approval before starting fabrication drawings.

Preparation and review of structural steel fabrication drawings is entirely of the responsibility of the Contractor and will not be approved by the Owner. However, all fabrication drawings shall be submitted by the Contractor for Owners reference and records prior to commencement of fabrication.

Bar bending schedule for all concrete works shall be prepared by the Contractor and submitted to the Owner for his reference.

All architectural features of buildings shall be detailed by the Contractor's qualified architect. Detailed drawings along with schedule of doors / windows etc floor / wall finishes including colour scheme shall be submitted for obtaining approval from the Owner. For all non-plant buildings, 2 or 3 three alternate options along with 3D view shall be submitted for Owner's review.

All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter-wise) and structural (section wise).

The designs shall clearly spell out the erection scheme for various structures envisaged by the Contractor and resulting additional loadings, if any, shall be duly accounted for. Before taking up actual erection work, detailed erection scheme proposed to be followed by the Contractor shall be submitted for Owner's approval.

Approval / comments conveyed by the Owner neither relieves the Contractor of his contractual obligations and his total responsibility for correctness of dimensions, materials of construction loadings, quantities, design details assembly fits, performance particulars, safety and stability of the structures including foundation / appurtenances and conformity of supplies with the statutory laws as may be applicable, nor does it limit the Owners right under this contract. No change in the approved designs / drawings shall be permitted without prior written approval of the Owner.

Owner or his representative has every right to go to Contractor's design office to check the quality control being implemented at their design office to ensure that the documents being prepared are of approved quality. The Contractor shall provide all assistance required by Owner for carrying out the audit.

Checking for any interference is the sole responsibility of the Contractor.

Erection scheme for all major equipments shall be submitted to Owner for his approval before taking up detail design works.

Specifications issued to sub-contractors must be submitted for approval.

All design calculations and drawings shall be in English and shall be in SI units.

Designs drawings and other documents submitted by the Contractor shall be thoroughly checked and approved by the authorized Contractor's engineers. Any unchecked / unsigned documents will not be reviewed by the Owner. Also design calculations not accompanied by supporting engineering drawings, incomplete or shabbily done design calculations, design calculations without adequate reference or backup data and documents where previous comments have not been incorporated will not be reviewed by the Owner. No claim from the Contractor for extension of time or extra cost on this account shall be entertained by the Owner under ay circumstances.

No check will be specifically carried out by the Owner to verify arithmetical / numerical accuracy of the calculations, input data, compatibility of dimensions among various drawings or between drawings and design calculations. These shall remain entirely the Contractor's responsibility.

Contractor shall submit copies of designs / drawings prepared by him in accordance with the distribution schedule.

All modification suggested by the Owner to meet specification requirements and sound engineering practice shall be incorporated by the Contractor at no extra cost to the Owner. In this respect, the decision of the Owner shall be binding on the Contractor. Owner will accord his approval only after the Contractor has incorporated in the design and drawings all modifications required by the Owner.

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

All structural analysis may be done adopting STAAD pro / SAP. Wherever finite element analysis is needed eg. for TG frame, the same shall be done by using NISA / GT Strudl / ANSYS. For power house, mill building etc, response spectrum analysis on 3D model has to be done (in line with IS:1893-2002). The complete input (soft copy with editable format) and output data (soft copy) is to be submitted for Owner's review and approval. The softwares mentioned above are not exhaustive.

Payment will not be made for defective works and other works completed without approved design and drawings.

Final completion report shall be furnished by the Contractor including narrative report with as built drawing in consultation with Owner. Hard copies of 10 set and soft copies 3 set.

SECTION 5.2

DESCRIPTION OF BUILDINGS, STRUCTURES AND FACILITIES

TABLE OF CONTENTS

5.2.1 GENERAL

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

5.2.1.1 General Requirements

1. Wherever possible, cable vault shall be provided in ground floor instead of cable trenches.

2. Openings / Rolling Shutters / Wide doors shall be provided for erection and removal during maintenance of Panels, Indoor Transformers, Equipments, etc and shall be considered in the layout of buildings.

3. All MCC Rooms, Switch Gear buildings and Pump Houses shall have an air conditioned operator room with pantry and Tool Store Area with shelves.

4. Ceiling fans, Modular furniture with electrical wiring and network cabling shall be provided in all office / operating personnel rooms.

5. Lifts and elevators shall be provided wherever specified in Electrical specification and as per statutory regulations.

6. Magnetic white boards of suitable size shall be provided in all conference, discussion rooms, training rooms and Officer Rooms.

7. Projector with electrically operated projector screens and audio system shall be provided in all conference and training rooms.

8. All non-plant buildings and Security building shall have concealed wiring.

9. All toilets shall be provided with exhaust fans.

10. Elevator / Lift shall be provided for buildings having more than two floors above the ground floor.

11. Where ever possible, pre engineered building construction method may be adopted for steel buildings.

12. All electrical buildings shall have the following rooms in two floor construction
    - Electrical room
    - Battery room
    - Control room (Air-conditioned)
    - Cable spreader room
    - Maintenance engineers room (5 metreX5metre, Air-conditioned))
    - Store cum tool room in ground floor
    - Toilet (Men & Women)
    - Pantry Room
    - AHU Room

13. Canopy with metal sheeting shall be provided to all outdoor motors.

14. All battery rooms shall have shelves for proper storage of chemicals.

15. Suitable provisions shall be provided for doors where ever access control systems are required.

16. Automatic sliding opening doors shall be provided for Central Control Room and Service Building entrance.

5.2.2 SITE RELATED INVESTIGATION

5.2.2.1 Topographical Survey

See section 5.1 of this specification.

5.2.2.2 Geotechnical Investigation

See section 5.1 of this specification.

5.2.3 SITE DEVELOPMENT WORK

5.2.3.1 Site clearance

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

Existing wells, pits, marshy areas etc shall be filled up with earth of approved quality.

The CONTRACTOR shall be deemed to have visited and carefully examined the site and surroundings and to have satisfied himself about the nature of the existing structures, underground services, general site conditions, the site for disposal of surplus materials, debris etc and all other items affecting the work. Claims due to ignorance of site conditions shall not be considered after submission of Bid.

Area for disposal of unsuitable materials resulting from excavation will be identified by the Owner inside the project boundary at the time of execution.

5.2.3.2 Site grading

The required grade level of the plant area shall be graded by the CONTRACTOR considering the contours, cutting and filling. Entire Project site to be leveled to FGL except Ash Dyke portion.

Excess excavated earth can be used for Grading of site.

The material used for general site filling shall be well graded soil. Non expansive with 8 to 15% fines to provide impervious and binding material. These fines are recommended to be in a limited range of plasticity such that the Plasticity Index varies from 4 to 9 and the liquid limit less than 35. The soil shall be compacted atleast to 95% modified proctor density.

In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the Contractor for the requirement specified above. It is the Contractor's responsibility tto identify borrow area and getting statutory clearances involved. Earth from Swamps, marshy as well as logs, expansive type of clays, peats, organic material, material susceptible for combustion, material which shall react with other material already used in work shall not be used as borrow material.

A minimum side slope of 1 vertical : 2 horizontal shall be maintained at all slopes. Slopes shall be provided with proper protection to prevent erosion.

5.2.3.3 Fencing and Gates

Fencing along with gates (main gates and wicket gates as applicable) of suitable size shall be provided around the following areas.

- Periphery of Main Power Plant Area
- Switchyard
- Transformer Yards
- Fuel Oil Tank Farm
- Site Stores Complex
- Hydrogen Generation Building.
- Permanent Store complex
- Wherever fencing is necessary due to security / safety / statutory requirements.

5.2.3.4 Roads and Drains

The approach road to the main entry of the plant from the State Highway shall be as per the plot plan.

All roads shall be RCC Roads.

All internal plant roads and approach road from the state Highways to the main plant (Double lane roads) shall be of 7.5 m wide with 2.5 m wide shoulders on both sides of the road. Single lane roads shall be of 4.0 m wide with 1.0 m wide shoulders on both sides of the road. Patrol road along boundary wall shall be single lane road.

Access roads to building/facilities (not shown on Plot plan) shall generally be single lane roads.

The drainage system shall be designed for rainfall intensity resulting from a 1 in 50 year frequency rainfall event.

Run off coefficients for paved areas and unpaved areas for design of storm water drainage system shall be 0.9 and 0.6 respectively.

Drainage design shall be as per relevant IRC Code (IRC SP 42)

5.2.3.5 Boundary Wall

Boundary wall of 4.0 m height above FGL shall be constructed all along the entire length of the plant boundary.

Over the 4.0 m high boundary wall, 0.6m high, 8 strands of anti-climbing barbed wire fencing on 50x50x6 Y-shape angle placed at 2.5 m c/c shall be provided.

The foundation for boundary wall shall be of RCC / Pile. The plinth & superstructure shall be with RCC frame with infill of brick / stone masonry / hollow block masonry.

5.2.3.6 Security Gate Complex

Approximate area for Security Gate complex shall be **400 sqm.**

The complete security gate complex consisting of approach road, Main Gates, Guard House, Wicket Gate, Time and Security Office, Speed breakers, Traffic barriers and Parking / Waiting space etc shall be carefully planned such that they function smoothly especially at the time of change of shift.

The whole complex shall be aesthetically pleasing merging with the architecture of the compound wall. The design of the entrance arch and gates shall be aesthetically pleasing.

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

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

Speed breakers shall be provided both outside and inside the compound with manually operated traffic barriers.

Adequate RCC paved areas shall be provided both inside and outside for parking of waiting vehicles.

There shall be two main gates, 3.0 m high and 7500 mm wide, each with two leaves and a guard house in between. For smooth operation of gates, rollers shall be provided which moves on rails embedded in the road paving. Main gate shall be electrically operated.

A minimum of 2 wicket gates (1.2m wide, 3.0 m high) shall be provided to allow entry and exit of pedestrian and cyclists. The gate posts and guard house shall be of RCC construction.

The gate frames shall be made of galvanized structural steel tubular / rolled section with plate / mesh for the body.

Dormitory facilities for an area of 100 sqm in the upper floor shall be provided. Necessary furniture, office room, Common Bath Room and Toilet facilities, Cupboards, etc shall be provided.

A security building of minimum size 20 sq. m. along with toilet shall be provided at entry gate in the fencing of main power plant area.

5.2.3.7 Watch Towers

Watch towers shall be constructed with RCC framework and brick in fill wall. Floor of the tower shall be at least 10.0 m above FGL. Covered area for each tower shall be approximately 2.0m x 2.0m.

Number of towers shall be such that the complete periphery of the plant can be watched from these towers but in no case the towers shall be spaced more than 500m.

Access spriral stair / ladder shall be provided.

Handrail shall be provided at the platform level.

5.2.3.8 Storm Water Diversion Channels

Construction of diversion channels along with sluice arrangements to pass the runoff from

adjacent watersheds and surplus water from the Ellappanaiken tank as listed below, such that the project site shall be devoid of any inundation due to flood in the nearby areas.

- A peripheral channel along the western boundary of the project site to drain off the runoff from watersheds on the western side of the project site.

The design of channels has to be carried out by considering various scenarios by varying the cross sectional dimensions and bed slope. The impact of existing check dam on the downstream side also has to be considered during the design.

Report titled “Design of Peripheral Channel to Pass the Runoff & Upstream Surplus in Udangudi Thermal Power Project Site” by Anna University, Chennai shall be referred to during the design of the channels.

The terminal points of "Storm Water Diversion Channel along western boundary of the project site" shall be considered as from North-West corner of the plant site to South-West corner of plant site. The upstream part of the drain from Ellappanaiken tank to North-West corner of plant site and the downstream part of drain beyond South-West corner of plant site are excluded from scope of work.

Approval from Tamil Nadu PWD for the storm water diversion channel shall be in the contractor scope.

5.2.4 CONSTRUCTION ENABLING WORKS

The CONTRACTOR shall provide for at his cost the following buildings and 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 sheet roofing over steel roof truss with cement concrete flooring and false ceiling with A/C as required.

5.2.4.1 Site office for Contractor’s Use

An A/C Conference room to accommodate about **50 people** shall also be provided in the site office complex.

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.

5.2.4.2 Site Stores Complex

A covered store shall be provided with brick cladding and 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 shall be affected on exposure to wind, sun and rain.

Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.
Storage yard (paved and unpaved, based on requirement) shall be provided with in the stores complex for storage of other material. Unpaved area shall be provided with anti weed treatment.

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

Stores complex shall be handed over to the Owner in good condition during the handing over of the plant.

5.2.4.3 Temporary Workshop and Garage

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

5.2.4.4 Fabrication Yard

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

5.2.4.5 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.

Testing laboratory shall be equipped with the following minimum apparatus, materials and competent, trained staff required for carrying out field tests.

1. Slump cone apparatus to measure slump.
2. Concrete cube testing machine with adequate number of moulds of (15cm x 15cm x 15cm) to measure compressive strength of concrete.
3. Vicat apparatus to find initial and final setting time of concrete.
4. IS-sieves with vibrating machine to determine fineness modulus of coarse and fine aggregate.
5. Abrasion & impact testing Equipment for testing coarse aggregate and apparatus to determine Flakiness Index of aggregates.
6. Complete ·apparatus for the test of air content of concrete by pressure method as per IS:1199.
7. Density bottle to determine sand bulkage
8. Hydro meter for testing pH value of water .
9. Thermometer for checking temperature
10. Apparatus for measuring proctor density, water content of compacted soil, determining CBR values.
11. All apparatus for determining dry density and water content of compacted soil determining CBR values.

Any other equipment felt appropriate by the Owner for measurement of plant thickness testing of structural members, welding etc. The moulds for cubes shall be checked frequently and made to conform to specifications contained in IS:516.

5.2.4.6 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.

5.2.4.7 Staff Welfare Facilities

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.

Adequate number of mobile toilets shall be provided at various work sites inside the plant boundary.

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.

5.2.5 POWER HOUSE BUILDING

STG building framing shall be of structural steel with moment connected framing in the transverse direction and bracing in the longitudinal direction. Internal columns shall be designed with shear connections to beams and fixed support at the base plate level. STG building shall be of non-basement structure.

One maintenance / service bays shall be provided for each unit. For equipment entry into the service bay specially designed rolling shutters shall be provided with appropriate operating mechanism.

Building shall be designed for considering crane loads. At crane girder top flange level a crane walkway shall be provided in line with Factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance required duly taking into account clearance required for mounting light fixtures.

Roofing shall consists of cast-in-situ RCC slab of minimum 50 mm thickness laid to a slope of 1 in 100, constructed over metal deck sheet of approved profile supported on steel purlins which are spanning between trusses. The thickness of metal decking sheet shall be minimum 0.8 mm.

External brick wall of 230 mm thick shall continue up to 3m height from ground level. Permanent colour coated Galvalume high tensile sandwiched insulated metal cladding sheet of approved make provided over brickwork above 3 m height.

Double skin insulated cladding made of (0.6mm base metal thickness) colour precoated Galvalume high tensile steel sheets shall be provided for wall cladding above 3.0m height upto roof level for Power House building. Cold rolled steel with hot-dip metallic coating of Al-Zn alloy shall be used as substrate. The surface shall be colour coated by oven baked paint

system over substrate. Permanent colour coated sheet shall meet the general requirements of IS 14246 and shall conform to Class 3 for durability.

Wherever brick wall is required above 3m (electrical room & transformer yard area) facing out side single skin colour coated sheet (min 0.6 mm base metal thickness) shall be provided on the walls to match the elevation.

Walls in front of transformers shall be of adequate thickness to satisfy “fire rating” as per TAC regulations.

Aluminium windows shall be side hung glazed using 6 mm thick wired glass generally. However in areas where cladding is of sheeting, fixed glazing in powder coated aluminium frame work and in accessible areas sliding windows in powder coated aluminium frame work using 6 mm thick wired glass shall be provided.

All the doors on external walls shall be of double plate flush steel doors.

Access shall be given to T.G building roof.

Roof shall be provided with elastomeric waterproofing membrane. HDPE pipes of minimum 150mm dia shall be provided for rain water down take pipe to drain off rain water from roof.

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

Catch pit with C.I grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish.

The drainage shall be led to sumps from where the water shall be pumped to plant drainage arrangement. Around equipment liable to frequent drainage / seepage / flooding, 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 shall be provided as required to isolate oil from the drainage water where the water is mixed with oil.

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.

AC plant shall be provided with brickwork side cladding. The roof framing shall support an electric hoist of adequate capacity. The dimension of the room shall be to suit the layout, operation and maintenance requirement of the equipment. Main entry shall be through a rolling shutter permitting entry of truck with machinery. A minimum of two nos. single leaf steel flush doors shall be provided for movement of personnel. Aluminium glazed side windows shall be provided for natural lighting and ventilation.

Foundations for major equipment like Steam Turbo Generator and Boiler feed pump shall be isolated from the building frame work.

There shall not be any vertical bracing obstructing the view from the control building to the TG bay at control room level. Vertical bracings shall be provided between ground floor and operating floor to allow smooth flow of forces. Vertical bracings and longitudinal ties may be provided for both the flanges for deep main columns along the longitudinal direction. Additional longitudinal tie shall be provided where ever there is profile change for the main columns.

No staircase shall be provided in front of the control room obstructing the view from the control room.

Roof extractors shall be provided for proper ventilation of the steam turbine hall.

Two (2) numbers each full height stair towers shall be provided for turbine generator area in each unit. These shall be provided in each of the areas as per the requirements of Tariff Advisory Committee. Additional stairs and platforms shall be provided for access to equipment as required for operation and maintenance. Additional stairs shall be provided for access to the control rooms and plant services areas to provide additional access between floors.

CEP Pit area shall be isolated from CW Pit in order to keep it dry.

Columns in all rooms / areas shall be encased with RCC / brick masonry for a height of 0.5 m (minimum) above floor level.

5.2.6 CENTRAL CONTROL ROOM BUILDING

The plant units control room area shall be a fully enclosed structure located abutting the Power House Building in between two turbine units. The building shall consist of dedicated main control room, control equipment room, computer room, sampling room, data acquisition system room, cable galleries, chemical laboratory, testing laboratories for relay, meters and C&I equipment, office areas and toilet facilities. VIP discussion hall is to be provided adjacent to the control room.

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.

All floors shall be of in-situ RCC slab provided over structural steel beams. Min thickness of structural concrete shall be 150 mm. Roof shall be given a slope of min 1 in 100 for proper drainage.

No openings shall be permitted on the roof of control room excepting possible openings for A/C duct to exercise proper control on air conditioning.

Cladding shall be of brick walls. Walls shall normally be supported on wall / floor beams. If wall beams cannot be avoided they shall preferably be given at the level of floor beams and shall be encased in concrete.

Portion of the structural steel column projecting into the control room shall be encased for full height with RCC / brick masonry to shield it from fire hazards.

Columns in all other rooms / areas shall be encased with RCC / brick masonry for a height of 0.5 m (minimum) above floor level.

Cable vault shall be provided with minimum 2 doors per room. The doors shall be flush steel doors.

No windows shall be provided on the turbine bay side.

Switch gear room shall be provided with minimum two steel doors to satisfy statutory requirement (2 hour fire rating). In addition a two leaf sliding doors of flush welded steel construction shall be provided to move the Switch gears 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 and glass doors. Lobby shall be formed of powder coated 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 common control building, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of control room and control equipment room(s) facing the operating floor to have a clear view.

For movements of panels suitably sized double leaf aluminium glazed doors shall be provided. Control room wall up to 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 around to reduce sound nuisance.

Battery room shall be provided with painted wooden Flush door with inner half part of the door covered with aluminum sheet.

Provision for storage of materials shall be provided in Battery rooms.

For Air washer room steel doors shall be used which shall be airtight. No window shall be provided in Air washer room.

Staircase shall extend up to roof.

Toilets shall be provided at the Switch gear room level and control room level.

Toilet floors shall be sunk and shaft shall be provided to route the soil pipe. Sunken floor shall be provided with damp proofing treatment.

Control room and electronic cubicle rooms are to be provided with false ceiling. False ceiling shall be designed aesthetically properly arranging, supply air diffuser, return air grill, fire protection sprinklers and light fittings. Aluminium ceiling system shall be provided. The false ceiling level shall be decided considering the CCR equipments.

All openings in floor for Switch gear and other panels shall be sealed with fire proof material after cables are connected.

For control building roof supporting the AC equipments regular structural RCC slab shall be provided.

5.2.7 MILL & BUNKER BAY BUILDING

The bunker and mill bay shall be a structural steel framed structure of appropriate length and width, having RCC floors and roof at required levels as per design requirements. The traveling conveyor feeder shall be located above the coal bunkers. Coal mills shall be located in this bay.

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 / Boiler from Mill building.

The framing shall be of structural steel. This shall be designed as a moment connected frame in the transverse direction and braced in the longitudinal direction.

The extent of the feeder floor shall be decided by the Contractor based on his maintenance requirements. Feeder floor shall be of RCC supported on structural steel framework. Handrails shall be provided on all the sides. A steel staircase shall be-provided for access to feeder floor from ground floor.

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 or steel handrail shall be provided for the tripper roof.

Roof of Bunker building shall be cast-in-situ R.C.C over metal decking sheets. Roof slab shall be sloped to one side to permit easy drainage. Rain water down take pipes shall be provided.

Bunker supporting structure shall be left un-cladded upto the bottom of tripper floor. For tripper floor upto 3 m above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated galvanised trough sheet cladding shall be provided. Fixed steel windows with 6 mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery.

Suitable type of foundations shall be provided for Mills.

Minimum of 3 level plan bracings shall be provided in the vertical portion of the bunker.

All floors and roof shall be given access from relevant Boiler structure floors.

Coal bunkers

The bunker shall be circular in plan and truncated conical sloped hopper bottom.

Coal Bunkers shall be fabricated from structural steel plates.

Bottom 1.0m of cylindrical portion and entire conical portion shall be lined with SS liner plates (SS 409M) of minimum 6 mm thickness.

Design of the bunkers shall be as per IS: 9178.

Plates shall be cut to the maximum width to reduce the number of horizontal joints. Vertical joints shall be staggered. All vertical joints above bunker supporting zones and both vertical and horizontal joint below the zone shall be inspected by radiography to ensure quality.

Trial assembly of the bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers.

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.

Bunkers shall be installed in mill building.

i) Bunkers of required capacity for storage of coal shall be provided. Bunkers shall be circular in plan with hopper bottom. To facilitate easy and continuous flow of material, the angle made by the hopper wall with the horizontal (valley angle in the case of square and rectangular hopper bottoms), shall preferably be 15° more than the angle of internal friction of the materials, but should not be less than 60° to the horizontal.

ii) The design of the bunker walls and supporting structure shall conform to IS:9178 (Part I & II). Density of coal for storage vol. calculation shall be 0.8 t/m3 and shall be 1.2 t/m3 for weight calculation.

iii) Maximum pressures during filling and emptying shall be considered. For the design of hopper bottom, maximum pv (during filling) should be considered. For the design of side walls maximum pw (emptying) shall be considered.

iv) Check for the maximum pressure should be made for the rapid filling and pneumatic emptying condition.

v) Effects causing increase in bin loads and decrease in bin loads as per IS:9178 (Part I) shall also be considered.

Mill Foundations

Mills are to be located on the ground floor. Mill foundations shall be RCC. In addition to Mill foundations provision shall be made in the Mill bay ground floor for trenches accommodating Mill reject system conveyors

Mill Maintenance platform

A Mill Maintenance platform shall be provided at appropriate elevation to attend to routine maintenance.

Mill maintenance platform shall be a platform with chequered plate or gratings over steel framing with handrails alround. 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.

5.2.8 BOILER STRUCTURE FOUNDATIONS

RCC foundations shall be provided for main and secondary column of Boiler and other equipment supporting structure.

5.2.9 ESP / FLUE GAS DUCT SUPPORTS AND FAN FOUNDATIONS

RCC foundations shall be provided for ESP superstructure columns.

Grade slab at ground level and cable trenches shall be provided. At the paved ground level, drainage trenches covered with grating at intervals shall be provided for final discharge into the drainage system / sump pit.

Suitable foundations shall be provided for FD, PA and ID Fans.

5.2.10 ESP CONTROL ROOM

This shall be a multi-storied RCC framed structure and the number of floors shall be based on the equipment requirements. The building shall accommodate switch gear rooms, control rooms and air washer room, etc. Side cladding shall be of brick wall.

Staircase area shall be protected against fire as per TAC regulations. Main door to switch gear room shall be steel sliding door having adequate area to admit switch gear. There shall be minimum two doors to the switch gear room, of flush welded steel type. Control room should have one swing type aluminium glazed double panel door and one single panel door.

Windows shall be Aluminium glazed for switch gear room with wired glass. For control room if window is provided the same shall be of fixed glass type with 6 mm thick sheet glass.

Main entrance of the building shall be a rolling shutter with appropriate ramp approach.

Aluminium false ceiling shall be provided in the Control room. Underdeck insulation shall be provided above false ceiling.

Roof shall be given access. An equipment hatch shall be given in the first floor with lifting beam to lift the switch gear / control panel to the first floor.

Rolling shutter of adequate size should be provided for taking the equipment inside in a truck.

5.2.11 BOILER AREA PAVING

Maintenance access pathways of minimum 4.0 m wide to all major equipment shall be provided. Such pathways shall be provided to the boiler elevator also to enable handling of equipment at higher level during maintenance. Such pathways shall be clearly identified. All drain / trench covers in these areas shall be designed to withstand truck loading.

The drainage of the entire area shall be properly planned. Network of RCC drains with RCC cover with slotted holes shall be provided covering the entire area which lead the storm as well as process leakage water to the peripheral drains. 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 column in the area shall be provided with encasing to a height of minimum 300 mm above paving level and in addition the bases also need encasing if base plate are below paving level.

5.2.12 TRANSFORMER YARD

Generator Transformer, Station Transformer, Unit Transformer and Standby Maintenance Transformer may be located in front of the turbine building. Transformers shall be founded on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Jacking pads shall be provided.

Transformers shall be provided with oil collection pit (soak pit) at the bottom as per requirements of electrical specification. In the transformer yard, burnt oil pit can be common for all the transformers of respective Unit and shall be sized for the largest transformer oil quantity and soak pits of all other transformers in the yard shall be terminated at common burnt oil pit. Drain pipes of transformers in the transformer yard shall be extended up to burnt oil pit as per requirements of electrical specification. Soak pit shall be filled with gravel. Burnt oil pit shall be of totally covered RCC construction with ladder, man hole, steel cover for man hole, pumping arrangement for dewatering the pit etc.

Fire wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as Fire barrier wall.

RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Rails shall extend upto maintenance bay of Power House Building.

Entire area shall be surrounded with 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.

Transformer Oil Filter Plant shall be housed in a Building.

5.2.13 SWITCH YARD

Refer separate section in this specification regarding Switchyard related structures and buildings.

5.2.14 COAL HANDLING SYSTEM

5.2.14.1 Crusher house

Crusher house shall be of steel structure of framed / braced design. Floors and roofs shall be RCC over structural steel beam. Side cladding shall be of permanently colour coated galvanized steel of 0.6 mm thick above 3000 mm wall on ground floor.

Roof shall be given adequate slope for drainage. Roof shall be given Heavy duty water proofing as per IS: 1346. Proper arrangement shall be provided to convey the rain water through galvanized gutter of matching colour and HDPE Down take pipes.

Adequate windows shall be provided with steel glazed side hung windows using wired glass. Wherever monorails are projecting outside for lifting of equipment, steel sliding doors shall be provided. Main entrance shall be through rolling shutter adequately sized to carry equipment inside. Other doors shall be of flush welded steel construction. Ramps shall be provided in front of main door.

Grade slab and intermediate platforms shall be RCC supported on steel beams. Handrail shall be provided around all big openings and kerb plates shall be provided around all small openings.

Crusher shall be mounted on the floor framing using Vibration Isolator system.

Two staircases shall be provided one inside and one outside, both of structural steel.

Elevator shall also be provided serving all the floors. Elevator cage wall shall be of permanently colour coated sandwiched metal cladding system. Elevator pit shall be RCC. Machine (M/C) room floor and roof shall be of RCC. Side cladding of M/C room shall be of sandwiched metal cladding. An RCC kerb wall of 300 mm shall be given all round the floor. M/C room shall be given adequate slope for drainage purposes. Main door to M/C room shall be of steel of flush welded construction. Adequate ventilation shall be given using steel glazed window. Elevator pit shall be kept at least 500 mm above general grade level to prevent flooding. A sump shall be provided inside the pit to collect and pump out water. Sump shall be given with access ladder.

Adequate space around the crusher in the crusher house shall be provided for opening the cage of the crusher and for removal of the shaft.

Partitions with slide doors shall be provided in the crusher house between the crushers to enable maintenance of standby crusher when the other crusher is operating. Adequate maintenance space and handling facilities shall be provided on both sides of the partition wall.

Foundations for crusher and drive shall be isolated from crusher house supporting structure with a minimum gap of 50 mm. Crusher house supporting elements punching through crusher pedestal is not permitted.

When floor beam form part of vertical bracing system, additional loads from floor beams transferred to bracing shall be taken into consideration.

5.2.14.2 Junction houses

The sizes of the junction towers, transfer house and crusher house and the floor elevations shall be finalised by considering a minimum clear walkway space of 1200 mm around the equipment in each floor. The clear distance between the floors shall be minimum 3000 mm and the headroom shall be suitable for handling / removing the equipment at the head end and tail end. Adequate space for maintenance of equipment shall be provided.

The floors of junction towers, transfer house and crusher house shall be designed for keeping the heaviest part of the equipment anywhere on the floor for maintenance purpose.

Construction details of Junction houses are similar to the crusher houses except that elevator, partition wall and toilet may not be necessary.

Chute loads on floors of houses shall be considered plugged with material for the entire height of the chute.

If vibration isolation system is not provided, dynamic analysis shall be carried out for beams supporting screens, rotating equipment and conveyor supporting beams in galler. It shall be ensured that the difference between the natural frequency of these beams and the operating frequencies is more than 20%.

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

Supports for gravity take up provided within the building shall be designed to cater for impact in the event of belt failure and counter weight release.

Cladding for junction towers near bunker area shall be provided from the lowest floor (at the elevated level) to the top of the junction tower.

5.2.14.3 Conveyor Galleries and Trestles

Over head conveyors shall be housed in a suitably enclosed gallery of structural steel. Maximum span of gallery shall be limited to 24 m unless higher span is necessitated due to site constraints.

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

Conveyor gallery shall have permanently colour coated metal sheet on roof and on both sides. Roof framing shall be given a slope of 1 vertical: 3 horizontal. Adequate provisions of windows shall be provided on both sides. Windows shall have grills of wire mesh.

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

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

End of conveyor gallery which shall be supported over transfer tower shall be so detailed that only vertical reaction is transferred from conveyor gallery. This side of the gallery shall therefore be supported on sliding PTFE support.

To admit proper light into the conveyor gallery perspex sheet shall be provided at the rate of one square metre per metre length of gallery on the roof and 0.2 sq.m per metre length of gallery per side on the sides of conveyor gallery. A continuous slot opening of 500 mm height shall be provided on both side walls just below the roof sheeting.

Loads due to cables, light fittings, fire fighting pipes, auxiliary pipes, temperature effects, wind loads effects of gravity take up etc, along with other combination shall be considered for design.

Temperature expansion joints shall be introduced at intervals less than 180m. Each block shall have at least 2 four legged rigid support guaranteeing stability of structure in the longitudinal direction. This shall also take care of the 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.

In case of conveyor installation with more than 10° inclination, stepped walk way without any intermediate landings shall be provided.

The effect of inclination of conveyors shall be taken into account for design of structures.

End portal of the gallery shall be designed to transfer all the vertical and lateral loads to supporting trestle Junction towers.

Cross over in the conveyor gallery shall be provided at intervals of approximately 100m.

Four legged trestles shall also be provided if the conveyor elevation is more than 40m.

5.2.14.4 Reversible Stacker cum Reclaimer

Stacker cum reclaimer rail shall be supported on RCC foundations giving continuous support to the rails. The beams supporting the rails shall be given expansion joint preferably every 45 metres. Stacker / reclaimer conveyor support shall also be provided connecting the above two beams.

Covered shed (with metal sheeting) for the stock pile shall be provided for area as per Mechanical specification.

RCC supports for dust suppression piping system shall also be provided. Top of pedestals shall be minimum 500 mm above FGL or paving level.

5.2.14.5 Coal Storage Yard

Paving shall be provided as described in section describing outdoor paving.

The entire coal storage area shall be sloped properly for easy drainage arrangement.

RCC drains with removable pre-cast RCC slotted cover shall be provided on either sides of each coal stack. These drains shall be so designed to carry the drainage from coal yard to the coal yard run off pit. Run off pit shall be of RCC sized to store minimum 30 minutes

storage. Water from the run off pit shall be let into the storm water drain.

RCC retaining wall of 1.0m height shall be provided along the periphery of the coal storage area.

Coal pile area run-off will be led to run off pit. Run off pit with two (2) compartments will be provided. Depth of pond shall be determined on the basis of inlet drain invert. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in the specification.

5.2.14.6 Emergency Reclaim Hopper and Shed

Hoppers shall be of RCC construction. The pit shall accommodate the hoppers along with feeder and conveyors below. The hopper pit shall be of RCC construction and designed as water retaining structure. During construction proper provision shall be made to make the pit completely water proof. For Reclaim hopper sloping surfaces 5 mm thick stainless liner of grade SS 409M shall be provided. Suitable sump shall be provided in the pit to affect surface water drainage. RCC access shaft shall be provided with staircase to the bottom of the pit. Monorail for taking machinery into the pit shall be provided in the access shaft projecting through two leaf steel sliding door. Plinth level of the pit shall be kept at least 500 mm above graded level with RCC sloped paving all round to enable bulldozer movement.

Shed above hopper pit shall be of structural steel construction. The columns shall be raised from the four corners of the pit and shall be designed as free standing, supported only by roof framing, to facilitate dozer movement. Roof shall be provided with permanently colour coated galvanized sheeting.

5.2.14.7 Tunnels, Pent houses and Transfer Houses

Tunnels shall be of RCC construction and designed as a water retaining structure as per IS 3370. During construction proper provision shall be made to make the tunnel completely water proof.

PCC screed shall be provided to direct the drainage on to one side of the tunnel. A small trench shall be provided on that side of the tunnel to lead the drainage to the nearest sump.

The tunnel shall be provided with RCC Ventilation duct. Brick work shall be constructed with grills for supply air. Tunnel shall be provided with walkway on either side of the conveyor. Single pipe hand rail shall fixed to the tunnel wall to serve as hand rail. Tunnel floor shall be provided with PCC steps to facilitate movement of operating / maintenance personnel. In the case of double conveyor such steps shall be provided in the centre also.

Where the tunnel enters the ground level a pent house is provided of RCC construction.

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

Tunnels under road way shall be designed for Class AA type loading per IRC standards.

Tunnels under railway track shall be designed for fully loaded wagon travelling at a speed of 10 Km/hr.

Tunnels shall have water proofing treatment on both the faces.

Where two tunnels meet a Transfer house is to be provided. Transfer house is by and large a junction tower but the meeting of conveyors takes place below ground level. Transfer house

shall be of RCC construction with RCC floors and roof, with RCC access shaft with staircase and monorail arrangement for carrying equipments down. Proper drainage arrangement shall be provided in the bottom most floor. Handrails shall be provided around all openings. Around access shaft proper plinth protection shall be provided with ramp towards the door. Access shaft should have one equipment entry which shall be two leaf steel sliding door and a single leaf flush welded steel door for entry of personnel. Transfer house shall be designed as a water retaining structure and provision shall be made during construction to ensure proper water proofing after concreting is over.

5.2.14.8 Coal Handling Switchgear Room / Control room

Number of switch gear room shall be decided based on the arrangement of various buildings and their electrical load requirement.

Switch gear room shall generally be two storied RCC framed structure with cable vault in ground floor and switch gears on the first floor. In the case of Switch gear cum control room, an additional floor shall be provided to accommodate the control room and offices above the switch gear room.

Roof shall be given proper slope and parapet, sunshade, facia shall be provided.

Staircase area shall be protected from fire safety angle as per TAC regulations. Main door to switchgear room shall be steel sliding door having adequate area to admit switchgear. There shall be minimum two doors to the switchgear room of flush welded steel type. Control room should have one swing type aluminium glazed double panel door and one single panel door. Windows shall be steel glazed for switchgear room with wired glass. Main entrance of the building shall be of rolling shutter with appropriate ramp approach.

Roof shall be given access. An equipment hatch shall be given in the first floor with lifting beam to lift the switch gear / control panel to the first floor. Roof shall be given a slope of minimum 1 in 100 towards the side opposite to transformer yard. Roof shall be given water proofing treatment. Adequate number of rain water down take pipe shall be provided. Garland drain as well as plinth protection shall be given around the building.

Transformer yard (for outdoor transformers, if any), toilets, equipment hatch, staircases, etc shall be provided.

5.2.14.9 Dust Suppression, Dust extraction and Ventilation System Structures

Civil works on account of the above system shall generally consists of pump houses, RCC tanks, slurry trenches, pump foundations, fan foundations etc spread over the complete Coal handling area. Location and details of these structures shall depend on requirement based on system design.

5.2.14.10 Bull Dozer shed / Auto-repair Shop

This shall be a steel frame structure with permanently colour coated Galvalume sheeting, with a column free area for bull dozer movement in shed area. The minimum area for this facility shall be 250 Sqm.

The auto-repair shop shall have sides with colour coated galvanized sheeting except for bottom three meters of brick work.

Ventilation and natural lighting shall be provided with steel glazed side hung windows. Doors shall be of flush welded steel for personnel movement. Rolling shutters of adequate size shall be provided for movement of vehicle.

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

5.2.15 ASH HANDLING SYSTEM

Ash Handling System shall comprise of bottom ash and fly ash handling systems, ash slurry handling system, ash water distribution system, ash slurry pump house, ash water pump house, vacuum / compressor pump house, ash pipe supports, ash recirculation pipe supports including culverts bridge etc. unto the specified terminals points.

All buildings and structures shall be RCC framed structures with RCC footings/raft as applicable. All buildings unless specified shall be provided with brick cladding.

Work shall include bottom ash slurry pipe supports, bottom ash extraction equipment supports, ash slurry pipe supports from ash slurry pump house to ash dyke are to be provided including garlanding, ash slurry pump house, dry fly ash pipe supports, supporting structure for buffer hopper, collector tanks and economizer tanks, dry ash silos, development of silo area (including paving, access roads, office block and watchman cabin), pump and equipment foundations, compressor house, MCC room, ash water pump house, ash water pipe supports, ash water re-circulation pipe supports, recovery water pump house, recovery water sump, RCC thrust blocks, sumps, miscellaneous tanks, supporting structures, vacuum pump house and other buildings, supporting structure facilities required to complete the system upto terminal points.

5.2.15.1 Ash Handling System Pump Houses

The superstructure of pump house shall be RCC framed structure. RCC frame shall have brick cladding.

Cranes / monorail for handling motors and pumps shall be provided. Main entrance shall be of adequately sized rolling shutter. In addition, minimum of two flush welded steel doors shall be provided.

5.2.15.2 Ash Handling System Sumps

Bottom ash over flow sump / Ash water tanks / sumps may be above or below the ground level. They shall be designed as a water retaining structure. RCC sumps for Ash Slurry Pump House shall be designed duly considering design water table level as well as additional surcharge pressure. Proper water proofing of the sump shall be ensured.

5.2.15.3 Ash Handling System MCC and Switch Gear Rooms

MCC and Switch gear room shall be RCC framed structure with cable trenches and switchgear / control room. Walls of the Control / Switch gear room shall be of brick, with wall designed as per TAC regulations.

5.2.15.4 Pipe Supports, Pipe and Cable Racks

Work shall include bottom ash hopper supports, bottom ash extraction equipment supports, pipeline supports and trenches from bottom ash hopper to ash slurry sump.

Pipe line from Ash slurry pump house to the final disposal area may run on RCC pedestals located minimum 500 mm above ground level with anchor blocks at all bends.

For road / rail crossings, pipes shall be laid through RCC Box culverts / steel bridge as required.

Pipelines shall be supported on RCC pedestals having RCC foundations. Pipes shall be suitably anchored with RCC pedestals to resist lateral and vertical movement.

5.2.15.5 Ash Silos

Ash silos shall be of RCC construction. Roof above silo may be of structural steel construction. Capacity and number of silos shall be as per Mechanical requirements.

RCC silos shall be designed as per IS:4995 (Part 1 & 2)

RCC silo shall be circular in plan.

The following loading conditions and effects shall be considered while designing the various components such as roof, bin walls, ring girder, hopper bottom, supporting column and foundations:-

i) Dead load of the structure.
ii) Super-imposed loads due to material handling and transportation machinery, if any.
iii) Bin load as per IS:4995 (Part-I).
iv) Live-load (for roof only) in accordance to IS:875 (Part 2 – latest).
v) Wind load in accordance to IS:875.
vi) Seismic loads in accordance with the site spectra report/recommendations mentioned under clause C1.2.4 to IS:1893 (latest).
vii) Effect due to temperature variation.
viii) Effect due to shrinkage of concrete.
ix) Effect of fixity of the bin at the top and bottom edges and with adjoining structures.
x) Permissible stresses and design shall be as per IS:4995 (Part-II).

5.2.15.6 Dry Ash Storage Silo Area

An office block with minimum area of 50 sqm and watchman cabin with area of 5 sqm (minimum) shall also be provided in the ash storage silo area. The compressor house and the office block shall be provided with toilet facility. Interior and exterior finishes, area paving etc. shall be as specified elsewhere in this specification.

Dry ash storage silo area shall be provided with 3.0 m high compound wall along with gates. All roads shall be RCC roads with adequate turning radii for ash trucks.

The water wash arrangement for ash loaded lorries with continuous water supply line from the proposed plant and settling tanks with two compartments for enabling removal of sedimented ash and spill over arrangement of clear decanted ash water to be made. For settlement of ash wash water provision shall be made.

Sufficient paved area not less than 5000 Sq.m at locations pointed out by owner for lorry parking etc. shall be provided.

Dry ash storage silo area shall be provided with the sump for collection of ash water.

5.2.15.7 Ash Handling Compressor House

The superstructure shall be either RCC or steel framed structure. RCC frame shall have brick cladding. For Steel frame the rigid framing in transverse direction and bracing in the longitudinal direction and gable end.

If required, cranes / monorail for handling pumps shall be provided. Main entrance shall be of adequately sized rolling shutter. In addition minimum of two flush welded doors of flush welded construction shall be provided.

5.2.15.8 Other Civil Works in Ash Handling System

Work shall also include bottom ash hopper supports, bottom ash extraction equipment supports, water pipe line supports and belt conveyors.

5.2.16 FUEL OIL HANDLING SYSTEM

Fuel oil pump houses shall be single storied RCC framed structure with 230 mm thick brick cladding and flat RCC roof. A paved platform shall be provided between the pump house and road tanker parking area with plain cement concrete over rubble soling, sloped towards a peripheral drain. The drain shall be led to a sump with oil water separator. Monorails shall be provided for handling the pumps. The basement shall be designed as water retaining structure.

Fuel oil tanks shall be of structural steel designed as per IS:803. Foundation of the fuel oil storage tank shall rest on thoroughly compacted fill of gravel, coarse sand etc. topped with minimum 75 mm thick compact crushed stone, fine gravel, clean sand etc. mixed in hot asphalt (8-10% by vol) of grade 80/125 and rolled or compacted. The filling shall be confined within a RCC ring wall with foundation.

The storage tanks shall be surrounded by RCC dyke wall above finished ground level to prevent the spread of fire or leakage of oil from a leaking tank to other areas. The 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. Fuel Oil Storage area shall be protected by chain link fencing. Foundations for trestles and pedestals for supporting the pipes, anchor blocks etc shall provide in RCC at appropriate locations.

Pump floor level shall be decided taking care of suction head to limit dead storage of oil in tanks.

Trucks unloading area shall be provided with proper ramp.

5.2.17 CW CHANNELS & FOREBAY

RCC cooling water channels shall be of rectangular shape and designed as a water retaining structure as per IS 3370.

Depth and width of channels shall match with the depth and width of the cooling water channel from cooling towers.

Expansion joint shall be given at a spacing of about 45 m. Pedestrian crossover shall be given across the channel at approximately 300 m spacing.

Top of the forebay and channel shall be kept 500 mm above finished grade level and handrail of galvanised M.S. pipes shall be provided for the entire length on either sides. Forebay shall be provided with GI steel ladders at four corners.

5.2.18 CW PUMP HOUSE

The pump house structure shall be of structural steel with metal cladding. Wall cladding shall be of brick work upto 3m from FGL floor and colour coated Galvalume sheet for the balance height. RCC roof slab over metal decking sheet shall be provided. Crane girder shall be of structural steel. Cage ladder shall be provided for access to crane platform. Maintenance bay of the pump house shall have R.C.C grade slab with required finish. Pump floor shall also have similar finish.

All windows shall be steel glazed side hung type. All doors shall be of flush welded steel construction. Maintenance bay shall be provided with rolling shutter. Proper ventilation arrangement by means of ventilators / roof extractor shall be provided.

Pump sump shall be designed as water retaining structure as per IS 3370. Each sump shall be provided with stainless steel groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. Number of coarse screen and fine screen shall be the same as the number of pump sumps. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering and lifting of stop logs and screens. These openings shall be covered with galvanised mild steel gratings when the screens are placed in position. Provision for handling of the screens and stop logs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens.

Each individual pump sump shall also be provided with a drain sump to empty the sump for attending to maintenance of pump.

Design

1. The pump house shall be designed as a framed structure with worst combination of loadings.
2. The pump house floors shall be checked for vibrations imparted by the pumps.
3. The sump and fore bay shall be designed as water retaining structure
4. The sump shall be designed under the following conditions:
   a) Walls fixed at bottom and hinged at top where top restraint is provided by floor slab/beams and earth pressure at rest (k0=0.5 shall be considered). If otherwise the wall shall be treated as a cantilever (ka=0.33 shall be considered).
   b) Outside empty and extreme end compartments filled and inside compartments empty
   c) Outside filled and extreme end compartments are empty and inside compartments filled.
   d) Outside empty and alternate compartments filled
   e) Outside filled and alternate compartments empty.

5. Fore bay shall be designed under following conditions.
   a) Walls shall be cantilever or counterfort retaining walls (ka=0.33 shall be considered).
   b) Outside empty inside full.
   c) Inside empty outside full.
   d) Pressure release valve shall be provided in fore bay base raft to prevent uplift during construction.
   e) Shear key can be provided for stability against sliding and design with passive pressure coefficient kp not exceeding 2.

5.2.19 CHEMICAL HOUSE AND CHLORINATION BUILDING

RCC framed structure with brick cladding to accommodate Chlorination room, chlorine cylinder storage, toilet block, etc. Side cladding shall be of brickwork except in Chlorine cylinder storage area where brick wall is provided only to a height of 1 m. All floors and roofs shall be of RCC. Roof shall be given proper slope. Finishing shall be as per finishing schedule.

5.2.20 CW INLET AND OUTLET CONDUITS

CW conduits from CW Pump House up to condensers and from condensers up to cooling towers shall be as described in the mechanical section.

Suitable approved coating system shall be applied to protect the surface from sea water effects.

Design of CW ducts shall be designed for the following conditions.

i) Internal Pressure Condition:
Following cases shall be considered for the design of pipe:

a) Maximum design water pressure
b) Surge or water hammer pressure
c) Pressure, under testing condition.

ii) External Pressure Condition

a) It shall be designed for external pressure due to soil overburden, surcharge loading, ground water, etc taken together.
b) Additional traffic load at road crossings.

iii) General Requirements:
It shall be designed as water retaining structure subjected to

a) Maximum external pressure when inside empty
b) Maximum internal pressure in absence of outside soil.
c) Uplift when inside empty and ground water level upto finished grid level.

iv) Top of CW duct shall be minimum 1.5m below grade / formation level.

5.2.21 DESALINATION PLANT AND WATER TREATMENT PLANT

Description of facilities shall be in accordance with the requirements spelt and under Mechanical Specification.

All water retaining / storage structures shall be designed assuming liquid up to the full height of wall irrespective of provision of any over flow arrangement.

The substructure of the storage tanks shall comprise of R.C.C wall and shall be designed as uncracked section in accordance with IS 3370 (Part I to IV) by working stress method.

Desalination building shall be RCC framed structure with brick cladding and covered with RCC. Pump Houses shall be RCC framed structure with brick cladding and covered with RCC Cast in situ roof slab.

All concrete surfaces in direct contact with sea water shall be applied with coating system as specified in RCC specification.

5.2.22 PIPE & CABLE RACKS

Pipe rack structures eg. lattice girders, bridges etc shall be constructed out of weldable quality mild steel conforming to IS: 2062. The design of lattice girders, portals and bridges shall confirm to IS: 800.

Racks may be multi-tiered and cable gallery shall normally laid in the top tier.

The racks are generally designed as a rigid frame in the transverse direction and braced in the longitudinal direction. Access ladder shall be provided at suitable locations at a maximum of 100m spacing. Where so required, chequered plate platforms shall be provided for maintenance purpose.

Pipe rack portal, bridges and supporting structure shall be designed for the loads due to pipe running full of material condition. Apart from vertical loads, the effect due to friction, temperature effect, forces transmitted at bends, wind effect on pipes and steel structure shall also be considered.

Pipe and cable racks shall be designed for worst combination of loads. Expansion provision shall be provided where ever there is a change in direction or where length of the rack exceeds 100m.

5.2.23 EFFLUENT TREATMENT PLANT

See separate section under Outdoor Civil Works in this specification.

5.2.24 SEWAGE TREATMENT PLANT

See separate section under Outdoor Civil Works in this specification.

5.2.25 MISCELLANEOUS PLANT BUILDINGS

5.2.25.1 Plant Air Compressor Building and Air Washer Room

This shall be a single storied steel framed building adjoining to the Turbo generator bay.

Water tank and supporting structures for louvres, filter and foundation for equipment such as fans and pumps. 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 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 to suit the dimension of the equipment he is supplying duly taking into account maintenance requirements.

5.2.25.2 DG House

This shall be a single storied steel framed structure with electric hoist. The dimension of the building shall be to suit equipment supplied and its operation and maintenance requirements. 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 checkered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.

5.2.25.3 Chemical / Hazardous Storage Building

This building shall be of RCC with limited number of internal column to result in large column free area. Side cladding shall be brickwork.

Loading and unloading platform for trucks, ramps for movement of forklift etc shall also be provided. Separate office space, chemical storage, hot storage, electrical storage, A/C stores,

toilet etc shall be provided. All windows shall be provided with MS grills of 12mm square rod for security. Rolling shutter of adequate size shall be provided for movement of truck / forklift etc. Grade slab shall be designed for truck traffic.

5.2.25.4 Hydrogen Generation Building

Hydrogen Generation Building shall be single storey RCC / Structural Steel construction with brick / metal cladding.

5.2.25.5 Maintenance Office Cum Stores

Maintenance Office cum Stores with provision for tool room of adequate area shall be provided in the following areas. This can be either independent building or can be part of Pump House / MCC / Other buildings nearby. Minimum size shall be 5.0 m x 15.0 m.

- Mill Area – (may be accommodated in ground floor of Bunker Bay or Power House Building)
- Boiler Area – (may be accommodated in ground floor of ESP Control Building)
- ESP Area – (may be accommodated in ground floor of ESP Control Building)
- Ash Handling Area
- Coal Handling Area
- Cooling Water Pump House / Forebay Area (may be accommodated in ground floor of CW Pump House or MCC Building)
- Sea Water Intake Pump House Area
- Sea Water Outfall Pump House Area
- Common for Transformer Yard and Switchyard Area (may be accommodated in ground floor of Switchyard Control Building).
- Common for Desalination Plant / D M Plant / Water Treatment Plant Area (may be accommodated in ground floor of DM Plant Control Room)
- Fuel Oil Tank Area (may be accommodated in ground floor of Fuel Oil Pump House)

5.2.26 NON-PLANT BUILDINGS

5.2.26.1 Service Building

This building shall be RCC framed structure having a minimum plan area of about 1250 sq.m in each floor with large column free area. No. of floors shall be decided by the Contractor depending on the space requirement of various facilities proposed to be housed. A minimum of four (4) floors are recommended.

This building shall be located close to the Turbine building and shall be connected by a covered corridor to the Turbine building at least at the operating floor level and at mezzanine / intermediate floor. Entry location inside to the power house building shall be selected avoiding major equipments.

Special attention shall be given to architecture of this building. The front elevation of shall have pleasing architectural elevations. Special attention shall be given in front of the building in landscaping the area and developing garden with flowering plants and fountains etc.

Specially designed long and spacious RCC porch shall be given in front at the main entrance for receiving cars of VIP's. Length of the porch shall be at least 15 m. Minimum width of porch shall be 5.0 m.

This building shall accommodate the following

- Offices for all technical persons
- Offices for the O & M staff
- Laboratory for Control & Instrumentation
- Relay testing & electrical testing rooms
- Conference room (100 seats) and attached dining hall with potable water supply and store for housekeeping materials.
- Library with book shelves, chairs and tables.
- Documents room
- Archives
- Stores
- Reception
- Pantry (in each floor) with wash arrangements.
- Space for printers and photo copiers in each floor
- First Aid Centre
- Separate toilets for ladies and gents (in each floor)
- Change room with shower and lockers for the O & M personnel
- ERP Data Recovery center and Server room with false flooring, Network Engineering Room, UPS and Battery room in Ground floor.
- Simulator training room with cabin for instructor.

There shall be separate rooms for plant head, senior managers. Cabins for senior officers and conference rooms shall have attached toilet. Cabins shall be provided as directed by the Owner.

Details of cabin arrangements in Service Building for Technical Officers shall be as below.

Category	Nos	Min area (m2)
I	1	50
II	6	30
III	20	20
IV	40	15
V	120	10
VI	30	6

The building shall be centrally air conditioned.

The building shall be RCC framed multi storied building with brick walls.

False ceiling in the entrance lobby shall be colour coated aluminium ceiling system.

Entrance to 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 powder coated aluminium frame work. 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 may be provided with PVC doors. All windows shall be glazed aluminium sliding types. Ground floor windows shall have 12 mm square MS rod grills for security.
Entrance shall be aesthetically decorated. Number of staircases provided shall be decided based on statutory regulations. A minimum of 2 staircases shall be provided. For the staircases in the lobby the treads and dado shall match with the floor finish. Hand rail shall also be of aesthetic appearance. At least one staircase shall lead to the roof.

Elevators (as specified in Electrical Specification) shall be provided at the entrance lobby.

5.2.26.2 Weigh Bridge and Control Room

Control Room shall be RCC framed structure with RCC roof and brick cladding. Minimum area shall be 30 sqm. Adequate windows shall be provided for ventilation & lighting. Water proofing shall be provided for roof. Flush welded steel doors shall be provided for personnel movement. Toilet facilities shall be provided.

5.2.26.3 Workshop and Permanent Store

Workshop

Minimum area for Workshop shall be 600 sq m.

In the workshop area, electric hoist of adequate capacity shall be provided. The workshop shall accommodate the machinery and facilities listed in the Mechanical section of the document.

Permanent Store

Minimum area for Store shall be **6000** sq m.

RCC Paving around store area **4000** sq. m.

A security building of minimum size 20 sq. m. along with toilet shall be provided at entry gate in the fencing of store area.

Breakup of store area shall be as below.

Store	Area (m2)
Mechanical – Boiler Section	1500
Mechanical – Turbine Section	1500
Coal Handling Section	1000
Electrical	1500
Control and Instrumentation	500

General

The workshop and store shall be of structural steel frame work with brick wall upto 3m. Galvalume cladding shall be provided for roof and as side cladding above brick work.

In addition the workshop shall provide for office space for workshop superintendent and his supervisory staff, locker room and change room for workers, etc. Office space for store keeper and supporting staff shall be provided. Toilets shall be provided.

Entry and exit of trucks shall be through adequately sized rolling shutters. In addition a minimum 2 single leaf steel flush door shall be provided for entry of the staff. Adequate windows shall be provided for ventilation and lighting.

Offices inside shall be of glazed wooden partition above 900 mm high single brick wall. Total height of partition including brick work shall be 2400 mm. Doors to the cabins shall be of particle wood.

Adequate storage racks shall be provided.

Adequate hoist facilities shall be provided.

5.2.26.4 Fire Station

The fire station shall have provision for parking 2 nos fire tenders and one bay for maintenance with pit, office for the station in-charge, duty room, stores, recreation cum class room, record cum general room, toilet blocks, fire panel room, storage for portable fire fighting equipments, etc as per TAC requirements. Manual hoists and trolleys shall be provided for installation and maintenance of equipments.

The minimum area for this facility shall be **500 Sqm.** This building shall be of RCC framed structure.

Parking area for tenders shall ensure fast movement of the fire tender in an emergency.

In addition adequate space shall be provided for hose drying and drill ground. The arrangement shall in general satisfy requirement of the local fire brigade.

5.2.26.5 Administration Building

This building shall be RCC framed structure having a minimum plan area of about **1500 sq.m** in each floor with large column free area. Minimum two floors shall be provided.

The Administration building shall be located outside the Power plant boundary but close to main gate, so that the visitors to Administration building need not have to undergo the regular security restriction as required for visitors to power plant.

Special attention shall be given to architecture of this building. The front elevation of shall have pleasing architectural elevations. Special attention shall be given in front of building in landscaping the area and developing garden with flowering plants and fountains etc.

Specially designed long and spacious RCC porch shall be given in front at the main entrance for receiving cars of VIP's. Length of the porch shall be at least 15 m. Minimum width of porch shall be 5.0 m.

This building shall accommodate the following

- Offices for all Technical, Administration and Accounts staff
- Reception lobby
- Telephone exchange
- Training cum Conference room (100 seats) and attached dining hall with potable water supply and store for housekeeping materials.
- Model room
- Archives
- Stores
- Records room
- Library
- Space for printers and photo copiers in each floor
- Pantry in each floor
- Auditorium
- First Aid Centre
- Separate toilets for ladies and gents (in each floor)

Cabins for senior officers, conference rooms and auditorium shall have attached toilet. Cabins shall be provided as directed by the Owner.

The building shall be centrally air conditioned.

The building shall be RCC framed multi storied building with brick walls.

False ceiling in the entrance lobby shall be colour coated aluminium ceiling system.

Entrance to 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 powder coated aluminium frame work. 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 may be provided with PVC doors. All windows shall be glazed aluminium sliding types. Ground floor windows shall have 12 mm square MS rod grills for security.

Entrance shall be aesthetically decorated. Number of staircases provided shall be decided based on statutory regulations. A minimum of 2 staircases shall be provided. For the staircases in the lobby the treads and dado shall match with the floor finish. Hand rail shall also be of aesthetic appearance. At least one staircase shall lead to the roof.

Roof also shall be designed as a floor such that the area can be utilised for get together.

5.2.26.6 Canteens and Dormitory

Two canteen buildings are envisaged.

1. Near the Administration building – Canteen with a Dormitory in the upper floor.

2. Near Fire Station – Canteen only
This building shall be handed over to the Owner within 6 (six) months of award of contract.

The dining area shall have the arrangement to seat 100 people at one time. In addition there shall be a separate executive dining area fully air conditioned and with gypsum board false ceiling to accommodate about 25 executives.

Toilets (Gents and Ladies) shall be provided in both Canteens.

Canteen building near the Administration building shall have Dormitory facilities for 50 personnel in the upper floor. Necessary furniture, Office room, Common Bath Room and Toilet facilities, Cupboards, etc shall be provided.

Number of rooms shall be as listed below.

- Five double bed rooms (bath attached).
- Two rooms to accommodate 5 beds each
- Three rooms to accommodate 10 beds each

Canteen building shall be RCC framed structure with brick cladding. Proper attention shall be paid to the architecture of this building. Spacing of columns shall be such that large column free areas are available in the dining area.

Adequate space shall be provided for stores, preparation, cooking, serving and washing facility. Toilet and hand wash shall be kept sufficiently away from cooking area.

Adequate exhaust fans and ventilation facility shall be given in the cooking area and in dining area. Special arrangement shall be made to lead off the waste water from canteen to the effluent treatment plant.

Main entrance door shall be of aluminium glazed swing type with two leaves opening outside. All windows shall be glazed aluminium sliding type. Fly proof mesh shall be provided isolating cooking area from dining area.

Tables and chairs in the dining hall shall have heavy duty stainless steel topping.

Sinks and wash basins shall be of heavy duty stainless steel.

Walls of dining area, serving and cooking area shall have glazed ceramic tile dado for a height of 2100 mm.

Flooring in dining area, serving and cooking area shall have heavy duty ceramic tiles.

Adequate number of platforms and racks shall be provided in kitchen and stores area.

Working platforms in kitchen shall have granite topping.

5.2.26.7 Dispensary

This shall provide for minimum two beds, a doctor's room, examination room, dispensary, waiting room, toilet block and an ambulance porch. The first aid centre shall be fully equipped to handle emergency. The floors and walls with dado to a height of 2100 mm shall be with glazed tiles. This shall be of RCC framed building with brick cladding.

5.2.26.8 Parking

Total parking area shall be 3750 sqm.

Parking area with plain concrete paving with ramps shall be provided as given below.

- Near service building with RCC covered parking area shall be provided for 20 cars / jeeps and about 50 two wheelers.
- Near Administration building also similar (to service building) covered parking facilities shall be provided.
- In addition, immediately on the outside of the security gate house, covered parking facilities for about 750 sqm shall be provided in modular steel construction with provision for expansion as required for two wheelers.
- Balance area shall be provided as open parking area as directed by the owner.

5.2.26.9 Bank Extension Counter and Post Office

A separate single storey building with provision for Bank Extension Counter, ATM Booths and Post Office with toilet facility shall be provided. Minimum area shall be 200 sqm. This shall be of RCC framed building with brick cladding.

5.2.27 OTHER STRUCTURES AND FACILITIES

The following buildings and structures are included in the scope and shall be designed after getting approval of respective GA drawings.

5.2.27.1 Condensate Storage Tank Foundations

Foundations for the condensate tank and associated pumps shall be of RCC construction.

5.2.27.2 Pipe Trenches & Duct Banks

All cable and pipe trenches shall be of RCC with minimum M20 grade. Trenches located outside buildings shall be projecting at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.

All drains and trenches shall be covered using Precast RCC cover slab of minimum M20 grade, each not weighing more than 65 Kg and shall be provided with a lifting hooks.

5.2.27.3 Service and Potable Water Overhead Tanks

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

Capacity for potable and service water requirements shall be as per Mechanical specification.

5.2.27.4 Horticulture and Landscaping Works and Green Belt Development

5.2.27.4.1 Horticulture and Landscaping Works

Contractor shall hire professionally qualified landscaping agencies to develop the landscaping and horticulture in the plant area. Special attention shall be given to development in front of Service building, Canteens, Administration building, Fire station, etc.

Around the cooling towers and coal stockyard area fast growing tall trees shall be planted to reduce drift and dust, nuisance respectively. Contractor shall include along with bid his broad proposal for horticulture and landscaping works.

The scope includes the digging of pits, supply of good earth, installation of watering system, manure, pesticides, plants, tree, shrubs, climbers, pots & plantation of trees, plants, shrubs, climbers in pits, pot with manure mix good earth, watering twice a week, maintenance & up keeping for a minimum period of 6 months from the commissioning of second unit. The area for plantation shall be as directed by the Owner.

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. Before the micro grading is started the contractor shall prepare a plan for Landscaping and get it approved by the owner. 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.

The area to be landscaped shall be clearly demarcated at site and got approved by the Engineer. The work shall be divided into following sub-items.

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

Preparing Clipped Hedges

Hedges made of Casuarina 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.

Planting Shrubs

Shrubs with coloured leaves like Crotons, Acalyphia, Oleander and Bouganvillea, 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.

Installation of Watering System

A watering system consisting of pumps, piping and sprinklers for irrigating the landscaped area as well as the green belt shall be provided by the contractor. This watering system shall cover the entire perimeter of the plant and the extent of green belt and landscaping shown in the plot plan.

Before the installation of watering system the contractor shall prepare a plan for watering System for the green belt and submit and get it approved by the owner. Drip Irrigation and Spray System consisting of complete GI 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. The owner, however, reserves the right to modify the layout system if he deems necessary although the owner earlier approved it.

5.2.27.4.2 Green Belt

Adequate plantation shall be provided along the periphery and in the power plant in areas earmarked in the Plot Plan to satisfy the norms and stipulation as laid down by the Govt. of Tamil Nadu and MOEF, Govt. of India.

The type and the density of trees / plants in the green belt area shall be in conformity with CPCB guidelines / Environmental Clearance.

The main objective of the green belt is to provide a buffer between the sources of pollution and the surrounding areas. The green belt helps to capture the fugitive emissions and attenuate the noise apart from improving the aesthetics quality of the region. A 35 – 50 m wide greenbelt will be developed along the periphery of the plant and in all open areas. Avenue plantation will also be developed as per the standard norms.

Approximately 1500 trees per Ha will be planted in consultation with the local Forest Department. The plant species suggested for the greenbelt development are presented in Table. However the selection of the species will be finalized in consultation with local forest department.

For green belt development, the recycled water shall be utilised.

Table : Plant Species Suggested for Green Belt Development

Sr. No.	Botanical name of the plant	Size of the tree	Type and suitable site
1.	*Acacia auriculaeformis*	Medium	Semi-evergreen fragrant white flowers suitable in green belts and on road sides
2.	*Adina corodifolia*	Large	Deciduous, a light demander, suitable on open areas and near flares
3.	*Anogeissus latifolia*	Medium	Deciduous, Suitable for green belts
4.	*Azadirachta indica*	Large	Evergreen, Medicinal
5.	*Bauhinia variegata*	Medium	Deciduous, good in green belts in garden and as a second row avenue tree
6.	*Borassus flabellifer*	Large	A tall deciduous palm can be used as wind break when of different age.
7.	*Boswellia serrata*	Medium	Deciduous suitable on green belt on shallow soils
8.	*Caesalpinia pulcherrima*	Small	A large shrub, suitable for gardens outside offices and along channels
9.	*Callistemon lanceolatus*	Medium	Deciduous for some time, ornamental plant in garden
10.	*Carrisa Carandas*	Small	Semi evergreen large bushy shrub good as a hedge to protect against noise.
11.	*Cassia fistula*	Medium	Deciduous, good ornamental tree in green belts.
12.	*Cassia siamea*	Large	Evergreen, good as an avenue tree.
13.	*Casuarina equisetifolia*	Medium	Evergreen suitable for covering low lying area and in green belts and along ponds.
14.	*Cedrela toona*	Large	Deciduous, good in open spaces, in green belts and along ponds.
15.	*Peltophorum inerme*	Medium	Semi evergreen, suitable on road sides, in gardens and outside office buildings.

The following plant species have been suggested for Road Side Plantation.

Sr. No	Scientific Name	Vernacular name
1.	*Bauhinia purpurea*	Kachnar
2.	*Leucaena leucocephala*	Subabool
3.	*Delonix regia*	Gulmohar
4.	*Cassia fistula*	Amaltas
5.	*Pongamia pinnata*	Karanj
6.	*Azadirachta indica*	Margosa

The general guidelines for development of greenbelt are:

- Trees growing up to 5 m or more will be planted along the plant premises and along the road sides
- Planting of trees will be undertaken in rows.
- Open areas inside the plant boundary will be covered with grass lawns.
- The spacing between the trees will be maintained slightly less than the normal spaces, so that the trees may grow vertically and slightly increase the effective height of the green belt.

- Planting of trees in each row will be in staggered orientation.
- Since the trunks of the tall trees are generally devoid of foliage, it will be useful to have shrubs in front of the trees so as to give coverage to this portion.
- In the 2nd & 3rd rows, shrubs consisting of Margosa, Kachnar, Amaltas, etc. will be grown.
- Shrubs and trees will be planted in encircling rows around the project site.
- The short trees (<5 m height) will be planted in the first two rows (towards plant side) of the green belt. The tall trees (>5 m height) will be planted in the outer three rows (away from plant side).
- For adsorption of dust and gaseous pollutants the following types of plants have been considered,:
- Fast growing
- Thick canopy cover
- Longer duration of foliage.
- Adequate height and spread of crown
- Small leaves (Lanceolate) trees which can sustain the sea breeze.
- Preference to perennial and evergreen trees

The choice of plants includes shrubs that grow 1 to 2 m high and trees of 3 to 5m heights. It will be ensured that the foliage area density in vertical is almost uniform by intermixing the trees and shrubs. Since safety during transport is a major consideration, shrubs in traffic islands and along road dividers will be short enough to be below the eye-level of motorists.

The species identified for greenbelt development will be planted using pitting technique. The pit size will be either 45 cm X 45 cm X 45 cm or 60 cm X 60 cm X 60 cm .Bigger pit size will be preferred. Soil used for filling the pit will be mixed well with decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.6 kg (on dry weight basis) for 45 cm X 45 cm X 45 cm and 60 cm X 60 cm X 60 cm respectively. The filling of soil will be completed at least 5-10 days before actual plantation.

It is proposed to cover an area of 20 - 50 m all round the proposed unit. Apart from the bulk plantation around the boundaries, Roadside avenue plantations will also be taken up. The green belt layout is shown in the plot plan. Year wise plantation program within the proposed plant premises is given in Table

5.2.27.5 Rain Water Harvesting

Rainwater harvesting shall be carried out in view of the following:

a) Conserving rainwater and thus reducing the overall water consumption for plant requirements.
b) Possibility of integrating the storm water drainage scheme of the power plant with rain water conservation.

Rain water harvesting supplements in meeting various non-potable purposes of water usage in the power plant like :

a) Water for gardening purposes;
b) Water for sprinklers that are used on coal; and
c) For use in flushing of toilets.

Water retention pond may be provided to avoid flooding downstream of plant drainage.

Size of the pond shall be decided during detailed engineering as per Hydrological study report. Location of the pond can be suitably decided as per the drainage pattern.

A detailed scheme of rain water harvesting to recharge the ground water aquifer may be prepared in consultation with Central Ground Water Authority / Ground Water Board or any

other appropriate authority and it is to be implemented for effective operation.

5.2.28 SEA WATER INTAKE AND OUTFALL SYSTEM

The sea water intake and outfall system include the following

- Intake velocity cap
- Seawater intake piping
- De-silting basin
- Seawater intake pump house
- Seawater piping to desalination plant and to CT basin
- Seawater outfall system

Description of these items shall be in accordance with the requirements spelt and under Mechanical Specification.

For the design of system, wave condition during cyclonic weather needs to be considered.

The intake shall be sufficiently submerged to avoid air entrainment and excessive wave loading at lowest low water and during the severe wave condition. It needs to be sufficiently high above the bed to avoid excessive sediment entrainments.

The intake well shall have velocity cap with adequate entry velocity to avoid entrainment of fishes. The draft above the velocity cap shall be adequate for fishing vessel. Marine buoys shall be provided at the intake location.

The structural part of caisson is to be fabricated in two parts i.e. Bottom portion and top portion. After the assembly of caisson structures hydro testing is to be carried out to ensure water tightness of whole caisson structure, suitable for towage to intake well location.

A 1:25 scale model of the intake well is to be tested in the wave basin of the “Ocean Engineering Centre” of IIT, Chennai to measure the wave forces and moments on the intake well and the variation of water levels inside and outside the well. The well model study is to be subjected to the action of both regular waves for two test conditions, intake well inlet closed during installation and intake well inlet open. The experimental results on wave forces and moments are to be compared with the results of the linear diffraction theory. The water level inside the well is to be measured to determine the submergence of suction pipes of pumps and location of the inlet opening of the intake well. The wave crest elevation in front of the well is also to be measured in order to fix the deck level of the well so as to avoid water overspill onto the deck.

All concrete surfaces in direct contact with sea water shall be applied with coating system as specified in RCC specification.

SECTION 5.3

GENERAL REQUIREMENTS

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5.3.1 ARCHITECTURAL CONCEPTS AND DESIGN

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 and local climate and due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes and 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 and form.

d) Overall colour scheme 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 facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements. Minimum two numbers of colour schemes shall be proposed for approval of the owner.

e) Overall emphasis shall be on developing an eco-friendly architecture, merging with the nature.

The scheme shall be conceptually finalised in totality including that of equipment so that the proper coordination with other agencies can be taken up at appropriate time.

Architectural Design

a) Natural light shall be used to the maximum extent, especially in the form of north light/sky light. For adequate light and ventilation, National Building code recommendations shall be followed.

b) Entrance canopies chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.

c) All the buildings shall be architecturally designed to meet the National Building Code (SP: 7) norms and local building bye laws, wherever applicable.

d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements may be required to be met with, wherever essential. The Architect shall be of National/International repute having experience in similar kind of works. The Architect shall evolve the design philosophy based on Owner/Engineer guidelines and shall present it in the form of presentation drawings, Prospective views, 3-D Models and detail drawings.

e) Architectural components shall be designed for the conditions at the site for a minimum design life of 30 years.

5.3.2 ROOF ACCESS

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

5.3.3 PLATFORMS AND WALKWAYS

Platforms shall be provided to all major equipment, which are not directly accessible from the floors, for maintenance. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.

Platform and walkways	-	750 mm minimum width
	-	With chequered plates/gratings
Minimum width of continuous walkway at crane girder level	-	750 mm with handrails on both sides

Approach to EOT crane shall be ensured by cage ladder or staircase.

5.3.4 STAIRS & LADDERS

5.3.4.1 Steel Stairs

Normally for all steel staircases,

Minimum clear width (back to back of stringer)	-	1200 mm
Maximum inclination with horizontal	-	35.75^{O}
Maximum height between successive landings	-	5 m
Minimum size of stair stringers	-	Shall be decided during detailed engineering considering loads, span and width of treads.
Minimum width of tread	-	250 mm
Maximum height of riser-Plant Buildings	-	180 mm
Maximum height of riser-Non Plant Buildings	-	150 mm

Treads shall be made of chequered plate / grating, with suitable nosing, and spaced equally.

Incase of space restriction,

Minimum clear width (back to back of stringer)	-	750 mm
Maximum inclination with horizontal	-	45^{O}

Steel stairs shall be provided with all stringers, treads, risers, newels, hangers, railings, and kickplates. The construction of the steel stairs shall be carried out in a solid and rigid manner. The treads and intermediate landings shall be formed of galvanised steel grating with angle connections to stringers and with nosing of chequered steel plate. Treads shall have punched and slotted side plates for bolting to stringers.

5.3.4.2 Steel Ladders

Ladders shall be provided to platforms, walkways and equipments which do not require frequent access. Normally ladders shall be vertical or its angle with vertical shall not exceed 5^{O}.

Ladders shall have minimum clear width of 450 mm with 20 mm diameter MS rungs at a maximum spacing of 300 mm. The steel ladders shall be made of side rails of 65 mm width and 12 mm thickness flats and 20 mm diameter rungs welded to the side rails. The side rails shall be bent at the top of the ladder and fixed on the roof / floor of the structure to allow for climbing down.

Ladders shall be provided with safety cage of minimum 750 mm diameter clear when the top of ladder is more than 4.5 m above the lower landing level. However safety cages shall start at 2.5 m above the lower landing level. The cage shall consist of 50mm width and 6 mm thickness steel bar hoops bent to the specified radius and spaced uniformly and horizontally on a maximum of 1000 mm with 5 equally spaced vertical steel bars fixed on the inside face of hoops.

5.3.4.3 RCC Stairs

Normally for all staircases,

Minimum clear width of stairs	-	1500 mm
Minimum width of tread	-	250 mm for plant buildings 300 mm for non-plant buildings
Maximum height of riser	-	180 mm for plant buildings 150 mm for non-plant buildings
Maximum no. of risers in one flight	-	15
Edge protection	-	MS angle nosing with minimum 50x25x3 angle with lugs.

5.3.5 HAND RAILS

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 walkways, stairs, and platforms shall be provided with handrails, supports, and bracing as well as kickplates of minimum thickness of 8 mm & projecting 100 mm above the platform surface.

Stainless steel handrails and posts shall be provided for the following buildings.

- Service Building
- Administration building
- Canteen
- One stair case from ground floor to operating floor in Power House Building for each unit.

All other handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 and shall be galvanized.

Handrail shall be a three-rail system with elevations of each rail from floor level shall be as listed below.

- the top rail at 1250 mm
- the intermediate rail shall be at 850 mm
- the bottom rail shall be at 450 mm

For platforms at elevation more than 30m, top rail shall be at 1500 mm and the intermediate rails at 450 mm and 1000 mm.

Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the protected horizontal opening and shall not exceed 1850 mm in such a case.

All handrails shall be shop fabricated and field welded or bolted to the erected structural steel.

5.3.6 PROTECTION AROUND OPENINGS AND EDGE PROTECTION

Protection Around Openings

For openings of size less than 300mm x 300mm, 200 mm high RCC kerb of 200 mm thickness shall be provided around openings and covered with chequered plate / gratings.

For large openings of size greater than 300mm x 300mm, 200 mm high RCC kerb of 200 mm thickness shall be provided around openings with 150 mm high 8 mm thick toe guards with handrails (removable / fixed).

Edge Protection

Edge protection angle of size 50x50x6 with lugs shall be provided for all concrete edges, where breakage of edge is expected. Eg: All round the cut-outs/openings in floor slab, STG foundation columns, edges of drains supporting grating covers, edges of RCC cable / pipe trenches / manholes supporting covers and supporting edges of pre-cast covers etc.

5.3.7 ANCHOR BOLTS AND INSERT PLATES

Anchor bolts

Anchor bolts shall be designed for working stresses, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Anchor bolts shall generally not be considered to transfer the shear to pedestal. Shear keys / bars shall be generally considered for transfer of shear. Shear and crushing strength of concrete shall also be checked.

Insert plates

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.

5.3.8 VERTICAL HEAD ROOM

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

Finished floors to bottom of beams (buildings)	-	3000 mm
Central Control Room building	-	3200 mm (Min)
Cable vaults	-	2300 mm
Doors, Walkways, Platforms, Stairs etc.	-	2100 mm
Walkway above false ceiling	-	1000 mm
False ceiling of office areas	-	2400 mm

Access for forklift trucks	-	2800 mm
Main roads / railway crossings & crane access	-	8000 mm
Roads and truck access, in case of trestles	-	8000 mm
Cable & Pipe Rack	-	8000 mm at rail / road crossing. 3000 mm at all other places

5.3.9 EXPANSION/CONSTRUCTION JOINTS

Expansion and construction joints shall be provided wherever required. Maximum spacing between Expansion joints in Concrete structures shall be 45m.

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 can be used. Preformed Duraboard HD 100 or equivalent shall be used as joint filler.

All expansion and construction joints of the water retaining structures and underground structures in RCC shall be made watertight using PVC ribbed waterstops with central bulb. However, kicker type (externally placed) PVC waterstops may be used for the base slabs and in other areas where it is required to facilitate concreting.

5.3.10 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 solid or perforated burnt clay bricks or concrete blocks shall be in accordance with criteria specified by Section 4 of National Building Code of India Part VI and codal provisions. Fly ash bricks may also be used.

All Masonry walls for buildings shall be raised on plinth beams.

All walls shall be non-load bearing walls. All external and internal walls shall be of at least one brick thick except for internal partition walls for office area, pantry, change rooms, first aid rooms and toilets which may be half brick thick. Half brick & one brick thick walls shall be provided with RCC bands (transoms and mullions) wherever necessary to curtail the unsupported length / width / height of the wall.

Salient points to be considered for masonry work:

a) Compressive strength of brick for all external walls shall be at least 75 kg/sq.cm and for all internal walls shall be at least 35 kg/sq.cm, for non-load bearing brick work.

b) Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transoms and mullions shall be provided.

c) DPC shall be provided at plinth level before starting masonry work.

d) Transoms shall be provided at lintel / door height. The spacing of mullions shall not exceed 2000 mm center to center.

Cut lintels shall be avoided.

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 3 m 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 / brick masonry. Minimum height of parapet walls shall be 750 mm and thickness 230 mm for brick work and 125 mm for RCC, with aesthetics of architectural design as approved by the Owner.

Brick work

Bricks are to be whole, uniform texture, sound, well burnt, free from cracks, square and well shaped, uniform in size, uniform red cherry or copper colour and shall emit a clear ringing sound when struck. Slight distortion or rounded edges are permitted provided no difficulty arises during laying of uniform course. Water absorption after 24 hours immersion shall not exceed 20% by weight. Dimensional tolerance shall not exceed 8%. Representative samples shall be submitted and approved samples shall be retained by the owner for future comparison.

Whole of the brickwork shall be carried out by the Contractor in a uniform manner. All the bricks shall be kept under water till they are completely soaked and shall be used for the works on their becoming skin dry. The Contractor shall set out and build all brickwork to the dimension, thickness and heights shown on the drawings. The Contractor shall build all brickwork in English bond and half brick walls and casing to pipe, chases etc in stretcher bond. Brickbats shall not be used except where required for bond.

The Contractor shall lay bricks in full mortar beds with shoved joints. The joints are not to exceed 10 mm in thickness and are to be full of mortar, close, well finished and neatly struck. The vertical joints in any course shall not be nearer than quarter of a brick length from those in the course below. All joints shall be of same width except for small variations to maintain bond. The brickwork shall be laid plumb and trim to line and level. No portion of brickwork shall be raised more than 1 metre above another at one time. If the mortar in any course has begun to set, the joints shall be raked out before another course is laid. The top course of brickwork in reinforced concrete framed structure shall be wedged against reinforced concrete surface and joint well filled with mortar. The Contractor shall flush up thoroughly with mortar all joints as the work proceeds. Where brickwork is to receive plaster, the joints shall be raked to a depth of 10 mm to provide proper bond. All half brick walls shall be reinforced with 2 nos. 8 dia bars at every fourth course. All masonry units shall be bonded to concrete and steel columns by galvanized metal wall ties (4mm thick, 50mm vide 200mm long) at the rate of one tie at every fourth course.

The brickwork as it progresses shall be thoroughly watered on its faces and top. New work shall be properly bonded with the old work. The surface of unfinished work shall be cleaned and thoroughly wetted before joining new work to it. Any work in which the mortar perishes shall be dismantled and rebuilt by the Contractor.

The Contractor shall carry out work in as clean a manner as possible and shall remove excess material and mortar droppings daily. Where brick walls are to receive plaster, excess materials and mortar droppings shall be removed and the surface shall be brushed clean. During cleaning operations, adjacent work shall be protected. Any damage resulting from improper protection shall be made good by the Contractor at his own cost.

The brick masonry works shall be cured for a period of fourteen (14) days after laying.

Encasing of structural steel shall be done by building masonry work around flanges, webs etc., and filling the gap between steel and masonry. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Owner. The minimum lap in chicken wire mesh shall be 50 mm. Other steel embedments shall be generally embedded in mortar and masonry unit shall be cut as required.

5.3.11 DRAINAGE

5.3.11.1 Floor Drainage

For all buildings and areas, suitable arrangement for draining out water collected from equipment blow downs, leakage, floor washing, fire fighting etc. shall be provided on each floor. Gully traps, inspection pits, junction pits, collecting pits etc. shall be located suitably and designed considering flow volume, easy access, maintenance and safety. Wherever applicable, floor drainage shall be routed to oil water separator.

All drains inside the building shall have 40 mm thick galvanized grating covers. In areas where heavy equipment loads would be coming, heavy duty precast RCC cover slabs shall be provided including provision of required oil traps wherever necessary, viz., TG bay, mill & boiler, transformer yard, switch yard, coal handling area, etc., in place of steel grating. These drains shall lead the water to drain sump.

Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.

5.3.11.2 Roof Drainage

Roof drainage system shall be provided for quick and efficient draining of rain water from roof to avoid seepage and damage to roof. The run off gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down comers and fixtures. System shall be designed to handle design for the specific site and shall be in accordance to stipulations of IS : 1742 and IS : 2527. Roof drains shall conduct water to storm drains around the building.

The rain water down comer pipes shall be HDPE pipes of minimum 150mm diameter conforming to IS 4984.

Rainwater collected from roofs shall be let into a rainwater harvesting pit. Rainwater collected from major buildings may be let into raw water reservoir.

5.3.11.3 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.

5.3.12 WATER PROOFING OF UNDERGROUND STRUCTURES

All underground structures like water retaining structures, other deep underground structures, etc., shall have plasticizer cum waterproofing cement additives conforming to IS: 9103. In addition, limits on permeability as given in IS: 2545 shall also be met with. Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage after hydro test. Construction joints of underground structures, where water tightness is required, shall be provided with waterstops. Hydro test for water tightness shall be done at full height as directed by the owner.

The concrete surface of structures in contact with soil shall be provided with water proofing treatment using minimum two coats of bituminous painting of grade 85/25 conforming to IS 702 at 1.7 kg/sqm minimum.

5.3.13 ANTI TERMITE TREATMENT

Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations, filling below the floors etc., as per IS: 6313 and other relevant Indian Standards, as directed by the owner.

5.3.14 DAMP PROOFING

Damp proof course in a thickness of 50mm and consisting of cement concrete with admixture of approved water proofing compound shall be provided at plinth level for masonry walls in super structure.

The proportion of cement to aggregates shall be 1:1.5:3 using 6 mm down stone chips with a waterproofing admixture. The percentage of waterproof admixture shall be as per manufacturer's specification but not less than 1% by weight of cement. The brick masonry surface shall be levelled, flushed up and prepared as directed to receive the damp-proof course. In masonry walls of buildings it shall normally be placed above the external ground level. It shall be laid for the full width of the wall. The top surface shall be kept rough or ribbed for proper adhesion of mortar for brickwork coming over it. All exposed surfaces of the damp proof course shall be finished fair and smooth. It shall be cured for at least seven days. After the surface has partially set, it shall be cleaned with brushes and finally with a piece of cloth lightly soaked in kerosene oil. Then hot bitumen (residual petroleum bitumen of penetration 80/100 of approved quality) shall be applied over the prepared surface in two coats at the rate of 1.7kg per sq. meter per coat and dry sand spread over it.

5.3.15 PLINTH PROTECTION

Plinth protection in 100 mm thick PCC shall be provided with 1000 mm wide or the distance between the brick wall to the garland drain. It shall be laid over prepared subgrade and base formed with broken brick bats or rubble to a thickness of 150 mm. Grade of concrete shall as specified in section related to Reinforced Concrete Works.

5.3.16 TOILETS AND BATHROOMS

Minimum one number toilet block each (for Gents and Ladies) with required facilities shall be provided for the following buildings.

Power House Building - Operating Floor and Mezzanine floors in each unit.

Tripper floor in Mill Building – Each unit.

Central Control Room Building – Control Room and Switchgear Floors

Admin Building – All floors

Service Building – All floors

All other buildings with operating / maintenance personnel rooms shall have minimum one toilet each.

One toilet shall be provided in the Boiler-ESP-Chimney area (common for both units).

One toilet shall be provided in Crusher House

Attached toilets shall be provided for all senior executive rooms and conference rooms.

For other buildings which are not listed above, toilet facilities if required in accordance with National Building Code shall be provided. Final requirements shall be as directed by the Owner.

The facilities provided in the toilet block shall depend on the number of users and as directed by the owner. Number of users in each building will be indicated by the owner during detailed engineering stage. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS: 1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS: 2064 and 2065 shall also be followed.

Entrance to the toilet block shall be provided with teak wood door with door closer.

Each toilet block shall have the following minimum facilities depending on the number of users as indicated by the Owner. Unless specified all the fittings shall be of chromium plated brass (fancy type).

i WC (Indian type, Orissa pan (580 x 440mm) as per IS : 2556 with all fittings including flushing system of appropriate capacity and type.

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

iii Urinal with all fittings with photovoltaic control flushing system as per IS: 2556 .

iv Wash basin (oval shape) with photo-voltaic control fittings as per IS : 2556 to be fixed on concrete platform finished and under fixed with 20mm thick polished granite stone.

v 25mm dia Stainless steel towel rail (600 x 20mm), with all fittings – one set each for WCs and Wash basins

vi Stainless steel liquid soap holder cum dispenser – one each for all wash basins

vii Janitor room

viii Provision for installation of water cooler with recessed floor and stainless steel grating for draining of spillage water, including provision for potable water supply connection.

ix Electric operated hand dryer with photo voltaic control

x Wall to wall Bathroom mirror (6 mm thick float glass) with high square edges including all fittings.

xi Provisions for ventilation shaft and exhaust fans. Number of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions.

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.

Boiler area toilet shall have minimum 2 no. WC (Indian type), 4 no. urinals, 4 no. wash basins, 4 no. mirrors, 4 no. soap holder cum dispenser, 2 no. Showers, towel rails (in WC and Shower), janitor room and a provision for installation of water cooler.

Emergency eye wash cum shower shall be provided in DM Plant, Battery Rooms, Chlorination Plant, Chemical storage areas, etc as per IS 1059 wherever necessary as per statutory requirements.

5.3.17 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 etc. and stipulations, approval 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 design stage. These shall include provision of railings, fire escape, locker room for workmen, pantry, toilets, rest room etc.

Adequate number of fire escapes shall be provided in a building. Fireproof doors, number of staircases, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC. For fire safety requirements of buildings IS: 1641 & IS: 1642 shall be followed in addition to TAC requirements.

5.3.18 FIRE WALLS

All masonry firewalls shall be minimum 345 mm thick and RCC fire wall shall be minimum 200 mm thick.

5.3.19 PLINTH LEVEL

Plinth levels of all buildings and pump houses shall be minimum 500 mm above the formation level or FGL.

Finished paving level of boiler area and transformer yard paving shall be kept 150 mm lower than the FFL of Power House Building.

5.3.20 BURIED PIPE LINES

a) Pipe lines may be run along the road.
b) RCC Culverts shall be built across road.
c) Low lying marshy lands and ditches, if encountered, shall be suitably filled with approved material, compacted to 90% proctor density on which the sand bedding is laid to support the buried pipeline.
d) The buried pipes shall be provided with thrust blocks and anchor blocks
e) Over head cross overs shall be necessary at locations where the pipeline encounters underground water lines or cables, etc.

SECTION 5.4

LOADS AND LOAD COMBINATIONS

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5.4.1 GENERAL

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

Foundation system shall be decided based as per the Geotechnical Investigation to be carried out by the Contractor.

All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant. Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analysed for both conditions of loading and shall be designed for more critical condition.

The applicable loads for the design shall be as listed below :

5.4.2 DEAD LOADS

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

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

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

Materials		**Unit Weight**
Plain Cement Concrete	-	24 kN/m³
Reinforced Cement Concrete	-	25 kN/m³
Structural Steel	-	78.5 kN/m³
Brick work	-	20 kN/m³
Cement Plaster	-	21 kN/m³
Roof Treatment (7 course bituminous)	-	0.3 kN/m²
Floor finish	-	24 kN/m³
Coal	-	12 kN/m³ (for structural design) 8 kN//m³ (for volume calculation)
Fly Ash	-	16 kN/m³ (for structural design) 6 kN//m³ (for volume calculation)
Bottom Ash	-	16 kN/m³ (for structural design) 8 kN//m³ (for volume calculation)

5.4.3 EQUIPMENT & PIPING / CABLING LOAD

Generally, loads of major equipments such as deaerator, heaters, etc., shall be based on the manufacturer's data of the specified equipments.

Static and dynamic loads of major equipments shall be based on the manufacturer's data of the specified equipments. Equipment loads shall be considered as given by equipment supplier.

Equipment loads which are of permanent nature shall be treated as dead loads.

Loads of all equipments like Deaerator, Heater, Feed water Tank, Cooling Equipment, Motors, fan drive pulleys, Pumps, Monorails, Ventilation duct, air inlet & exhaust duct, Electrical control and relay panels, Cable load, Pipe load (static and dynamic), Tanks, AHU, Batteries, Air Washer, etc. shall be considered over and above the imposed loads.

However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered e.g. switchgear and control room floors are usually designed for a live load that includes the equipment weight.

All equipment, tank and piping design loading shall include hydraulic testing loading. Weight of equipments, ducts, tanks, pipes, conduits, etc., supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loading, anchorage and constraint effects.

Air and gas duct loads shall include weight of insulation, duct attachments, dust accumulation loads whichever is applicable and other loads as applicable.

Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.

Surge loads may occur in some vessels or equipments. In such cases, the magnitude and direction shall be obtained from the respective suppliers and applied during design.

Equipment loads shall be specifically determined and located. For major equipment, structural members and bases shall be specifically located and designed to carry the equipment load into the structural system. For equipment weighing less than the live load, the structural system shall be designed for the live load. Equipment loads shall be noted in the design calculations to permit separation in calculation of uplift and stability.

Static and dynamic loading of major equipments including Turbine generator, boiler feed pumps, PA, ID, FD fans, Coal mill and coal crusher shall be obtained from manufacturer certified drawings of specific equipments.

Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying laydown areas for specific components, each area to be identified by permanent marking.

5.4.4 IMPOSED LOADS

5.4.4.1 General

Imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks / hangers, erection loads, operation / maintenance loads etc. The loads considered shall not be less than that specified in IS: 875 (Part II).

The loads listed here under are minimum live loads for the areas involved. Special use areas shall be investigated and loads revised upward as necessary. Floors and supporting members which may be subjected to heavy equipment live loads shall be designed on the basis of the weight of equipment or specifically defined live loads, whichever is greater.

The specific minimum floor live loads are listed below:

Live loads shall consist of uniform live loads and equipment live loads. Uniform live loads are assumed unit loads which are sufficient to provide for movable and transitory loads, such as the weight of people, portable equipment and tools, planking and small equipment, or parts which may be moved over or placed on floors during maintenance operations. These uniform live loads should not be applied to floor areas which shall be permanently covered with equipment.

Equipment live loads shall be calculated based upon the actual weight and size of the equipment and parts to be placed on floors during dismantling and maintenance, or to be temporarily placed on or moved over floors during installation, whichever is most severe.

Floors and supporting members which are subject to heavy equipment live loads shall be designed on the basis of the weight of the equipment in addition to a uniform load of 5 kN/m2, or specifically defined live loads, whichever is greater. Each member in the floor which may carry these loads shall be designed for the heaviest piece or pieces of equipment arranged in the most critical position. For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor from floors below. Permissible stresses for beams and columns shall be increased by 25% for temporary loads during installation of equipments.

5.4.4.2 Roofs

a.	Flat Roof	- 1.5 kN/sqm plus hung loads for accessible roofs - 0.75 kN/sqm plus hung loads for non-accessible roofs. - 5.0 kN/sqm for accessible roofs with HVAC equipment etc
b.	Sloped Roof	- As per IS:875
c.	Dust Loads on Roof, floors and platforms open to atmosphere.	- 1.0 kN/sqm

5.4.4.3 Turbine building

a.	Ground Floor	- General area 15 kN/sqm - Heavy equipment storage areas 25 kN/sqm - Maintenance bay 30 kN/sqm
b.	Operating Floor	- Rotor Removal area live load shall be as per requirement by BTG vendor but not less than 40 kN/sqm - Equipment Laydown Area 30 kN/sqm - Other areas (Corridors etc.) 20 kN/sqm

		-	Rotor removal area beams shall also be checked for ½ the rotor load at the center of the beam.
c.	Heater bay floor	-	10 kN/sqm
d.	Deaerator floor	-	15 kN/sqm (in addition to loads on deaerator supporting pedestals)
e.	Precast concrete covers	-	5 kN/sqm for non vehicular area 20 kN/sqm for vehicular area
f.	Mezzanine floors	-	15 kN/sqm
g.	Platform around deaerator	-	10 kN/sqm
h.	Floor around feed water tank	-	20 kN/sqm
i.	Cable vault floor	-	7.5 kN/sqm in addition to actual cable loads
j.	Roof Exhauster	-	20 kN Each
k.	Cable tray loads	-	1.0 kN/m or as specified in Electrical drawings

5.4.4.4 Mill and Bunker area

a.	Floor at (+/-) 0.00	-	25 kN/sqm (under operation) or actual loads as specified by the manufacturer.
b.	Feeder floor	-	20 kN/sqm + 0.5 kN/sqm (dust load) + Hung loads (if any).
c.	Tripper floor	-	20 kN/sqm + 0.5 kN/sqm (dust load) + Hung loads (if any).
d.	Roof	-	5 kN/sqm + Equipment Load + Dust load

5.4.4.5 Main Control Building and other electrical buildings

a.	Control Room Floor	-	10 kN/sqm
b.	MCC Room	-	10 kN/sqm + Cable tray hung loads
c.	Cable Vault Floor	-	7.5 kN/sqm in addition to actual cable loads
d.	Battery Rooms	-	15 kN/sqm
e.	AHU, AC & Ventilation plant floors	-	10 kN/sqm
f.	Switchgear room	-	10 kN/sqm + Cable tray hung loads
g.	PLCC, relay room	-	10 kN/sqm
h.	Cable tray loads	-	1.0 kN/m or as specified in Electrical Drawings

i.	Minimum live load	-	5 kN/sqm

5.4.4.6 Pump Houses

a.	Operating floor slab	-	15 kN/sqm or as required by equipment supplier whichever is higher
b.	MCC Room	-	10 kN/sqm
d.	Roof	-	1.5 kN/sqm

5.4.4.7 Other Areas

a.	RCC Floors	-	5 kN/sqm for offices, laboratories, conference rooms and general floors
b.	Stairs and balconies	-	5 kN/sqm
c.	Chequered Plate / gratings	-	The gratings/chequered plates shall be designed for minimum live load of 7.5 kN/sq.m However, the supporting member shall be designed for a live load of 5 kN/sq.m
d.	Walkways	-	5 kN/sqm
e.	Toilet rooms	-	2 kN/sqm
f.	Pipe and Cable racks	-	2 kN/sqm (minimum) + friction loads

5.4.4.8 Culverts and allied structures including buried RCC Pipes shall be designed for Class "AA" loading (wheeled and tracked) and checked for Class ”A” loading as per IRC standards.

5.4.4.9 Covers for trenches & channels which are not exposed to vehicular traffic shall be designed for Live Load of adjoining area or 4 kN/sqm whichever is higher. Where channels are likely to be exposed to vehicular traffic, the requirements of Code of Practice for road bridges shall be adhered to.

5.4.4.10 Piping Anchor and Restraint Loads

Piping load shall be as per load plan drawings unless otherwise mentioned.

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

For design, pipe friction load shall also be considered. Pipe friction load shall be considered as 30% of pipe operating load.

A load of 1.0 kN/sqm shall be considered as Hung Loads for piping unless otherwise mentioned.

Frictional force between the pipes and supporting structure in longitudinal direction need not be considered along with seismic or wind forces.

Pipe hanger loads for the major piping systems, such as the main steam, reheat steam, feed water and extraction systems, shall be specifically determined and located. Piping expansion and dynamic loads including thrust loads at bends shall be considered on an individual basis for their effect on the structural systems.

Loads imposed on periphery beams around pipe chase areas shall also be considered on an individual basis.

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

5.4.4.12 In addition to live loads, a minimum of 0.5 kN/sqm shall be considered as Hung loads for electrical, ventilation & air conditioning unless otherwise mentioned.

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

5.4.5 CRANE, MONORAIL & ELEVATOR LOADS

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

5.4.5.2 Impact Factor

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

5.4.5.2.1 Crane Loads

The building frames shall be analyzed for the maximum wheel load when the lifted load is near A row in one case and the same is near B row in another case.

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

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

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

5.4.5.2.2 Monorail Loads

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

b. Impact factor of 25% of lifted load for electrical pulley and support design

5.4.5.2.3 Elevator

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

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

5.4.6 TEMPERATURE LOAD

Suitable expansion joints shall be provided in the longitudinal direction of the structure wherever necessary with provision of twin columns to account for the expansion and contraction due to changes in temperature of materials of the structure.

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.

Analysis shall be carried out for ambient temperature variation. The 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 temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand thermal stresses due to 50% of the temperature variation.

Co-efficient of thermal expansion for steel shall be taken as per IS: 800. Co-efficient of thermal expansion for concrete shall be taken as per IS: 456.

5.4.7 WIND LOAD

Site specific parameters for wind loading shall be as per the criteria specified in Project Information attached in this specification.

Wind loads on structures shall be calculated as per provisions of IS: 875-1987 (Part 3). The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered.

The various design parameters for the project site as defined in IS: 875-1987 (Part 3)

Category of terrain	-	Category 2
K_2 varies with height	-	As per IS:875-1987 (Part 3)
Topography factor K_3	-	As per IS:875-1987 (Part 3)

The wind analysis shall consider the wind direction relative to the structure and both external and internal pressures as applied to the windward and leeward sides of the structure.

In design of structures, wind force on equipments supported on frame including all fixtures, piping, staircases, ladders, handrails, etc., shall also be considered.

5.4.8 SEISMIC LOAD

Seismic forces shall be considered as per the criteria specified in Project Information attached in this specification.

All plant equipment and structures shall be designed for Seismic loads as per the latest edition of IS: 1893 (Part 1 & 4).

Response spectrum method shall be used for the seismic analysis using at least five modes of vibration.

The structures shall be classified into four categories as per Table 5 of IS: 1893 (Part 4).

The damping factors shall be as per Table 4 of IS: 1893 (Part 4).

RCC Structures	-	5%
Steel Structures	-	2%

The importance factor for each structure shall be as per Table 2 of IS: 1893 (Part 4).

Response Reduction factor shall be as per Table 3 of IS: 1893 (Part 4).

Method of analysis for each structure shall be decided as per clause 10.3 of IS 1893 (Part 4), which depends on the seismic zone & category of the structure.

5.4.9 EARTH PRESSURE LOAD

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

However, for design of substructure of pump house, cold water basin of cooling water and under ground liquid storage tanks earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure etc., a minimum surcharge load of 20kN/sqm shall also be considered for the design of all underground structures including basement, channels, sumps, cable & pipe trenches etc., to take into account the vehicular traffic in the vicinity of the structure.

In case of heavy wheel loads, lateral surcharge due to actual wheel loads shall be substituted.

When a portion or whole of the adjacent soil is below free water surface, computations shall be based on submerged weight of soil plus full hydrostatic pressure.

When pressure relief valves are allowed for the underground structures only 50% relief shall be considered on lateral pressure due to ground water and the buoyancy check.

Dynamic effect of earth pressure due to seismic conditions shall be considered along with hydrodynamic effect water / liquid storage structures.

5.4.10 HYDROSTATIC PRESSURE LOAD

Ground water level for calculation shall be considered at finished grade level.

Buoyancy load also be considered.

5.4.11 OTHER LOADS

Test loads of pipes, tanks, vessels, etc., where ever applicable shall be considered.

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

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

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

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

Equipment loads shall not be considered as a part of DL for checking the stability of the structure.

For large structure design, construction loading depending on methodology of construction shall be considered. Temporary loadings likely to be imposed are due to handling of concrete, formwork, hoist fixing, storage of materials, temporary access etc. Loads due to foundation settlement shall also be considered.

For large structures the method of construction and the type of formwork to be used shall be decided by the Contractor in advance and should be enclosed in the bids submitted. Construction loadings that may occur during execution of work shall be considered in the design of the structure. Factors causing temporary loading may include the following depending upon the method construction.

a. Barrowing of concrete
b. Scaffolding and formwork
c. Loads produced by anchoring devices of climbing scaffolds
d. Hoist fixings
e. Storage of materials on scaffolding
f. Temporary access
g. Tower crane fixing

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.

Wheel and Crawler Loads

Loads exerted on bridges, roadway pavements, parking and unloading areas, buried piping, box culverts, and embankments shall be reviewed and selected prior to design of the underlying items. The loads as recommended for IRC class AA loading and class A vide live load shall be utilized for the design of bridges, roadways, and parking and unloading areas.

However, exact loadings shall be considered in areas where appropriate, loadings such as loaded scrapers, crawler cranes, stator transport trailers, etc., might exceed these loadings.

5.4.12 LOAD COMBINATIONS

5.4.12.1 Building / Structures

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

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

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

Crane Lifted Load shall be considered during wind condition.

Crane lifted load need not be considered in calculation of lumped mass for seismic analysis. 50% of the Lifted load of crane shall be considered for seismic load combinations.

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

Wind and Seismic loads acting in the transverse and longitudinal direction shall be considered independently as separate load cases.

5.4.12.2 Underground Structures

Based on the data on subsoil and underground water, adequate precautions shall be taken for design of foundation and underground structure. All under ground structures such as sumps, pits, trenches etc. shall be designed considering soil, water and surcharge pressures.

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, reservoirs, trenches and other underground structures.

a. Only liquid pressure from inside and no earth pressure & ground water pressure and surcharge pressure from outside (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. Base slab of the pump house shall be designed for the condition of different combinations of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

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

e. Water in one compartment and other compartments empty (where more than one compartment is provided).

Walls of reservoir with top slab shall be designed as propped cantilever slab between top and bottom slabs (where L/h > 2.5) or as a two way slab with three sides fixed and top side propped (where L/h <2.5).

The structures shall also be checked for stability and factor of safety shall not be less than those specified under applicable Clause of IS 456 against overturning and sliding. Proper considerations in design shall be taken to prevent any possibility of floatation due to upward thrust caused by underground water. Factor of safety against uplift shall be at least 1.2 as per IS 3370 (Part-1). Special care shall also be taken to prevent floatation during construction period.

5.4.13 SPECIAL STRUCTURES

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

Coal bunkers

The coal bunker shall be designed as per criteria specified in IS: 9178 (Part I&II).

Ash silos

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.

Coal Handling System

The following loads shall be considered for design of various structures:

(a) Flat roof - accessible	:	1.00 KN/sqm dust load
- Non accessible	:	1.25 KN/sqm dust load
(b) Inclined roof	:	1.00 KN/sqm dust load
(c) Building floors	:	5kN/m2 + equipment load if any +1.0 kN/m2 for spillage load
(d) Load due to material on belt	:	1.6 times weight of the material on belt to take care inertia forces, over burden and impact factor.
(e) Spillage load		
i) Gallery walk way	:	1.0 KN/sqm
ii) Seal plate	:	1.0 KN/sqm
(f) Belt tension for twin conveyors	:	One belt at starting condition and one in running condition
(g) Impact factor for drive machines	:	1.50

5.4.14 INCREASE IN STRESSES

Concrete Structures

The increase in stress is applicable only when wind (or seismic) and temperature are combined with those due to dead, live and impact in case of working stress method for concrete.

Steel Structures

For steel structures the increase in stresses by 33.33% is allowed when effect of wind or seismic is taken into account provided wind load is not the main load acting on the structure.

Soil Bearing Pressures

Allowable bearing capacity of soil / pile capacity may be allowed to increase by 25% under seismic / wind load condition except for chimney, NDCT and other wind prominent structures, where increase in bearing capacity / pile capacity shall not be considered.

SECTION 5.5

REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS

TABLE OF CONTENTS

5.5.1 GENERAL

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

5.5.2 DESIGN METHODOLOGY

5.5.2.1 General RC Structures

All designs of RCC structures shall be carried out by limit state method as per IS: 456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456.

For reinforcement detailing IS:5525 and SP:34 shall be followed.

The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

5.5.2.2 Foundations and Underground Structures

Foundations for structures and equipment shall be proportioned to resist the worst conditions of loading and shall be generally designed as per the provisions of IS:1904. The depth of foundation shall be determined based on loading on foundation, safe bearing capacity at the founding level, constructional and technological requirements. The allowable bearing pressure for design of foundation shall correspond to values confirmed by results of detailed soil investigation taking into account limits of allowable settlement considered for design of structures and equipment. Safe bearing capacity shall be determined from shear failure and settlement criteria and least value shall be considered.

The foundations shall be designed for the following factors of safety:-

a) Shallow foundations : 3.0

b) Deep foundation systems : 2.5

For this purpose, any foundation depth of more than 4.0 metres shall be treated as a deep foundation.

Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS: 1904 and other Indian Standards.

Maximum settlement for, (as per Table 1 of IS: 1904)

a) Isolated footings : 25 mm

b) Rafts : 40 mm

However, the settlement shall be restricted to a lower value, if necessary as per the system requirement.

Settlement criteria for shallow foundations shall be generally as follows, subject to specific equipment requirement & differential settlement.

i)	Total settlement	:	38 mm
ii)	Differential settlement	:	6 mm

Static, dynamic and integrity tests shall be performed by an independent testing analyst.

All foundations including machine/equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant parts of IS: 2974 and IS: 456 as per working stress / limit state method of design. Raft foundation shall be designed as per IS: 2950

All underground pits, tunnels, basements, cable and pipe trenches, etc., shall be leak proof RCC structure where specified design depth of ground water table so warrants. Effects of uplift and reduction in bearing capacity due to underground water table shall also be considered.

In case of isolated foundations, partial contact between foundation and soil strata shall be considered wherever applicable and footings shall be checked for minimum contact area (90%) and maximum bearing pressure. Foundations shall be checked for safety against sliding and overturning.

No foundation shall rest on filled up soil. Minimum depth of foundation shall be at least 1.5m below virgin soil. CNS (cohesive non swelling) soil shall be used for foundations on shallow depth.

For all underground structures such as basement, sump etc., and water retaining structures special care shall be taken to water proof them. Approved integral water proofing compound shall be added to concrete mix to ensure water tightness. PVC waterstop shall be provided at all construction joints as required. Water retaining structures shall be hydro-tested as per IS:3370 for leakage and in case leakage is noticed pressure grouting or any other approved procedure shall be adopted to rectify it. Sumps with pumping arrangements shall be provided at suitable location in underground structures to collect and pump out any incidental water collection to nearest storm water drainage outlet.

Generally foundation for buildings & equipment shall not be structurally connected to ground floor slab. The top level of the stem for building structural column foundations shall be so provided that no part of the steel column base assembly protrudes over finished floor level. The column base assemblies shall be encased with M-15 grade concrete up to floor level.

Supporting structures and foundations for equipment that may cause vibration shall be designed for the dynamic effect of equipment together with the direct loads. The dynamic loads and other relevant data required for analyzing the dynamic effect shall be taken as per manufacturers' data and recommendations.

Foundations of equipment subjected to dynamic loading shall be isolated from adjoining floors/foundations to prevent propagation of vibration to adjoining structures. Structures and foundations supporting vibrating, equipment shall be proportioned to avoid resonant frequencies. The dynamic analysis shall be done as per the stipulations as recommended by respective IS codes as well as the stipulations recommended by equipment manufacturer.

75mm thick lean concrete 1:4:8 shall be provided below footings, pile caps, base slab etc. as blinding concrete layer.

Pile Foundations

The detailed design, preparation of construction drawings, installation and testing of piles forming foundations to buildings and structures shall conform to the latest IS:2911 – Code of Practice for Design and Construction of Pile Foundations.

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.

5.5.2.3 Liquid Retaining Structures

Water retaining structures shall be designed as per provisions of IS 3370 and IS 456 by working stress method.

In case of leakage in the above structures injection grouting method shall be applied to repair the structure according to the requirement of IS: 6494.

All water retaining / storage structures shall be designed assuming liquid up to the full height of wall irrespective of provision of any over flow arrangement.

Pressure relief valves with 50% uplift load can be permitted in the following underground structures

a) Cooling Water Fore bay
b) Cooling Water Channel

Pressure relief valves shall be of gun metal.

Approved water proofing compound shall be used for addition in concrete to all liquid retaining structures.

In all liquid retaining structures, PVC water bar shall be provided at each construction / expansion joint. The sequence of construction shall also be specified on drawings showing construction joints.

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

5.5.2.4 Machine Foundations

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

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

Dynamic analysis shall be carried out for all major vibratory equipment foundations where manufacturer supplies the complete dynamic loading data along with limitation on design criteria. All block foundations resting on soil shall be designed using the elastic half space theory or Barken's theory. Block foundation resting on piles shall be designed using Novak's or Barken's theory.

The mass ratio for centrifugal machine shall be 3 and for reciprocating machine ratio shall be 5. 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 the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes and / or machine manufacturers shall be satisfied.

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

For the foundations supporting minor equipments 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.

Steam turbine generators, Boilers Feed Pumps and crushers may be supported on vibration isolation system. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096. The whole system is supported on block foundation consisting of common raft and pedestals. Requirement of vibration isolation system shall be decided based on the requirement specified by the equipment supplier.

For design of inertia block of fan foundations, mill foundations, same criteria as specified above shall be followed except that the analysis can be based either on a plate model / Three dimensional solid finite element model. Dynamic analysis shall be performed, frequency and amplitudes shall be checked as per codal / manufacturer requirements. The permissible amplitude of vibration shall be as specified by the manufacturer guidelines. It shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads.

All such foundations shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitably to ensure integral action.

For inertia blocks above vibration isolation system for dynamic foundations shall use concrete of minimum of grade M30.

The foundation systems for rotating equipment shall be sized and proportioned not to exceed the bearing and settlement criteria and to assure satisfactory performance of the equipment. In addition to a static analysis, a dynamic analysis shall be performed to determine the fundamental frequencies of the foundation system. To preclude resonance, the fundamental frequency of the foundation shall be 25 percent away from the operational frequency of the equipment. The dynamic behavior of the foundation shall meet the requirements of IS: 2974 (Part I to IV).

If minor equipments are to be supported on building structures, floors etc suitable vibration isolation shall be provided.

5.5.2.5 Tank Foundations

Foundations for vertical steel tanks shall be resting on hydraulically compacted clear river sand, in layers of 500 mm thickness topped with 150 thk PCC. PCC layer shall be topped with 50 thk. Anti-corrosive asphalt layer, which in turn is topped with 50 thk. Premix carpet. The entire sand fill along with toppings shall be confined within a RCC ring beam of appropriate design.

5.5.3 STABILITY OF STRUCTURES

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits trenches, basements, etc.

Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken in to consideration.

All building and sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

a. Factor of safety against overturning 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.

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

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

5.5.4 MINIMUM THICKNESS OF STRUCTURAL ELEMENTS

The following minimum thickness shall be followed :

a.	Suspended floor slab / roof slab / walkways / canopy slabs etc.	-	125 mm
b.	Ground floor slab (non — suspended)		
	Plant buildings	-	200 mm
	Non — Plant buildings	-	150 mm
c.	Water Retaining Slab / Walls	-	200 mm
d.	Cable / Pipe Trenches / Underground pit / Launder walls and base slab	-	125 mm
e.	All footings (including raft foundations)	-	300 mm
f.	Tapered footings	-	200 mm (Min. at edges)
g.	Parapets / Chajjas	-	125 mm
h.	Sunshades	-	75 mm at edge
i.	Precast louvers / fins	-	50 mm
j.	Precast trench cover slabs / floor slabs/ louvers	-	75 mm
k.	Paving	-	100 mm
l.	Pile cap	-	500 mm

m.	Basement walls and base slab	-	200 mm
n.	Silo / bin walls	-	150 mm
o.	Underground reservoir		
	Below ground water table	-	200 mm
	Above ground water table	-	150 mm

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig 1 of IS 456. Minimum fire rating of 2 hours shall be considered where fire hazard is expected.

5.5.5 MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS

Pedestals to Steel columns for building structures

Top of RCC pedestals for structural steel columns shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation levels of some columns shall be changed suitable to accommodate underground services, pits trenches, etc.

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

Top of Pedestals to Steel Columns for Equipment structure and Pipe Racks:

a.	Equipment in open area	-	as required (500 mm min.) above FFL
b.	Equipment in covered area	-	as required (150 mm min.) above FFL
c.	Structures / equipment supplied by Vendor	-	as per vendor's data subject to vendor's minimum or as specified above
d.	Coal Handling Area	-	500 mm above finished ground level
e.	Ash Handling Area	-	500 mm above finished ground level
f.	Pipe and Cable Rack	-	500 mm above finished ground level

Anchor bolts shall be provided in pedestals for fixing of structures subject to uplift forces. Such pedestals shall be checked for uplift with 50% soil overburden and 0.9 times dead loads.

5.5.6 MINIMUM HEIGHTS FOR ENCASEMENT OF STEEL COLUMNS

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

a.	Open area	-	300 mm above paved level
b.	Covered sheds	-	150 mm above the finish floor level
c.	Structural steel buildings	-	1000 mm above the finish floor level
d.	Boiler columns	-	upto a height of 8.0m from paved level.

5.5.7 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. 53-grade Ordinary Portland Cement (OPC) conforming to IS: 12269, fly ash based Portland Pozzolona cement as per IS: 1489(Part-I) or 43-grade ordinary Portland Cement as per IS: 8112 shall be used. For aggressive/saline soil approved cement shall be used. Sulphate resistant cement shall conform to IS: 12330.

Mix (1 : 4 : 8)	-	Fill concrete Foundation below brick wall Blinding layer below foundations, pile caps, grade slabs, Trenches and underground structures, etc. (Minimum thickness of the layer shall be 75 mm)
Grade M15		Base plate encasement Encasement of structural steel work Screed concrete
Grade M20	-	Ground floor PCC slabs Grade level paving Pavement around building including plinth protection work
Grade M25	-	All RCC drains
Grade M30	-	All RCC members including: Foundations, Superstructure, Grade beams, Pedestals, Ground floor slabs, Roof slabs, Water retaining structures, Pile and Pile Cap, Cable and pipe trenches including precast covers
Grade M35	-	For Coal Mill Foundations
Grade M35	-	For foundation of STG, BFP, PA Fan, FD Fan, ID Fan etc.,

Intermixing of different grades of concrete in the same structure shall not be allowed in a particular structural element.

Minimum cement content shall be governed by the requirement of IS: 456 for normal concrete structures and IS: 2911 for piles.

However higher grade of concrete shall also be used than the minimum specified above to satisfy the design requirement for TG foundations, BFP foundations, under ground structures, etc.

The Minimum Cement content and water cement ratios shall be as per the concrete mix design report subject to a minimum cement and maximum water cement ratio (as per IS: 456) for Concrete grades as follows:-

M15	:	240 kg/m^3 & 0.6
M20	:	300 kg/m^3 & 0.55
M25	:	300 kg/m^3 & 0.50

M30	:	320 kg/m^3 & 0.45
M35	:	340 kg/m^3 & 0.45
For Piles	:	400 kg/m^3 & 0.45

For water retaining structures the minimum w/c ration shall be 0.45

Unless specified 20mm and downgraded aggregates shall be used for all structural concrete works. However 40mm and downgraded aggregates may also be used under special conditions for foundation. Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases of high percentage of reactive silica content, aggregate may be allowed where low alkali cement shall be used. Lime stone aggregate shall not generally be used for foundations which are subjected to high temperature and repeated temperature cycles (like in the case of all machine foundations).

5.5.8 REINFORCEMENTS

High strength deformed steel shall be used for all RCC structures. The grade of reinforcing steel shall be Fe500 or Fe415.

All reinforcement shall be of CRS (Corrosion Resistant Steel) bars conforming to the requirements of IS 1786 and shall be used for all RC structures unless specified else where.

Reinforcement bars shall be as per the following codes:

High Yield Strength Deformed bars	-	IS: 1786
Mild steel bars	-	IS: 432 Grade 1
Welded wire fabric	-	IS: 1566

Inter mixing of different grade of reinforcing bars in the same structure shall not be done.

Reinforcement detailing shall be as per IS: 5525 and SP 34.

Minimum percentage of reinforcement shall be as per relevant applicable standards.

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

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

5.5.9 GROUTING

Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticizer 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.

Ready mix grout with Shrink-comp or Conbextra GP2 or equivalent shall be used for base plate grouting works for all major equipments.

Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M35 for equipment foundations and M40 for dynamic equipment foundations.

Nominal thickness of grouting shall be at least 50 mm for building columns and pedestals of major equipments or as specified by the equipment supplier.

For pipe rack pedestals, secondary posts, stair and ladder base etc. grouting shall not be less than 25 mm thick.

Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.

Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water. Water in anchor bolt holes shall be removed before grouting is started.

Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release entrapped air link chains can be used to work the grout into place.

Grouting through holes in base plates shall be by pressure grouting.

Forms and shims used to obtain adequate clearance shall not be removed and the anchor bolts shall not be tightened for at least three days after placing the grout. After the removal of forms and shims, area occupied by shims shall be filled and the area between the base and edge of the foundation shall be finished smooth to allow drainage away from the base. Attachment of interconnecting piping of machinery and complete load transfer of machinery shall not be done before the bolts are tightened.

5.5.10 MINIMUM COVER TO FOUNDATION BOLTS

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

a. Clear distance from the edge of the base plate / base frame to the outer edge of the pedestal shall be minimum 50 mm.

b. Clear distance from the face of pocket to the outer edge of the pedestal shall be 75 mm.

c. Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 75 mm.

5.5.11 MINIMUM COVER TO REINFORCEMENT

The clear cover to reinforcement shall be for 2 hours fire rating as per table 16A of IS: 456 and also meet the requirement of durability requirements based on exposure conditions as per table 16, which ever is stringent.

The minimum cover to the main reinforcement for all the structures, unless otherwise specified, shall be as follows :

Slabs (roof and floors, canopies, chajjas, waist slab in stair etc.)		:	15 mm or dia of bar whichever is more
Beams, Lintels		:	25 mm or dia of bar whichever is more
Columns		:	40 mm
Pedestals		:	50 mm
Dry pits / retaining walls			
i.	Face in contact with earth	:	50 mm
ii.	Free face	:	40 mm
Water / Liquid retaining structures			
i.	Face in contact with liquid	:	40 mm
ii.	Away from liquid but in contact with earth	:	50 mm
iii.	Base raft, pile caps	:	75 mm
Footing			
i.	Sides and top	:	50 mm
ii.	Bottom	:	50 mm
iii	Piles	:	75 mm

5.5.12 MISCELLANEOUS REQUIREMENT

5.5.12.1 Formwork Requirements

Plywood formwork shall be used for all water retaining / conveying structures and for all over ground concrete works. For other areas steel / plywood formwork shall be used.

No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

In watertight construction, methods of fixing formwork, which result in holes through the concrete section when the formwork is removed, shall not be used. All wall ties shall have water baffles and wall kickers shall be cast monolithically with the base slab.

Approval for the size, type and position of any holes, insert or fixing required by Contractor shall be obtained before work proceeds. Unless otherwise specified or approved all holes shall be formed and all inserts cast in at the time of pouring No part of the concrete works shall be drilled or cut away without approval.

Formwork panels shall be stiff enough to prevent damage to the concrete surface caused by excessive movements of the panel during vibration of the concrete.

Damaged and used formwork shall not be re used without repairing.

All joints in form work and joints between the form works shall be sufficiently tight to prevent loss of liquid from the concrete through these joints.

The part of the ties shall be capable of being removed, so that no part remaining embedded in the concrete shall be nearer the surface of the concrete than the specified thickness of cover to the reinforcement. Holes left after the removal of ties shall be filled with concrete or mortar of approved composition.

Formwork props shall be positioned between permanent supports so that all members are supported at not more than 3 meters centre in both directions.

The props shall be in the form of space frames, composite or single members with sufficient stiffness or bracing so that props shall neither sway nor buckle under loads which they are designed to carry.

The formwork or the false work shall not be removed from a structural component until CONTRACTOR ensure that the concrete has attained sufficient strength.

The concrete is to be regarded as sufficiently hardened when the component has attained such strength that it can resist all loads acting at the time of removal of the formwork.

Particular care shall be taken with components which have to carry virtually the full design load directly upon removal of the false work (e.g. in the case of roofs, or floor slabs which have to support loading from floors above them which have not yet hardened).

Props shall remain in position for as long a period a possible, particularly for structural components, which are subjected to a major proportion of their design loading as soon as the formwork has been removed.

No superimposed load shall be allowed on any part of the concrete work prior to the removal of the forms and props.

Tolerance for formed and concrete dimension shall be as per IS:456.

5.5.12.2 Placing of concrete

Before each concreting CONTRACTOR shall give sufficient notice to the Owner as directed such that an inspection shall be made before the concreting.

The concrete shall be mixed in the mixer of adequate capacity having a power elevated loading hopper. The mixer shall be equipped with an automatic water-measuring tank filled with a device for locking the discharge setting. The Mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

Any concrete surplus to immediate requirements shall be thrown away. In no case circumstances may the surplus be used later.

The volume of mixed materials in each batch shall comply with the mixer manufacturer's written recommendations.

Concrete shall be transported as quickly as possible from the mixer to its final position without segregation or loss of any of the ingredients.

All equipment to be used for transporting material shall be kept clean; all containers used for transporting concrete shall be thoroughly washed out whenever mixing ceases.

Concrete shall be placed continuously up to construction joints while it is still sufficiently plastic for adequate compaction.

At all times when reinforced concrete is being placed a competent steel fitter shall be in continuous attendance. CONTRACTOR shall adjust and correct the position of any reinforcement, which may be displaced.

CONTRACTOR shall keep on site a complete record of the works showing the time and date when concrete is placed in each part of the work.

Concrete shall be thoroughly compacted by suitable mechanical vibrators during placing and shall be carefully worked around all reinforcement and embedded fixtures and in to the side and corners of the formwork.

Whenever, concrete is being vibrated at least one spare vibrator of each type in use shall be available in case of breakdown.

Compaction shall start as soon as there is sufficient concrete within the formwork to immerse the vibrator and vibration shall continue during the placing operation so that at no time shall there be a large volume of uncompacted concrete in the form work.

For top surfaces of slab and other surfaces for which formwork is not provided a smooth finish shall be provided with a wooden float after compaction.

The concrete shall not be placed directly against a vertical form face but shall be placed to flow to this surface during the compaction process. Care shall be taken to avoid the form face being splashed with mortar during the placing operation.

Exposed surfaces, immediately after final set, shall be protected from the sun. All concrete shall be well watered after it has been set and shall be kept continuously damp until thoroughly cured. Provision shall be made for adequate water distribution to all parts of the work so that if required this treatment can be continued sufficiently throughout the whole period of construction. In order to to keep the concrete continuously damp, all exposed surface shall be covered with continuously damped gunny bags or shall have water compounded on them, for full period of curing.

On exposed concrete surfaces in high sun temperatures and /or strong drying wind conditions CONTRACTOR shall use curing method, which also shields the concrete, and this shall be placed in position not later than half an hour after final tamping.

Base mat and top deck of machine Foundations shall be cast in a single pour inaddition to the requirement specified above.

5.5.12.3 Temperature Control of Concrete

The placing temperature of fresh concrete shall not exceed 23 deg.C.For maintaining the temperature of 23 deg. C during concreting of machine foundations, crushed ice shall be used in mixing water.

5.5.12.4 Scheme for Concreting

Weigh batching plants shall be mobilized for all machine foundations. Concrete pump shall be mobilized for TG raft, TG Top deck, BFP Deck, PA/FD/ID Fan deck, Mill Deck. Arrangements for stand-by Plant and Equipments shall also be made.

5.5.12.5 Testing of concrete in structures

The types of tests described hereinafter are applicable to the finished parts of the structures.

They may be used in routine inspection and for quality control.

Type of tests:

a) Cutting cores: The procedure used shall comply with the requirements of IS:516 or an approved equivalent standard.

b) Gamma radiography: The testing shall be carried out in accordance with the requirement of IS:13311 Part 1 or equivalent.

c) Ultrasonic test: Such tests may be used to obtain approximate indications of the strength of the concrete in the structures (IS:13311 Part 1).

d) Electromagnetic cover measuring devices: Such tests may be used to verify the position of the reinforcement and shall be in accordance with the requirements of design (IS:13311 Part 1).

e) Rebound hammer test: Such tests may be used to obtain approximate indications of the strength of the concrete (Ref. IS:13311, Part 2).

f) Load tests of structures or parts of structures: If the results of the above mentioned check tests show that the quality of the materials is inadequate or if other defects are revealed, the Owner may require a loading test to be made.

For the purpose of testing floors, roofs and similar structures and their supports, the test load shall be equivalent to the sum of the characteristic dead load and one-and-a quarter times (1.25 times) the characteristic imposed load for a period of 24 hours which the works or part thereof to be tested have been designed.

Wherever certain procedures for testing of parts in structures (e.g. piles) are required by standards or codes of practice, these are to be followed. All tests must be conducted in the presence of the Owner.

If within 24 hours of removal of the imposed load, the structure does not recover at least 75% of the deflection under superimposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80%, the structure shall be deemed to be unacceptable.

If the result of the test is not satisfactory, the Owner shall instruct that the part of the works concerned be taken down or cut and reconstructed to comply with this specification. The contractor shall at his own cost take down or cut out and reconstruct the defective work.

The Owner may require other tests to be carried out. Number of samples, tests and types will be as per Owner requirements.

All the costs for the above mentioned tests shall be borne by the contractor

Ultrasonic pulse velocity test shall be carried out for the top decks and columns of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete.

In addition, additional cubes (at the rate of one cube per 150 cum of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes to serve as reference UPV values.

5.5.12.6 Other Requirements

Haunches and Fillets at the junction of roof / bottom slab with vertical walls shall be provided with cast in situ cement concrete.

A screed layer not less than 100 mm thick of cast in situ concrete shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.

5.5.13 CORROSION PROTECTION OF CONCRETE STRUCTURES

5.5.13.1 Admixture

Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA) shall be used. CPCIA shall be free from nitrites, chromates and non-migrating types and having 7-8 years of usage history in Indian conditions conforming to ASTM-G-109 with an efficiency factor of minimum 25 times. Dosage as per manufacturer specifications shall be compatible with the type of cement used.

5.5.13.2 Concrete Surface Treatment

Two coats of tar extended moisture compatible coating with a DFT of 300-350 microns. The system shall have minimum 7 years successful usage history in Indian conditions with the following properties

- Salt spray test ASTM-B-117 : Pass 1000 hours min
- Adhesion ASTM-D-4541 : 3.8 N/mm2 min
- Resistance (Impedance) : 10^8 Ohms

5.5.14 PROTECTION OF CONCRETE STRUCTURES IN CONTACT WITH SEA WATER

All concrete surfaces in direct contact with sea water shall be applied with tar extended two component coating system.

High Performance Moisture Compatible Corrosion Resistant Coating System shall be as per technical specifications of Central Electrochemical Research Institute, Karaikudi (CSRI affiliate institute), Tamilnadu, PIN-630006.

The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

The coating system shall confirm to the following:

Properties of Paint

Base	High Performance Moisture Compatible Corrosion Resistant Coating System CECRI know-how system
Volume Solids	70 %

Specific Gravity (ASTM-D-1475)	1.25 ± 0.1
Dry Film Thickness (ASTM-D-1186)	160 ± 10 μm per coat
Coverage	4 – 4.5 sq.m per litre
Touch Dry	2 Hours
Recoating	24 Hours
Properties of Coating	
Salt Spray (ASTM-B-115)	2000 Hours
Resistance to sea water (carried out upto 6 months)	Passes
Coating Resistance (carried out upto 6 months)	10^9 Ω cm^2
Adhesion (ASTM-D-4541)	4.5 Kn minimum
Flexibility (ASTM-3363	1/8 " passes
Elongation	33 %
Impact (ASTM-G-14-04)	45 cm passes

Paint material and its application method shall be obtained from any manufacturer who has been granted license by CECRI, Karaikudi for technical know-how for High Performance Moisture Compatible Corrosion Resistant Coating System.

The application method of coating shall be got duly approved by CECRI, Karaikudi.

5.5.15 STRUCTURES IN COAL HANDLING PLANT AREA

The Contractor shall have to consider the following design criteria during design of structures in CHP area in addition to other design parameter mentioned elsewhere in this specification.

1. All underground R.C. basement like structures with provision of water proofing treatment (excluding structures under influence of Railway Load) including Tunnels subjected to subsoil/liquid pressure shall be designed as per IS-456.

2. All structures under the influence of Railway load with provision of water proofing treatment shall be designed strictly in accordance with stipulations contained in Indian Railways Bridge Rules and relevant codes considering stress in concrete governing. However, check for shear strength at certain critical section shall have to be done as per IS-456 as decided by the Owner. Impact factor for Railway loads shall be 0.4 times the wheel loads for movement of the same.

3. The underground walls/raft of basement/tunnel shall be designed adopting sound engineering practice. The minimum thickness of various components shall be as follows irrespective of method of design adopted:

   a) Walls of depth from 0 — 5 M : 300 mm
   b) Walls of depth from 5 — 10M : 500 mm

c) Walls of depth from 10 — 15 M : 700 mm
d) Base Slab of u/g basement : 500 mm
e) Roof of tunnel : 500 mm

4. Dispersion of loads (arising out either of Railway load, Dozer load surcharge or any other load) through soil and coal shall be considered 7 vertical: 1 horizontal or 1 vertical: 1 horizontal whichever is critical.

5. Factor of safety of foundation/structure during and after construction shall be as under:

   a) Sliding and over turning as per 15-456 and 1S-1094
   b) Minimum FOS shall be 1.20 considering dead weight of structures as 0.9 times the actual value.
   c) Uplift of shallow foundations due to tension in building column Minimum FOS shall be 2.0

6. For design purpose the ground water table shall be considered upto finished grade level.

7. For design of R.C. structures. Bulk density and angle of repose for coal shall be considered as 1.2 MT/Cu.M and 31 Deg. Respectively.

8. For deep underground structures, minimum clear cover for outer reinforcement shall be 40 mm unless otherwise stated.

9. All hoppers shall be designed under the following load conditions:

   e) The hopper is full upto it's full capacity with top surface horizontal at grating level.
   f) The hopper IS partially empty with the highest level of coal at grating level and making an Angle of 37 Deg. With horizontal.

   The above conditions are to be analysed for the case where the whole content of coal within the hopper is supported by the hopper only without taking support from paddle feeder platform (in case of Track Hoppers) The hopper shall also be designed for lateral coal pressure, frictional forces during filling and emptying and forces due to impact and falling of arches of coal within the hopper etc.

   The Reclaim Hoppers additional loads due to bulldozer or coal pile unto 4.0 M height or a critical combination of the above two loads shall be considered.

10. In addition to dead load, live load, wind/seismic loads, all steel structures specially conveyor galleries and trestles shall be designed for thermal loads for a difference of temperature of 40 Deg.C.

11. The crusher foundation shall be of R.C.C. analysed both for static and dynamic load conditions as per IS-2974. The top deck shall be minimum 1.0 M thick. The amplitude of vibration under normal running condition shall not exceed 100 Micron and under 2 (two) missing hammer condition or severe maintenance condition (whichever is critical) shall be limited to 200 Micron. Three Dimensional (3D) method of analysis shall also be adopted for calculating frequency and amplitudes in addition to plane frame method. The Crusher Foundation may also be supported on suitable heavy duty vibration isolators having viscous dampers supported on building steel frame. The top R.C.C. deck in such case also shall not be less than 1.0 M.

5.5.16 CONSTRUCTION REQUIREMENTS

5.5.16.1 Standards

Unless otherwise specified, the following standards shall apply to the works covered under this chapter.

Cement

IS:269 33 grade ordinary Portland cement.
IS:455 Portland slag cement.
IS:1489(Part-1) Portland pozzolana cement – Fly ash based.
IS:4032 Method of chemical analysis of hydraulic cement.
IS:6452 High alumina cement for structural use.
IS:8041 Rapid hardening hardening portland cement.
IS:8112 43 grade ordinary Portland cement.
IS:12269 53 grade ordinary Portland cement.
IS: 12330 Sulphate resisting Portland cement.

Aggregate

IS:383 Coarse and fine aggregates from natural sources for concrete.
IS:460 Test sieves (All parts).
IS:2386 Methods of test for aggregates for concrete (All parts).
IS:2430 Methods of sampling of aggregates for concrete.

Concrete Plain and Reinforced

IS:456 Code of practice for plain and reinforced concrete.
IS:516 Method of test for strength of concrete.
IS:737 Wrought aluminium and aluminium alloy sheet and strips for general engineering purposes.
IS:1199 Methods of sampling and analysis of concrete.
IS:1607 Methods for test sieving.
IS:1834 Hot applied sealing compounds for joints in concrete.
IS:1838(Part-1) Preformed fillers for expansion joint in concrete pavements and structures (non extruding & resilient type)– Bitumen impregnated fibre.
IS:1893 Criteria for earthquake resistant design of structures.
IS:2645 Integral cement water proofing compounds.
IS:2750 Steel scaffolding.
IS:2974 Code of practice for design and construction of machine foundations (All parts).
IS:3370 Code of practice for concrete structures for the storage of liquids (All parts).
IS:4326 Earthquake resistant design and construction of buildings — code of practice.
IS:6494 Code of practice for water proofing of underground water reservoirs & swimming pools.
IS:9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS:9103 Admixtures for concrete.
IS:9893 Precast concrete blocks for lintels and sills.
IS:10262 Recommended guidelines for concrete mix design.
IS:10297 Code of practice for design and construction of floors / roofs using pre-cast reinforced / pre-stressed concrete ribbed or cored slab units.
IS:10566 Methods of tests for preformed fillers for expansion joints in concrete paving and structural construction.
IS:10790 Methods of sampling of steel for prestressed and reinforced concrete (All parts).
IS:12118 Two parts polysulphide based sealants (All parts).

IS:13920 Ductile detailing of reinforced concrete structures subjected to seismic forces – code of practice.
SP:23 Handbook on concrete mixes.
BS:5606 Guide to accuracy in buildings.
ACI:347 Recommended practice for concrete formwork.

Reinforcing Steel

IS:432(Part 1) Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement.
IS:1566 Hard-drawn steel wire fabric for concrete reinforcement.
IS:1568 Wire cloth for general purposes.
IS:1786 High strength deformed steel bars and wires for concrete reinforcement.
IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.
IS:2751 Recommended practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
IS:5525 Recommendations for detailing of reinforcement in reinforced concrete works.
IS:9417 Recommendations for welding cold worked bars for reinforced concrete constructions.
SP:34 Handbook of concrete reinforcement and detailing.

5.5.16.2 Materials

The materials described below shall be specified and used.

Aggregates

Fine aggregates shall be clean natural sand. Coarse aggregates shall be crushed rock. All aggregates shall meet the IS requirements of IS:383.

Admixtures

Plasticizers and retarders shall be used to control setting time and to obtain optimum workability. Interior slabs to be trowel finished shall use less air entrainment. The use of calcium chloride shall not be permitted.

Water

Clean water of potable quality shall be used in all concrete mixes.

5.5.16.3 Storage of Materials

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration. Storage of materials shall conform to IS-4082 “Recommendation on stacking and storage of construction materials and components at site”. Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the contractor.

5.5.16.4 Sampling and testing of cement

All deliveries of cement to the concrete supplier shall be accompanied by a certified mill test report and shall include all of the physical and chemical properties as required by relevant IS-12269 for grade 53 cement, IS-8112 for grade 43 and IS-12330 for sulphate resistant cement.

The manufacturer’s test certificate will normally be accepted as proof of compliance with the specification, but the Owner may order further tests of a character specified in the appropriate Indian standards. The confirmatory tests are to be conducted by a recognized quality control

organization. The contractor shall bear all expenses required for the preparation, dispatch, and tests of the samples. In case the results of such tests show any sample to be inferior to specifications, the whole consignment from which the sample was taken shall not be used and shall be immediately removed from the site.

5.5.16.5 Delivery and storage of cement

The following information shall be provided for all cement shipments (either whole or part) which are intended for delivery to site: date of manufacture, date of original loading, destinations en-route, date of unloading, intended date of delivery to site.

Cement which has been manufactured for longer than 6 months on the proposed date of delivery to the site shall be inspected, sampled and tested for approval purposes before delivery to the site.

The contractor shall obtain and provide to the Owner the manufacturer's Bulk Average Test Certificate for each consignment of cement to the works. The certificates shall be provided before the consignments are required for use and shall show the chemical composition and physical properties determined in accordance with the relevant standard.

Samples shall be taken from each consignment of cement and tested as directed by the Owner in an approved independent laboratory.

When bulk cement deliveries are proposed, the contractor shall provide all information required by the Owner concerning off-site storage and loading arrangements and shall provide reasonable facilities for the Owner to inspect these arrangements for approval purposes.

Consignments shall be used in the order in which they were delivered.

All bagged cement shall be stored in a weatherproof building having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements shall be fully completed and approved by the Owner before any cement is delivered to site.

Each consignment of cement shall be separately stored for ease of access, identification, inspection and sampling. Sufficient stocks shall be maintained on site to ensure the proper progress of the works and the stock holdings shall be to the approval of the Owner.

If bagged cement is stored in silos it shall be charged into the silos through at 6.3 mm mesh screen which is welded or bolted to and covers the entire feed area of the silo charging hopper.

Cement stored in silos shall be adequately protected against rain, humidity and dewfall, and all silo charging and discharging points shall be properly sealed. Silo aeration equipment shall if available, incorporate de-humidifiers.

No cement from any consignment shall be used in permanent works without the approval of the Owner.

Cement which contains air-set or hardened lumps, re-powdered air-set material, foreign matter or which has been contaminated or is otherwise unsatisfactory in the opinion of the Owner will be rejected and shall be removed from site without delay.

The contractor shall be responsible for satisfying himself that the performance characteristics of cement are not such as to necessitate excessive cement content or be likely to cause or accentuate any undesirable properties in the fresh or hardened concrete notwithstanding apparent compliance with this specification.

Bulk cement shall be used for structures, bagged cement shall be used for masonry, plaster etc.

5.5.16.6 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The quality of water shall meet the requirements as per IS 456.

Ph value of water shall not be less than 6.

The concrete supplier shall provide chemical and physical test data for each source of water to be used prior to use.

When water is transported in tank trucks, each unit shall be accompanied by a chemical test report indicating compliance with the above requirements. All water to be analysed by an independent laboratory before any work commences and at intervals as direct by the Owner tests and quality of water shall be in accordance with IS:456 or equivalent.

The contractor shall make his own arrangement for water for construction and other purposes.

5.5.16.7 Aggregates

The aggregates for concrete shall be crushed natural rock subject to Owner's approval. The aggregate to be used in the work shall be supplied from an established pit or quarry. The aggregate source shall have a minimum five (5) years history of satisfactory performance in structural concrete and consistency of supply.

The concrete supplier shall obtain from the aggregate producer, or otherwise provide current test, examination, inspection reports performed and certified by an approved laboratory for submittal to the Owner.

As a minimum, this information shall include the following items:-

Item 1 A comprehensive description, with current photographs of the pit or quarry, including but not limited to, identification by name and location, type of deposit, age, potential reserves, primary products by size including average gradation based on previous six (6) months production and the range for each sieve size; mining methods, process equipment, quality control organization and laboratory; the primary and alternate means of product transportation; listing of primary and secondary users of the product.

Item 2 Petrographic examination in accordance with IS:2386 (Part-8) performed by a qualified concrete aggregate petrographer. This report shall be based on material produced and examined within the previous six (6) months and must be representative of the current production.

Item 3 Coarse aggregate shall be sampled from current production in accordance with IS:2386 (Part 1 to 8). Three [20 mm, 10 mm & 5 mm] nominal maximum size (NMS) aggregates shall be sampled and tested.

Aggregates when subjected to the tests defined in items above, unless otherwise approved by the Owner shall meet the requirements of IS:383 and IS:456.

Testing is to be carried out at the following intervals:

Type	Coarse Agg.	Fine Agg.
Grading	Daily	Daily
Specific Gravity	7 days	7 days
Magn Sulphate soundness	30 days	-
Clay, Silt and dust content	Daily	Daily
Shape (elongation and flakiness)	3.5 days	-
Los Angeles Abrasion	Initial stage only	Initial stage only
Moisture content	2 days	2 days
Drying shrinkage	Initial only	Initial only
Organic impurities	30 days	30 days
10% fines value for concrete	7 days	-

Combined grading also on a daily basis.

Storage and handling of aggregates

Aggregate stockpiles shall be arranged and used in a manner to avoid segregation and to prevent contamination with other materials or with other sizes of like aggregates. Aggregate delivery trucks shall be covered to prevent wind blown contamination. Aggregate stockpiles shall be located relative to prevailing winds to mitigate the accumulation of wind-borne dust.

Adequate storage shall be provided for each aggregate. The aggregate storage area shall be on concrete pavement sloped to drain excessive moisture. The aggregate storage area shall provide bulkheads to separate piles and protect against wind blown contaminants. Provision shall be made to shade and sprinkle the aggregates with potable water.

Rescreening Coarse Aggregate:

Rescreening and washing of coarse aggregates is required, if necessary, to reduce total chloride and/or sulphate contents to a level less than the maximum allowed by the specifications. If rescreening is required, the screening and washing shall be just prior to transferring aggregate to batch plant bins. Aggregates shall be dewatered over a screen to remove excess water before being stored in the batch plant bins.

Fine aggregate

Fine aggregate source shall be manufactured crushed stone or rock 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.

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:-

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

There shall be no clay or fine silt present.

The amount of hollow shells like to form voids or remain partially unfilled and present in material retained on a IS 2.36 mm sieve, determined by direct visual separation, shall not exceed 3% by weight of the entire sample. Fine aggregate shall not contain appreciable amounts of flaky and/or elongated particles.

The water absorption of fine aggregate, determined in accordance with BS 812 shall not exceed 2.0% by weight.

Fine aggregate subjected to five cycles of the soundness test, specified in IS:2386 (Part-5), shall not show a loss exceeding 10% when sodium sulphate solution is used and 15% when magnesium sulphate solution is used, except where approved otherwise.

Tests are to be executed in accordance with IS:2386. The grading of fine aggregate for concrete work shall comply with the requirements of IS:383. The grading of the aggregates should be such as to produce a concrete of thespecified 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.

Coarse aggregate

Coarse aggregate shall be crushed rock and shall be free from decomposed stone, clay, earth or other deleterious substances. The specific gravity of the coarse aggregate shall not be less than 2.5 t/m3. Aggregate of crushed natural stone is deemed adequate if the stone reveals a crushing strength of 1000 kg/cm2 when tested. Friable, flaky and laminated pieces, mica and shale shall only be present in such quantities as not to affect the strength and durability of the concrete.

The grading of coarse aggregate for concrete shall comply with the requirements of IS:383.

Samples of aggregates shall be submitted to the Owner, together with sieve analysis showing the proportion by weight passing sieves. When aggregates which are satisfactory to the Owner have been selected, the contractor shall secure his entire supply of each material from the same source so as to maintain the same quality and grading throughout the work. Should it become necessary to change the source or characteristics of the material supplied this shall only be done after additional tests.

5.5.16.8 Concrete Additives

Use of concrete additives

Concrete additives approved by the Owner shall be used to improve consistency, workability, quality and strength of the concrete.

Chemical admixtures manufacturer shall provide certified test reports from qualified independent laboratories showing actual test results indicating material that complies in all respects with the applicable specification.

Admixtures used in concrete shall conform to the appropriate specification and requirements as indicated below:-

a) Air entraining admixtures shall conform to IS:9103.
b) Water reducing and retarding admixtures shall conform to IS:9103. Accelerating admixtures shall not be used. High range water reducers shall be naphthalene-sulfonated polymer based material. No admixtures containing chlorides shall be used.
c) Chemical admixture suppliers shall provide certified test reports with each shipment indicating compliance with the appropriate specification. The test reports shall include the chloride content of the admixture, specific gravity and solids content.
d) Fibres: Polypropylene fibres shall be collated, fibrillated polypropylene fibre of approved manufacture.
e) Corrosion inhibitors: Reinforced concrete subject to contact with seawater and brine, as a result of submergence, splashing, spry, leakage from piping or plant, or from any other cause, shall have a proprietary concrete corrosion inhibiting compound incorporated into a concrete mix.

   The corrosion inhibitor shall be appropriate to the protection of steel reinforcement against corrosion throughout the 25 year design life of the structures. The corrosion inhibitor shall be compatible with the required concrete mix and shall be appropriate to the environmental exposure. Before incorporating corrosion inhibitor into any concrete mix, the contractor shall submit details for review and written consent by the Owner.

Admixtures used in production of concrete shall be the same as used in establishing the required concrete mix and shall be used in accordance with the manufacturer's directions.

Accelerating and retarding additives

Such additives shall only be used in case of necessity and after obtaining the written approval of the Owner.

Plasticisers and air entraining additives

Plasticisers and air entrainers are intended to reduce bleeding of free water at the surface. It shall only be used after the written approval of the Owner and in accordance with the manufacturer's instructions.

5.5.16.9 Concrete Mixes

General description and proportions and mixing

The mix proportions are to be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete is to be placed. The mix design shall be carried out by the contractor from approved agency. The design of mixes shall be based on the principles of IS:456- 2000.

Concrete aggregates and cement shall be proportioned and batched by weight. Water and liquid additives shall be proportioned. If the contractor wishes to use cement in bulk, his method of obtaining the correct proportions of cement shall be approved by the Owner before use.

Trial mixes

Before concreting commences, the contractor shall, at his own expense, make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing, transporting and compacting of the concrete with the equipment he proposes to use in any particular situation. Only materials which the contractor intends to use for concreting (including all admixtures) shall be used in the trial mixes. Test cubes from trial mixes shall be made and tested in accordance with IS:516. As per IS:456 and IS:516, three separate batches of concrete should be made, workability of each batch determined and three test cubes shall be made from each batch for each age (e.g. for 7 and 28 days) at which tests are required. The strength shall conform to target mean strength as per IS:456 – Requirements for design mixes.

The appropriate strength requirements may be considered to be satisfied if none of the strengths of the cubes is below the required characteristic strength and if the average strength of the nine cubes is not less than recommended by IS:456 and IS:516, trial mixes.

Quality and testing

Not more than 5% of the test results may fall below the 28 days specified strength. Making and curing of test specimens shall be in accordance with relevant IS:456, IS:516 and IS:1199. All mixes can only be placed following approval by the Owner. The mean strength shall exceed the characteristic strength by a margin of 1.65 times the standards deviation expected from the batching plant. However, no standard deviation less than 3.5 N/mm2 shall be used as a basis for designing a mix.

Trial mixes and field tests

Sufficient laboratory trial mixes shall be effected to show that concrete complies fully with the specified performance criteria. The following tests are to be included:-

a) Air content < 1%
b) Slump: Piles 170 + 25 mm, regular work 80 + 20 mm as per IS:1199.
c) Fresh and hardened concrete densities
d) Field trial mixes are to be carried out under full-scale site conditions as per IS:4925 (for structural concrete only).
e) Where directed by the Owner, concrete incorporating reinforcement details shall be cored to assess stratification of mixes. Cores of 150 x 200 mm (dia and length) are to be used.
f) Each trial mix shall have 9 x (150 x 150 mm) cubes taken to measure 24 hours/7 days and 28 day compressive strengths. These trials shall be run for three consecutive days (for structural concrete only).
g) At least 3 x sets of field trials shall be tested according to the provisions laid down in laboratory testing.
h) The average 28 day characteristic strength for trial mixes shall be higher by 10 N/mm2 than that for cubes taken in the field. Failure to comply shall result in the mix having to be re-designed.
i) All test results will have to be complied before approval can be given.

Consistency of concrete

The amount of water used in the concrete shall be adjusted as required to ensure such a consistency that it can be readily transported, placed and compacted without segregation of the materials or bleeding of free water at the surface. Addition of water to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of the concrete shall be checked by slump tests measured in accordance with IS-1199 and shall not exceed the values given in clause 7.1 of IS-456-2000.

Mixing of concrete

Batching plant conforming to IS:4925 shall be used for large jobs and as directed by the owner. Minimum 2nos. concrete batching plants with capacity 30 m^3 of concrete per hour per batching plant shall be installed The accuracy of the measuring equipment shall be within ± 2% of the quantity of Cement , water or total aggregates being measured and within ± 5% of the quantity of any admixture being used . The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically. Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged. Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Owner. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

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

5.5.16.10 Laboratory

The contractor shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time to the Owner. The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards.

5.5.16.11 Strength of Concrete

Testing of fresh concrete by means of test cubes

All test cubes shall be made and tested for compressive strength in accordance with IS:456, IS:516 and IS:1199. The minimum required strength for different classes of concrete is as indicated elsewhere in the specification.

The grade of concrete required will depend partly on the particular use and the characteristic strength needed to provide the structure with adequate ultimate strength and partly on the exposure conditions and the cover provided to any reinforcement.

A minimum of four test samples (of six test cubes each) shall be taken on each concreting day (from the same mix) and for at least each 40 m^3 of concrete mixed. At least one sample shall be taken for each shift.
For columns, beams and cantilevers seven (7) cubes for every 15 m^3 of concrete poured shall be taken. The concrete for test samples shall be taken directly from the concrete mixer and shall be handled (vibrated etc) under similar conditions to those prevailing during the construction. The moulds for the test cubes shall be made of steel. Tests shall be carried out in an approved laboratory.

The strength level of each type and each strength concrete will be evaluated separately and the concrete strength will be considered satisfactory if:

Compressive strength:

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:-

a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of Table 11 of IS:456.
b) Any individual test result complies with the appropriate limits in col. 3 of Table 11 of IS:456.

Flexural strength:

When both the following conditions are met, the concrete complies with the specified flexural strength:-

a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm2.
b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm2.

If the results are less than those specified, the Owner must suspend all concreting work and order further tests. Any concrete found not to comply with the specification shall be broken out and replaced to the satisfaction of the Owner.

The contractor shall pay all costs incurred in making, curing, delivering and testing of concrete cubes.

5.5.16.12 Transport of Concrete

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods which will prevent the segregation, loss or contamination of materials. The concrete shall be placed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site. The concrete shall be transported through transit mixers .Before using concrete pumps, placer pipelines, chutes or spouts it is necessary to have the written approval of the Owner.

The contractor shall obtain permission at least 24 hours in advance of any concrete pour.

5.5.16.13 Concreting Operations

Inspection prior to concreting

All concreting methods shall be subject to the approval of the Owner.
Concrete placing shall not be started until the Owner has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

Placing of concrete

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns and similar members.

The contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

The temperature of concrete shall not exceed 40℃ measured at discharge into the works.

The maximum allowable temperature of any point within any cast element is 60℃. The maximum allowable temperature differential between any two points in the same element is 15℃. Additional temperature control measures during construction (such as the use of insulated formwork) will be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements. Temperature monitoring of concrete work is required where:

a) the minimum dimension of any casting is 0.8 metres or more, or
b) where otherwise instructed by the Owner.

Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours time shall be subject to the same treatment as the construction joints.

Concrete shall not be dropped into place from a height exceeding 1.5 metres.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

Compaction and mechanical vibration of concrete

As concrete is being placed it shall be compacted by mechanical vibrators complying with IS:2505, IS:2506, IS:2514 & IS:4656, to obtain a dense material free from honeycombing, free from water and air holes. The contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

Finish of concrete

The concrete face shall have the finishes indicated on the drawings or in the present specification. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

5.5.16.14 Construction, expansion and contraction joints

Construction joints

The number of construction joints should be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings. Alternatively, the location of joints should be subject to agreement between the Owner and the Contractor before any work commences.

Construction joints should be at right angles to the general direction of the member and should take due account of shear and other stresses.

Concrete should not be allowed to run to a feather edge and vertical joints should be formed against a stop board.

The top surface of a layer of concrete should be level and reasonably flat unless design considerations make this undesirable. Joint lines should be so arranged that they coincide with features of the finished work.

If a kicker (i.e. a starter stub) is used it should be at least 70 mm high and carefully constructed. The kicker must be incorporated with the previous concrete.

Where possible, the formwork should be designed to facilitate the preparation of the joint surface, as the optimum time for treatment is usually two to four hours after placing.

The maximum horizontal length of wall to be poured in one operation in any one direction is 7.5 metres. A period of 7 days to be allowed between adjacent pours except where waterstops are provided when this can be reduced with Owner's approval. Alternatively a gap of 600 mm wide shall be left between adjacent pours and filled after 7 days from the date of formation subject to Owner's approval.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast should be free from laitance and should be roughened to the extent that the largest aggregate is exposed but not disturbed. Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Particular care should be taken in the placing of the new concrete close to the joint. This concrete should be particularly well compacted and if possible a vibrator should be used.

Where the Owner considers that special preparation is necessary, i.e. for an in-situ structural connection, preparation should be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush, which is sufficient to remove the outer mortar skin and expose the larger aggregate. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking of hardened surfaces should be avoided.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

Expansion and contraction joints

The expansion joints, contraction joints and other permanent structure joints shall be provided in positions as shown in the drawings. Joints shall be straight and vertical, except where other specified, and concrete
surfaces on both sides of the joint shall be flush. Where necessary, waterstops of a type approved by the Owner shall be embedded in the concrete. The waterstop should be made of high quality material which must obtain its resilience through the service live of the structure for the double function of movement and sealing.

The surface of waterstops should be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints the waterstop should be provided with anchor parts. The cross-section of the waterstops should be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

All joints between structural steel and concrete parts shall be sealed by a suitable permanent flexible compound.

5.5.16.15 Concreting at night

When approval is given to carry out concreting operations (under control of the Owner) at night or in places where daylight is excluded, the contractor has to provide adequate lighting at all points of mixing, transportation and placing of concrete.

5.5.16.16 Concreting in high ambient temperature

"IS:7861 (Part 1) – concreting in hot weather" shall apply.

The temperature of the mixed concrete at the time of placement shall not exceed 40°C. The contractor shall take special measures in the mixing, placing and curing of concrete. These measures shall include the shading of aggregates, spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water) and reduction of transportation time to the minimum. During placing suitable measures shall be provided to prevent premature setting of concrete placed in contact with hot surfaces. All concreting areas, formwork and reinforcement shall be shielded from the direct rays of the sun and sprayed with water when necessary.

5.5.16.17 Protective measures for concrete

Immediately after the compaction of the concrete has been finished, the contractor shall ensure adequate protection from the weather. Excessive drying can lead to crack formation as a result of plastic contraction. The concrete surface shall be covered with a layer of sacking, canvas, straw mats or similar absorbent material, special protection sprays kept constant moist for at least 7 days.

Curing compounds or other methods of preventing evaporation may be used if approved by the Owner. Where formwork cannot be removed within 24 hours after placing the concrete, the formwork shall be kept shaded from the direct rays of the sun and shall be sprayed with water.

Owner's approval to the use of a particular curing compound and to the method of application will only be given after the contractor has completed satisfactory site trials and a sample panel has stood for at least 28 days.

Where large sections of concrete are poured, special precautions to the approval of the Owner shall be taken to reduce and dissipate the heat generated by the setting and hardening of the concrete (e.g. built-in cooling water pipe system).

The minimum amount of reinforcement shall be present to prevent shrinking cracks.

No load of any kind, however light, shall be allowed on concrete which has not properly set and the contractor shall prevent any load to be imposed on the concrete structures until it has been declared by the Owner to be ready to carry loads.

5.5.16.18 Concreting under-water

Underwater concreting shall be done as per IS:456. Underwater concrete must comply with the following characteristics:-

a) The quantity of cement must be not less than 350 kg/m^3 when using aggregate mixes with a maximum particle size of 40 mm.
b) The water-cement ratio must not exceed 0.6.
c) Preferred aggregates are those with continuous grading curves lying approximately in the middle of the favourable range.
d) Slump shall be as per clause 7.1 of IS:456.

Underwater concrete is to be placed continuously without interruption. For water depths upto 1 m the concrete may be placed without tremie. In the case of water depths exceeding 1 m, the concrete is to be placed in such a way that it does not fall freely through the water. The tremies must at all times dip sufficiently far into the freshly placed concrete to ensure that the concrete emerging from the tremie does not come into contact with the water. All work connected with the placing of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. Work shall not proceed until all phases and methods to be used in the placing operations have been approved by the Owner.

5.5.16.19 Waterproof concrete

This concrete must meet the provisions of IS:3370. Waterproof concrete must be sufficiently dense (impermeable).

Waterproofing and protection of underground concrete structures

Water aggressive to concrete should be kept away from the fresh concrete. Concrete which is exposed for a prolonged period to “very severe” chemical attack must be protected against direct access of the aggressive substances. The protection, which is to be laid as protection to all concrete surfaces in contact with the ground, shall consist of an approved waterproofing membrane. The membrane shall adhere to all concrete surfaces, including undersides of structures and other surfaces where concrete is cast in contact with the membrane. Such membranes shall be PVC sheets of minimum 0.35 mm thickness with knobs of Maxlock supplied by Maxcorona Owners Pvt. Ltd., or equivalent. The waterproof membranes shall be installed in strict accordance with manufacturer’s instructions.

The membranes shall extend 15 cm above ground level.

When setting forms and reinforcing steel caution shall be exercised to avoid damage to the impervious membrane. The surface of the impervious membrane extending outside the forms shall be protected during subsequent operations. Any puncture or damaged areas shall be cleaned and patched according to manufacturer’s instructions.

5.5.16.20 Concrete with high wearing resistance

Concrete which is exposed to severe mechanical action, e.g., due to intensive traffic, sliding of bulk materials, frequent impact blows or movements of heavy objects, or due to fast-flowing water carrying solids, or other causes, should possess high wearing resistance and correspond at least to grade 30.

The aggregate upto 4 mm size should consist predominantly of quartz or materials of at least equal hardness; the coarser particles should consist of stone or artificial materials possessing high abrasion resistance. In the case of particularly severe mechanical action, it will be necessary to use special hard materials. The particles of all types of aggregate should have a moderately rough surface and be of compact shape. The combined aggregate should be as coarsely graded as possible. Furthermore, the concrete should be as stiff as possible, in order that there will be no concentration of cement slurry or water in the top layer. The concrete should be kept moist for at least 7 days after placing.

5.5.16.21 Finishing of formed surfaces

Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that shall be covered with earth backfill. Exterior surfaces that shall be exposed above grade and all interior surfaces, except those not usually exposed to view, shall be cleaned and rubbed. Rubbing shall produce a smooth, uniform surface free of marks, voids, surface glaze, and discolorations.

Rubbing shall be done by hand with a carborundum stone using only the mortar produced by the rubbing action and the application of water.

Projecting ends of all form ties shall be removed. The resulting recesses shall be cleaned, wetted, and filled with patching mortar. Patches on rubbed surfaces shall match the texture of the adjacent concrete.

Finishing of unformed surfaces

No surface treatment shall be required for buried or permanently submerged concrete. As a minimum, unformed surfaces shall be finished by screeding and floating. Surfaces requiring a trowelled finish shall be finished by screeding, floating, and trowelling. Float finished and screeded surfaces shall be finished to provide a flat profile within a 6 mm deviation as measured from a 3 meter straightedge. Trowel finished surfaces shall be finished to form a flat plane. The surface profile shall not deviate more than 3 mm when measured from a 3 meter straightedge.

Screeding

Screeding shall provide a concrete surface conforming to the designated elevations and contours with all aggregates completely embedded in adjacent mortar. Surface irregularities in screeded surfaces shall be limited to the tolerances specified.

All sumps and tank cover slabs shall be provided with minimum 50 mm thick screed concrete.

Floating

The surfaces shall be screeded and given an initial float finish as soon as the concrete has stiffened sufficiently to work. Coarse aggregate disturbed by the float or causing a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a smooth float finish of uniform texture and color.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

Trowelling

The exposed portions of the tops of equipment bases, tops of interior curbs, and the surfaces of interior slabs not receiving a separate finish shall receive a steel trowel finish. Trowelling shall be performed after the second floating when the surface has hardened sufficiently to prevent excess cement from being drawn to the surface. Trowelling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

Surfaces to be covered with neoprene-hypalon coatings shall be lightly trowelled but not burnished.

Brooming

Brooming shall follow the float finish for exterior surfaces where a nonslip surface is required. Brooming shall be done with an acceptable steel or fiber broom not less than 450 mm wide. Brooming ridges shall be transverse to the normal traffic direction and shall be between 1.5 mm and 3 mm deep. Adjacent strokes of the broom shall overlap slightly. Broomed surfaces shall be free of porous spots, irregularities, depressions, and small pockets or rough spots.

Aggregate Exposure

Surface mortar shall be removed and the aggregate exposed from surfaces that shall be covered with mortar, concrete, or grout at a later time.

Edging

Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having a 6 mm corner radius.

Finishing mortar

Finishing mortar shall be added if there is not sufficient mortar available from the concrete mix. The proportions for this finishing mortar shall be 102 kilograms of concrete sand to one bag of Portland cement, mixed with enough water for proper application. Slump for finishing mortar shall not exceed 50 mm.

5.5.16.22 Formwork

Design and construction

For stability and type of formwork and support framing used, IS:14687 is to be observed. The formwork and the supporting structure are to be so dimensioned as to be able to withstand all vertical and horizontal forces safely. Supporting structures shall be sufficiently rigid to maintain the forms in their correct position and to be true to shape and dimensions so that the final concrete is within the limits of the dimensional tolerances.

The contractor shall submit in sufficient time in advance for the approval of the Owner the calculations, designs and details of the methods adopted and materials proposed for the formwork. Approval in no way absolves the contractor from full responsibility for their correctionsness and completeness in every way nor shall claim any extra cost or time.

Particular attention must be paid to the formwork supports and braces to avoid any slip when the concrete is poured.

Preparation and inspection of formwork

Before concrete is placed, all formwork shall be inspected to see if it is built according to the approved plans and to see if it has been cleaned and is free from sawdust, shavings, dust, mud, earth or other contamination and properly oiled. Contact surfaces of panels shall be treated with a suitable release agent (e.g. non-staining mineral oil) where applicable. Surfaces which are not oiled shall be wetted thoroughly to prevent warping.

Erection and placing of formwork

All formwork shall be erected and placed in accordance with the construction drawings approved by the Owner. Shutttering shall be true to line and braced and strutted to prevent deformation under weight and pressure of the wet concrete, live-loads, wind and other forces. The deflections shall not exceed 3mm.

The formwork for beams and slabs shall be erected so that the form on the sides of the beams and of the soffits of slabs can be removed without disturbing the beam soffit. If the formwork for columns is erected to the full height of the columns, one side shall be provided with openings for concreting in order to guarantee a proper compaction of the poured concrete.

Formwork for walls and elsewhere shall be arranged for a maximum concreting height of 2.5 m in a single pour. Where necessary panel openings are to be provided in the forms for cleaning, inspection, access of vibrators, etc. Before placing of concrete, bolts, ties and fixings shall be positioned and all devices used for forming openings, holes, pockets, chases, recesses, etc shall be fixed to the formwork carefully.

All formwork will be inspected and approved by the Owner before concrete placing commences but this shall not relieve the contractor of any of his responsibilities under the contract.

Striking of formwork

Formwork shall not be removed until the concrete has sufficient strength to carry its own weight plus any constructional or designed loads likely to be applied with a normal factor of safety. It shall be removed in such a manner that no shock or injury shall result to the concrete. Before removal of the formwork, the concrete shall be examined and removal shall proceed only on the instructions and under the supervision of a competent person. In accordance with IS:456 clause 11.3.1, the striking period for cast in-situ concrete under certain conditions may be taken.

Special care is necessary in the case of components which have to carry nearly the full calculated load as soon as the formwork is struck. Columns, piers and walls are to be struck before the beams and slabs supported by them. Scaffolds, formwork supports and self-supporting floor formwork are to be carefully lowered by releasing the devices. Extreme care shall be taken to avoid chipping of corners during removal of formwork. To keep deflections through creep and shrinkage to a small amount, auxiliary supports should be left in place or immediately repositioned after striking.

5.5.16.23 Binding wire

Binding wire for general use shall be 1.6 mm dia annealed wire.

5.5.16.24 Reinforcement supports

Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening the reinforcement. Spacers shall be cast from concrete of the same quality as that in which they will be embedded. Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size. Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the contractor shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.

5.5.16.25 Certificates

Each consignment of steel reinforcement shall be accompanied by a test certificate from the manufacturer showing that the steel has been tested and analysed and the date of such tests and analyses and that such tests and analyses comply in all respects with the standards. The following tests shall be carried out on reinforcement:-

a) Cast analysis
b) Carbon equivalent value
c) Tensile strength, yield stress, elongation
d) Bend test
e) Bond classification
f) Chemical analysis

Stock of reinforcing steel

In order to ensure due progress of the works, the contractor shall at all times maintain on the site a stock of reinforcing steel sufficient for the following month's work. No reinforcing steel shall be used upon the works until it has been accepted as satisfactory by the Owner. All bars for reinforcement and steel fabric reinforcement shall be stored on the site under cover on timber or concrete supports suitably spaced and of sufficient height to keep the steel not less than 150 mm clear of the ground.

Rejection

The Owner at his discretion may order random testing of the reinforcement steel and in the event of any failed test reject the entire lot notwithstanding the manufacturer's. The contractor shall remove all rejected reinforcing steel from the site without delay at his own expense.

5.5.16.26 Bar-bending schedules

The contractor shall prepare bar bending schedules based on the detailed reinforcement drawings. These shall be presented to the Owner for approval. Approval of these schedules by the Owner in no way absolves the contractor from full responsibility for their completeness and correctness in every way nor shall any claim for extra cost or time be allowed on the grounds of such errors or discrepancies which may arise between drawings and schedules.

5.5.16.27 Waterstops

Waterstops shall be PVC or equivalent and shall be used. Type and manufacturer shall be submitted to the Owner's approval. The minimum thickness and width of PVC waterstops shall be 6 mm and 225 mm respectively.

All intersection pieces shall be prefabricated by the manufacturer and only welding of butt-joints in running lengths will be allowed to be carried out on the site.

The site welding of butt-joints shall be executed by using the manufacturer's purpose-made electrically heated jig and work shall be done by a competent and trained personnel only. The manufacturer's instructions shall be carefully observed.

The wings of the waterstops shall be formed with corrugations or bulbs to achieve a good bond. Moreover, the waterstops shall conform to the following requirements:-

a) The tensile strength not less than 10 N/sq.mm when tested.
b) The ultimate elongation shall not be less than 22% when tested.
c) The tear resistance shall not be less than 2 N/ sq.mm when tested.
d) The material shall not crack when tested.
e) Under accelerated elongation, the tensile strength shall not be less than 8 N/ sq.mm and the ultimate elongation shall not be less than 200%.

The waterstops shall be installed so that they are securely held in position during the placing of concrete which shall be fully and properly compacted around the waterstops to prevent voids or porous areas. Adequate clearance between the reinforcement and all the waterstops shall be kept to permit proper compaction of concrete.

No holes or nailing shall be made through any waterstop for fixing purposes. Jointing by lapping two pieces of waterstops shall not be permitted. The free edges of waterstops shall at all times be protected from direct sunlight.

5.5.16.28 Curing

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed. Trowelled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish.

Water curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Water curing shall begin within 12 hours in dry weather and within 24 hours in damp weather. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water may be interrupted for surface rubbing. The concrete surface shall not be permitted to dry. After the rubbing has been completed, rubbed surfaces shall be covered with burlap and kept saturated for the remainder of the curing period.

Membrane curing

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface. Membrane curing compound shall be spray applied at a coverage of not more than 7.4 square meters per liter. Membrane curing shall not be used on surfaces that shall be covered

at a later date with mortar, concrete, damp—proofing, tile, or any coating. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks.

5.5.16.29 Floor Sealer

All concrete floors shall be given two coats of clear floor sealer in addition to that applied as membrane curing compound. The first coat shall be applied at the end of the curing period before any traffic is permitted on the floor. The second coat shall be applied after the floor has been cleaned in preparation for the final inspection. Floor sealer shall be applied in strict accordance with the manufacturer's recommendations.

5.5.16.30 Repairing of Damaged or Defective Concrete

Concrete which has completed its final setting shall be inspected by the Owner and any cracks, honeycomb areas, segregations, etc shall be marked. No repairs shall be carried out until direction by the Owner.

Surface defects in formed concrete shall be repaired to the satisfaction of the Construction Manager within 24 hours. Concrete that is porous, honeycombed, or otherwise defective to a depth in excess of 25 mm shall be cut out and removed to sound concrete. Edges shall be square cut to avoid feathering. Cut surfaces shall be coated with epoxy bonding compound before the concrete is placed.

Defective concrete shall be replaced within 48 hours after the forms have been removed. Concrete repair work shall not interfere with the curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and shall be finished to match adjacent surfaces.

5.5.17 PERMISSIBLE DEFLECTIONS

The following deflection criteria shall be considered in sizing of structures as per respective clause of IS-456.

Horizontal deflection : H/325

Vertical deflection : L/325

The final deflection due to all loads including effects of temperature, creep and shrinkage measured from as cast level of the supports of floors, roofs & all other horizontal members shall not exceed span/250.

The deflection including effects of temperature, creep & shrinkage occurring after erection of partitions and the application of finishes should not normally exceed span/ 350 or 20mm, whichever is less.

SECTION 5.6

STEEL STRUCTURES

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5.6 STEEL STRUCTURES

5.6.1 GENERAL

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

a. Steel building structure and open structures.

   This shall include beams, columns, bracings, supporting structure for floors, roof slabs, cladding etc.

b. Crane gantry girders, monorails, etc.

c. Coal bunkers

d. Large diameter oil tanks

e. Platforms and walkways

f. Ladders, staircases, handrails etc

g. Pipe racks and cable racks.

h. Coal conveyor galleries and trestles
i. Steel flues for R.C.C. Chimneys

j. Galvanised latticed structures for switchyard

Wherever possible, without compromising system requirements, prefabricated structural steel construction shall be adopted.

Wherever possible, without compromising system requirements, RCC floors and roofs in structural steel buildings may be constructed over metal decking sheet.

5.6.2 MATERIALS

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

All sections for structural steel shall be rolled sections only. Pipe / tubular sections also may be used, if meeting functional and design requirements.

Pipes for handrail shall be medium grade as per IS: 1161.

Crane rails shall conform to IS: 3443.

Foundation bolt material shall be of mild steel (property class 4.6) and shall conform to IS: 1367 – Part 3 (2002) and IS: 5624 (1993), material grade shall conform to IS: 2062 grade A unless noted otherwise in the drawing.

Steel shall be procured from SAIL or any other approved main producers.

Plates above 25 mm thickness shall be subject to ultrasonic test as per ASTMA435 or equivalent

to check the presence of lamination.

Washers shall conform to IS:2016, IS:5369, IS:5372, IS: 5374, IS: 6610 and IS: 6649 as applicable. Spring washers shall be provided for those parts, which carry dynamic loads and where black bolts for connection are permitted. Welding Consumables Mild steel electrodes shall conform to IS: 814. The electrodes used for welding shall be of suitable type and size depending upon specification of parent material, method of welding, position of welding and quality of welds desired. The Contractor shall furnish a certificate issued by the manufacturer to the effect that the electrodes supplied are in accordance with the above specifications.

Grating

All gratings shall be pressure locked type (preferably Electro-forged) manufactured in accordance with applicable Indian Standard. All removable grating shall be bolted or clipped to supports. Sizes of grating shall be such as to allow easy handling. Grating units at all penetrations shall be made up in split section All gratings shall be arranged such that bars in either direction are in line. All gratings and accessories shall be hot dip galvanised.

It may be of rectangular pattern of parallel bearing bars of 40 mm depth and 5 mm thickness and cross bars of 25 mm depth and 3 mm thickness. Bearing bars shall be at 30 / 40 mm c/c with cross bars at 100 mm c/c.

In Boiler area, all gratings fabricated from MS flats shall meet minimum requirements as bearing bars of 32x5 thick spaced at 30 mm c/c and cross bar of twisted square bar (6 mm diagonal) at 100 mm c/c

Chequered Plates

Removable chequered plates shall be provided with two lifting holes and the size of plates shall be such as to allow easy handling. All edges of plates shall be smooth and straight with 3 mm clearance between plates. All chequered plates shall rest flat on their supports without rocking. All chequered plates shall be hot dip galvanised. Chequered plates shall conform to IS: 3502.

Galvanising

Hot dip galvanised coatings on iron and steel articles shall be carried out in accordance with IS:4759 and other relevant IS standards. Galvanising shall be checked and tested in accordance with IS:2629. The coating shall be smooth, continuous and free from flux stains.

Small areas of galvanised coating damaged by welding, cutting, or during transport shall be repaired by applying at least two coats of zinc-rich paint. All structural steel works, which are not galvanised, shall be painted.

The minimum average coating weight of galvanizing shall be 610 gm / sq.m.

5.6.3 FRAMING

All steel framed structures shall be either “rigid frame“ or “simple space frames“ or a combination of two. Column base shall be considered fixed or hinged.

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.

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

The Steam Turbine Building design shall be a combination of rigid frame in transverse direction and braced frame in longitudinal direction.

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

Concrete floors (with shear connectors from top flange of steel beams) shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However, wherever large cut outs are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required.

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.

Columns may be designed to support the load combination that produces the maximum interaction ratio. Exterior columns shall be designed to resist wind moments between braced elevation as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing or non-concentric bracing work points.

5.6.4 DESIGN METHODOLOGY

The design of steel structures shall be done in accordance with the provisions of IS: 800 and other relevant IS codes as applicable to specific structures.

Main columns, bracings, ties and main grid beams of Power House Building, Control Room Building and Bunker building may be sized with a maximum interaction ratio of 0.90 during initial design stages to take care of changes in equipment layout / loads and unforeseen future loads.

All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings/moment connections shall be used to assure stability of structures. Structure shall be designed such that the surfaces of all parts shall be accessible for inspection, cleaning, painting and maintenance.

Crane gantry girders shall be single web plate girder or welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorail beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced suitably if required.

Permissible stresses for different members shall be allowed to exceed up to 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 shall 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.
- 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 allowable stresses as per Clause 34.4, IS 456.

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.

All column base plate at braced bay shall be provided with shear key to transfer lateral load to the pedestals.

The following criteria shall be followed for indicating loads on the design drawings.

For vertical beam reactions, the load shall be indicated whenever the value exceeds the maximum allowable uniformly distributed load.

For axial loads in floor beams, the actual horizontal load which the beam end connection must resist shall be indicated for each end of the beam. Note that this value may be different for opposite end of the same beam. For truss members, only one member force shall be noted for each member.

Angle sections shall not be used as flexural members except for roof trusses, purlins, side girt and walkway runners only.

Lateral forces along the length of the building will be resisted by bracings in horizontal and vertical frames. The transverse lateral load will be resisted by stiff jointed frame action. Additional bracing or moment connection will be used to assure stability of the structures.

All structural steel members subjected to tension shall be connected to pedestals with holding down bolts. Anchor plates of bolts shall be fillet welded to bolts with 8mm (minimum) weld. Anchorage shall be determined based on bond stress developed between embedded bolt and concrete.

5.6.5 PERMISSIBLE DEFLECTIONS

The permissible deflection 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 loads are acting concurrent with normal loading conditions.

5.6.5.1 Vertical Deflection

a. For beams supporting dynamic equipment - Span / 500

b. For beams supporting floors / masonry - Span / 325

c. For beams supporting pipes (pipe rack) - Span / 400

d. For roofing and cladding components - Span / 250

e. For gratings and chequered plates - Span / 200 subject to a maximum of 6 mm

f. Coal conveyor gallery bridges - Span / 450

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

5.6.5.2 Horizontal deflections

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

a. Single storey building (without crane load) - Height / 325

b. Multistoried building (without crane load) - Height / 500

c. Pipe rack columns - Height / 200

d. Open structures - Height / 200

e. Crane gantry girder due to surge - Span / 2000 limited to Maximum of 15mm

f. Building main columns at crane rail level due to action of crane surge load only - Height / 2500 limited to Maximum of 10 mm

g. Open gantry columns at crane rail level due to action of crane surge load only - Height / 4000 limited to Maximum of 10 mm

h. Coal handling trestles - Height / 1000

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

5.6.6 MINIMUM THICKNESS AND SIZES OF STEEL ELEMENTS

5.6.6.1 Minimum Thickness

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

a. Trusses, purlins, girts and bracing : 6 mm

b. Columns and beams : 8 mm

c.	Gussets	:	8 mm
d.	Stiffeners	:	8 mm
e.	Base plates	:	10 mm & above
f.	Chequered plates	:	6 mm o/p & above
g.	Grating flats	:	5 mm

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

For axially loaded members in framework, minimum angle section to be used shall be ISA 50x50x6.

5.6.6.2 Minimum Sizes

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm, and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm.

Width of steel rolled section connected to other member shall be at least 50 mm.

The depth of beams for platform of all structures shall not be less than 125 mm.

5.6.7 SLENDERNESS AND DEPTH RATIO

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

The following limiting ratios of depth to span shall be considered as 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 / equipments	-	1/15
d.	Roof purlins and girts	-	1/45
e.	Gable columns	-	1/30

5.6.8 JOINTS / CONNECTIONS IN STEEL STRUCTURES

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

a. Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.

b. Size of fillet weld for flange to web connection for built up section shall be as follows:

   i) For box section weld size shall be designed for 60% of full shear capacity or actual

shear whichever is more. Where fillet weld is not possible, full penetration butt 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 than 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 6mm.

c. Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.

d. Moment connections 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. Welding shall be used for shop fabrication and joints. All butt welds shall be full penetration butt welds. IS: 816 and IS: 9595 shall be followed for welding of structures.

f. 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 Owner/Engineer.

g. 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

h. Splicing: All splicing work shall be of full strength. Field splicing shall be done with web and flange cover plates for full strength. 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 plate.

i. For site connections, high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints using permanent mild steel bolts may be adopted e.g. purlins, side girts etc. For high strength friction grip bolt connections IS: 4000 shall be followed. High strength friction grip bolts shall be of property class 6.6 or 8.8 and shall conform to IS: 3757. High strength bolts shall be installed as bearing type joint except where loads are reversible.

j. A minimum of two bolts per connection shall be used.

k. 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.

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

m 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.

n. For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be

ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange shall not be permitted. Bearing edges of crane girders shall be machined.

o. The work point of the bracing connection shall be the centre of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. Double angle bracings (back to back or star) can be used. The double angle back-to-back with gusset plates in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

p. Horizontal bracings shall be angle / tee section connected to the bottom portion of the top flange of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at columns locations.

q. For Major columns of main building, column splices shall be designed to resist the greater of the design axial tension load and moments in either the major or minor axis, whichever produces the greatest number of bolts. For horizontal bracings to act as torsion bracing the bracing shall not be connected to the bottom flange. Splicing of columns shall be 1.05 times the capacity of the section.

r. Minimum size of fillet weld shall be 6 mm. Main structural elements shall be welded continuously. Intermittent weld shall be used only on secondary members, which are not exposed to weather or other corrosive influence. Overhead welding shall not be permitted. However if it is un-avoidable welding shall be carried with 4G with approved WPS.

s. Efficiency of site welds to be considered shall be as follows:

i)	Fillet weld above 25 m from ground	50%
ii)	Others	80%

Shop connections shall be all welded and field connections shall generally be bolted unless otherwise if specifically indicated by owner. Field bolts, wherever provided shall be high tensile of 20 mm dia or of higher diameter and of property class 8.8 (minimum) as per IS: 1367 (latest) for all major connections. All bolts, nuts and washers shall be procured from the manufacturers as approved by Owner. The bolted joints shall be designed for friction type connection and the HT bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams shall be carried out by using MS black bolts not less than 16 mm dia (minimum property class 4.6) conforming to IS:1363 (latest) unless specified otherwise. All removable type connections shall be with bearing type HT bolts of grade 8.8 (minimum).

Welding shall be in accordance with the recommendation of IS:816 (latest) Code of Practice for arc of metal arc welding for general construction in mild steel and IS:9595 (latest) recommendation for metal arc welding of carbon and carbon manganese steels. Built-up members will be fabricated using submerged arc welding procedure. All electrodes, flux, bare wire etc shall be procured by the contractor only from manufacturers approved by owner. All butt-welds in beams, girders & columns will be of full penetration. All butt-welds will be radiographically or ultrasonically tested as per IS-822 and standard practice.

The bare wire electrodes for submerged arc welding shall conform to IS:7280 (latest). The combination of wire and flux for submerged arc welding shall be as follows:

Filler wire shall be of classification AWS-A-5.17-EH14 and flux shall be of agglomerated type of classification AWS-A-5.17F7 A2-EH14.

Low hydrogen electrodes as approved by the Owner shall invariably be used in the following cases:-

a) For welding of all important joints such as butt-joints in columns (flange or web), butt-joints in main frame beams (flange or web) etc.
b) For welding steel members having thickness more than 20 mm.

In case of fillet weld between two components, the thickness of the thinner part shall be considered.

Minimum preheat & interpass temperature for welding over 40 mm to 63 mm (thickness of the thicker part at the point of welding) shall be 66℃ and for over 63 mm, it shall be 110℃. However, higher preheat & interpass temperature may be required due to joint restraint etc and shall be followed as per approved welding procedure.

5.6.9 FABRICATION AND ERECTION

Contractor shall prepare detailed fabrication drawings and erection scheme based on the design drawings approved by Owner. Fabrication drawings are not to be submitted to Owner for approval as the responsibility for correct detailing rests exclusively on the Contractor. However these drawings shall be furnished to Owner for their reference to effect payment and information.

Fabrication shall in general follow the provisions of IS:800, 816, 9595, 1367, 9178 and good engineering practice where provisions of IS:800 are not clear.

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

Erection of fabricated steel components shall be as per erection drawings prepared by Contractor and approved by his Owner

Tolerance for erected steel structures shall be as per IS:12843.

The workshop shall be equipped with sufficient and satisfactory facilities with qualified and competent workmen and welders. The Contractor shall submit to the Owner all detailed drawings of structural steel to be fabricated in the workshop. The fabrication works shall commence only after obtaining approval of the Owner for these drawings. The Owner reserves the right to be present during any or all of the fabrication and assembly of the structural steel.

At the stages of fabrication, structural steel members shall be identified by a suitable marking scheme. Cutting, holing, assembly, welding and bolting shall be carried out in accordance with appropriate IS Standards. Tolerances in fabrication of structures shall be in accordance with IS:7215.

The structural steel shall be pre-assembled in the workshop to such an extent as to ensure proper site erection.

Levelling of base plates shall be carried out by levelling screws or shims subject to the Owner's approval. The structural steel erector shall verify the positions of the anchor bolts of the base plates before the concreting of the foundations. The base plates shall be set at a minimum of 35mm above the concrete foundations in order to allow for the grouting. The deviation for plumbing of columns shall not exceed 1 to 1000 of the total height of the column. The position in plan of the column base shall not deviate more than 10 mm along either of the setting out axes. The positioning in plan of the column base shall be carried out by non-shrink grout subject to the Owner's approval.

Unless otherwise specified the erection of the steel structures shall comply with IS:800 and other relevant IS standards. Deviations / tolerances in erection of structures shall be limited to the stipulations of IS:12843.

Steel packing plates shall be provided where necessary to ensure that the total remaining gap between the connected parts does not exceed 2 mm.

All non-matching holes or holes required for new connections shall be formed by drilling and in no case will burning of holes be permitted.

All bolts shall project through the corresponding nuts and check nuts, but such projection shall not exceed three threads. Where connections have to be made by high strength friction bolts, the mating surfaces must be clean from any oil, grease, and any type of paint or primer. All fixing bolts, screws, nuts, clips, and washers shall have approved anticorrosive finishes. Any temporary bracing or temporary restraint shall be left in position until such time as erection is sufficiently advanced so as to allow for its safe removal.

5.6.10 INSPECTION OF WELDING

Welding

All shop welding as well as site welding shall be carried out by qualified welders. The test certificates for welder's qualification shall not date back more than six months prior to the execution of the welding works. For site welding, all welders shall be obliged to pass qualification tests to determine their ability to perform such type of work. The sample welds shall be carried out on specimens of equal shape, thickness, and chemical analysis as of the material to be welded. The testing of welders shall be carried out in accordance with IS:817.

The Contractor shall submit detailed method statements for both shop and site welding, including the following:

1. Material to be welded
2. Weld edge preparation
3. Welding process
4. Type of electrodes
5. Welding position
6. Welding sequence
7. Number of weld passes
8. Quality control for shop and site welding

The contractor shall not proceed with the welding works until his method statement is approved by the owner.

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) Dye penetration 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.

The extent of quality control in respect of welds for structural elements shall be as follows.

5.6.10.1 Visual Examination

All welds shall be 100% visually inspected to check the following:

(i) Presence of undercuts
(ii) Surface cracks in both welds and base metals.
(iii) Unfilled craters
(iv) Improper weld profile and size
(v) Excessive reinforcement in weld
(vi) Surface porosity

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.

5.6.10.2 Dye Penetration Test (DPT)

This shall be carried out for all important fillet welds and butt welds to check the following.

a. Surface cracks
b. Surface porosities

Fillet Weld : 5% of the total length, dye-penetration test shall be carried out to the root run.

Butt Weld : 10% of the total length, dye-penetration test shall be carried out to the root run after back gouging.

Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.

5.6.10.3 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 Owner to detect the following:

(i) Cracks
(ii) Lack of fusion
(iii) Slag inclusions
(iv) Gas porosity

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1-92 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.

5.6.10.4 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 OWNER to detect the following defects:

i) Gas porosity
ii) Slag inclusions
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 width of the welded joint plus 20 mm on either side of the weld.

Contractor shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Owner.

Generally, splicing shall not be provided in tension flange of bunker girder. Spot radiography shall be carried out on 100% joints in tension zone and 10% joints in compression zone. Minimum 300 mm length shall be spot radiographed. When radiograph is not possible, ultrasonic test shall be carried out after grinding the surface with prior approval of Owner.

5.6.10.5 Acceptable Limits of defects of weld

Limits of Acceptability of welding defects shall be as follows.

i) Visual inspection & Dye Penetration Test

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 8.15.1 & 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 defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 & clause9.25.3 of American National Standard ANSI / AWS D1,=.1-92 respectively, for statically and dynamically loaded structures.

iii) Radiographic Testing

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clause 8.15.3 & 9.25.2 of American National Standard ANSI / AWS D1, 1-92 respectively for statically and dynamically loaded structures.

5.6.10.6 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.

(iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

5.6.11 REQUIREMENTS FOR SPECIFIC STRUCTURES

5.6.11.1 Storage tanks

Design, fabrication and erection of the cylindrical welded oil storage tank shall follow the provisions of IS:803. The stresses in the tank shall be computed on the assumption that tank is filled with water. Tension in each course shall be computed at 30 cm above the centreline of lower horizontal joint of the course under consideration.

Wind and internal vacuum loads shall be considered together to check the stability of tank.

Joint efficiency factor shall be taken as 0.85 for butt joints to determine the minimum thickness of shell plates provided all the vertical and horizontal butt welds are spot radiographed. Where welds are not inspected by radiography joint efficiency factor of 0.7 shall be used. However it is recommended that all butt welded joints shall be radiographed.

Minimum thickness of shell plate shall be as given in clause 6.3.3.2 of IS:803 to which corrosion allowance shall be added. Maximum thickness of shell plate shall not exceed 40 mm.

Bottom plate uniformly resting on the substructure shall have a minimum thickness of 8 mm for tanks up to 10 m in diameter and 10 mm for higher diameter. Bottom plate shall project at least 25 mm all-round beyond the outer edge of weld attaching the bottom to the shell plate.

For large diameter oil tanks supported cone roof shall be provided. Arrangement of columns and rafter shall in general be as per fig 9 & 10 of IS:803. Roof plates shall have a minimum thickness of 6 mm and shall not be attached to the supporting member. A kerb angle shall be provided at the top of the shell in line with clause 6.3.6.2 of IS:803. Roof plates shall be attached to the kerb angle with a continuous fillet weld on the top side only. Minimum slope of roof shall be 1 in 16.

Rafter clips for the outer row of rafters shall be welded to the shell. Columns shall not be rigidly attached to the bottom plates guide. Clips shall be welded to the tank bottom to prevent lateral movement.

Roof supporting columns shall be made from structural shapes or pipe or built up section. Suitable base frames or reinforcing pads shall be provided at the column base to distribute loads coming on the tank bottom.

Appurtenances and mountings covered under section 7 of IS:803 shall be provided in addition to any other appurtenance which may be required for the safe and smooth operation of the fuel oil storage and oil handling system.

After erection and inspection of the tank, the tanks shall be tested as per clause 12 of IS:803. Leakage if any noticed shall be repaired to the satisfaction of the OWNER and the tank retested to satisfy acceptance criteria.

Tanks shall be provided with two coats of epoxy coating for internal surfaces over two coats of compatible primer.

The design of tanks for seismic and slosh condition shall be as per API 650.

5.6.11.2 Coal handling system structures

Toe guards shall be provided on sides of conveyor gallery, toe guard shall have a minimum size of 100 x 6 mm.

In case the inclination of the conveyor is more than 10°, walkway shall be given steps.

For the design of conveyor gallery, load due to cables, light fittings and pipes as well as effect of gravity take up loads shall also be considered, in addition to dead load, wind load and imposed load.

Lattice girders supporting the conveyor shall be suitably braced at top and bottom chord levels to transmit the wind load to the end portals connected to trestles. Roof purlins and walkway runners shall also be suitably braced at both ends.

In the case of galleries, temperature expansion joint shall be introduced at intervals less than 180 m to divide the galleries into temperature block. In each block at least one number four legged rigid support guaranteeing stability of structure in the longitudinal direction shall be provided. This shall also take care of all longitudinal forces in the given block. Effect of wind load acting on 2-legged trestle shall also be considered while designing the 4-legged trestle.

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.

Conveyor galleries and trestles having two conveyors belt shall be designed for both conveyors working together.

Chute loads on floors of houses shall be considered plugged with material for the entire height of the chute.

In case chequered plates are used as floor covering the thickness of plate o/p shall be 8 mm. Suitable plan bracings shall be provided 75 mm from top of steel to transfer all the horizontal forces

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

Bracing patterns and locations shall be so planned such that they do not hinder movement of personnel and movement of equipment during maintenance. When floor beam form part of vertical bracing system, additional loads from the floor beams transferred to the bracing shall be taken into account.

Angle section shall not be used as flexural members except for purlins, side girts and walkway runners. Minimum angle size used shall be L50x50x6.

All foundation bolts shall be provided with double nuts.

End connection for rolled beams and channels shall be designed for a minimum of 60% of their shear capacity and built up beams for 80% of their shear capacity in addition to axial load.

Dynamic analysis shall be carried out for beams supporting screens, vibrating feeder, rotating equipments and conveyor supporting beam in conveyor gallery.

To admit proper light into the conveyor gallery perspex sheet shall be provided at the rate of 0.1 square metre per metre length of gallery on the roof and 0.2 square metre per metre length of gallery per side on the sides of conveyor gallery.

5.6.12 PAINTING

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.

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 make.

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.

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.

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.

5.6.13 DELIVERY, STORAGE AND HANDLING

All structural steel works shall be protected from damage during handling, transporting, unloading, and storage. Particular attention shall be given to stiffen free ends and to prevent any permanent distortion. All bolts, nuts, washers, and small articles shall be suitably packed and identified. All structural steel shall be stored on thick timbers to prevent any dirt or accumulation of water under the steel.

Safety

The safety precautions to be applied during the erection of the steel structures shall be in accordance with IS: 7205 and other appropriate IS standards.

Inspection at Site

After erection of the structures, the Contractor shall carry out inspections and checks in the presence of owner in order to demonstrate completeness of the works and correctness of the assembly. The Contractor, subject to owner's approval shall propose the inspections and checks to be carried out. In order to facilitate inspections as well as future maintenance, the structures shall be provided with steps, ladders, handrails, and other facilities in approved positions. The Contractor shall provide for the owner's use all equipment and instruments for inspection.

SECTION 5.7

OUTDOOR CIVIL WORKS

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5.7.1 DRAINAGE AND SEWERAGE

All drainage lines for storm water, sewage, and waste drainage etc. shall preferably be laid in service aisles close to the road. Separate network shall be provided for lines of storm water, sewage, and waste drainage.

5.7.1.1 General

Piping and fittings shall comply with the following standards:

Unplasticized PVC pipes for gravity sewers and for underground drainage shall comply with IS:4985.

Cast iron pipes and ductile iron pipes shall comply with relevant Indian Standards as mentioned above.

Stoneware pipes shall conform to IS:651.

RCC pipes for underground sewer and culverts shall be of class NP2 or NP3 conforming to IS:458.

Cast Iron rain water pipes shall conform to IS:1230.

Glass reinforced plastics (GRP) shall comply with IS:12709.

Manhole covers and frames shall comply with IS:1726.

Pipe Trenches

Prior to laying of pipes, the respective pipe trenches shall be subject to thorough inspection by the owner with respect to alignment, slope, dimensions and suitability of bottom to meet requirements of proper pipe laying. In general, each pipe trench deeper than 1.5 m shall be secured by means of planks, sheet piling, struts and bracings, whatever is required according to the soil conditions, groundwater, nearby road vibration resulting from traffic. The spacing of bracings shall be such as to allow mechanical excavation of the trench where required. All pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported.

The width of a trench shall be adequate for satisfactory jointing of pipes and thorough tamping of the bedding material under and around the pipes. The bedding surface shall provide a firm but slightly yielding foundation of uniform density throughout the entire length of the pipe or the culvert and shall in general be slightly cambered in a direction parallel to the pipe centre line to compensate for expected settlement and ensure tight joint in the lower half of the pipe.

Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template. Where rock in either edge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness of 200 mm minimum. Where a firm foundation is not encountered at the grade established, due to soft or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected material as approved by the owner, properly compacted to provide adequate support for the pipes.

Deviations from given levels shall not be greater than ± 20 mm.

All pipes shall be checked for defects and damages prior to placing. Material that does not conform to the specification or which is found to be defective or damaged shall be rejected and

removed from the site. If more than 10 % of the pipes are rejected because they do not conform to the specification, the owner retains the right to reject the whole consignment.

During connection of pipe sections, the contact surfaces carrying sealing compounds shall be kept clean. All open ends for later connections shall be closed to avoid entering of soil or other contamination into the bores. The pipes shall be laid with their socket ends facing the direction of the flow (such that flow is from socket end to spigot end). The pipes shall be lowered in the trenches by a method as approved by the owner. The pipes shall then be joined by caulking. After placing, each pipe section shall be thoroughly checked as to alignment, level and slope.

After each section of the pipeline has been laid it shall be tested for water tightness before backfilling the trench. On successful completion of testing, the trench shall be backfilled with the excavated earth in layers of 200 mm and shall be watered and rammed. Any subsidence occurring in the line of trenches after backfilling shall be repaired by the Contractor Pipe supports shall be so constructed as to guarantee the uniform transmission of loads. For concrete supports, a cement-mortar layer shall be applied before placing the pipes to guarantee a uniform transmission of forces.

Manholes

The grade of concrete for manholes shall be M25 for cast insitu. Manholes may be prefabricated or cast in place. Sections of connecting pipes shall be incorporated into the construction of manholes and placed at the elevation, direction, and grade required. The inner ends of the pipes shall be flush with the inner faces of the walls, unless otherwise specified. Half round channels of size suitable for the inlet and outlet pipe diameters shall be formed on the floor of the pit with PCC

The floor of the pit shall be haunched towards the channel as per requirement. Inside of pits shall be finished with cement-sand plaster (1:4) and finished smooth with cement punning. Care shall be taken to avoid unevenness on the surface and sharp bends in the channel. The invert level after finishing shall be as shown in the drawings.

Concrete Encasement of Pipes

Pipelines running under roads, etc. shall be encased in 250 mm thick concrete of Grade M20 for full length. Before concrete is placed, the pipe and all fittings shall receive a double wrapping of bituminous felt. The thickness of the concrete encasement around the pipeline shall be at least the same as the pipe diameter. The concrete shall be reinforced by reinforcing steel bars in case of lack of space in any direction, side or top.

Testing

The Contractor shall test all drainage and sewerage pipelines, joints and fittings before back filling the trenches. The tests shall be carried out between each two manholes in the presence of the owner.

Pipelines shall be clean and dry and the joints shall not be covered with soil the underground water level shall be at the lowest possible level testing shall be carried out by water subject to the approval of owner.

Testing by Water

Water shall be so filled in all parts of pipes, of whatever diameter to be tested, that all air in the pipes is expelled and the pipes are completely filled with water. The pipes shall be tested for 0.5 bar pressure of water and the time for test shall be 12 hours. If any leak is noticed in the pipeline, the Contractor shall repair such leak to the satisfaction of the owner. If in the opinion of the owner any damage had occurred in the pipelines in the process of pouring the concrete or backfilling, he shall have the right to order re-testing of the doubtful part. If a second testing proves that the

pipeline is not serviceable, then the Contractor shall have to locate the damage, make it good and carry out re-testing until he secures satisfactory results.

The Contractor shall fix plugs in ends of pipes to be tested and shall take necessary precautions to prevent plugs or fixing tools from getting inside the pipes as a result of water flushing.

5.7.1.2 Storm Water Drainage System

The plant storm water drainage system shall take in to account the topography of the plant area, area drainage patterns and intensity of rainfall etc. All storm water drains shall be designed for the maximum hourly rainfall intensity.

All storm water drainage shall preferably be through open storm water drains on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. In case of road along boundary wall, storm water drain may be provided on one side.

Surface drains shall be open drains of RCC rectangular cross section. All drains in the power block area and around buildings shall be covered drains.

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.

Minimum slope for paved areas towards drains	-	1 in 100
Maximum drainage travel extent	-	10 meters

Uncontaminated area surface drainage shall be connected to nearest open storm water drains through rectangular drains.

Contaminated area surface drainage shall be collected through separate network.

Interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.

Minimum width of RCC rectangular drains	-	450 mm
Drainage pipe material	-	RCC class NP2 conforming to IS: 458 except road and rail crossing areas
	-	RCC class NP3 for road crossings
	-	Pipes conforming to railway loading standards for rail crossings
Minimum velocity for self cleansing	-	0.6 m/sec
Maximum velocity for pipe drains	-	2.4 m/sec
Maximum velocity for open drains	-	1.8 m/sec
Minimum slope of drains	-	1 in 2000
Minimum earth cover over drain pipes in paved areas	-	450 mm

Minimum width of garland drains all round the building	-	300 mm
Minimum thickness of side walls and bottom slab	-	125 mm or as per design requirements whichever is greater

Diameter of pipes used for drainage / culverts shall be between 300 mm to 600 mm. Beyond 600 mm, box drains / culverts shall be provided.

Run-off co-efficient for paved and unpaved areas shall be 0.9 and 0.6 respectively.

Surface drains shall normally have a bed slope not milder than 1 in 2000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge.

Manholes shall be provided to piped drainage lines at every 50 m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be of 1.0 m x 1.0 m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.

The cushion over the pipes for storm water culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M-15. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.

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 to be let.

The Contractor shall furnish a comprehensive layout of drainage system, taking consideration of different construction phase for the approval of the Owner.

Drainage shall be provided for all roads, pavements, sidewalks, buildings, structures and wet areas including cable/pipe trenches, tunnels, basement of buildings, coal stockyard and pits etc. Where gravity flow is not possible. pumps shall be installed for lifting and/or diverting pressurized water to location of discharge points. Pump sumps and pumps shall be provided at all necessary locations.

Proper drainage of floors, basements, cable / pipe trenches tunnels and pits shall be provided for fire water, operation and leakage water.

The outdoor storm water may be drained through concrete lined open ditches ultimately connecting to nearest drainage channel. All building roof and non-contaminated floor drainage, drainage of cable / pipe trenches, tunnels, pits, basements etc., shall be provided with suitable buried piping system (gravity flow) for discharging ultimately into the common outdoor drainage system.

5.7.1.3 Plant Effluent Drainage (Oily Waste / Process Waste Drainage)

The oily / process waste shall be drained / collected through a separate sewer system consisting of underground (overground if required) concrete / cast iron pipes. Catch pits shall be provided at the source location and they shall be interconnected by buried pipes. No bends and branches shall be provided in the pipe line. Manholes shall be provided at all junctions of pipes. Catch pits shall have a minimum internal dimension of 600mm x 600mm. They shall be of RCC construction and provided with CI grills.

The main and branch connection pipes shall be sized for the expected maximum discharge subject to a minimum of 250 mm NB and 100 mm NB respectively. The pipes shall be adequately sloped for drainage and shall carry flow to neutralisation pit / ETP / Oil water separator as

required.

Industrial oily waste water shall be passed through oil water separator system before connecting to the effluent treatment plant.

The drainage of oily waste water from transformers shall be provided with dual system. The oily water during normal operation shall be passed through oil water separator system and then connected to drainage system. The oily water during emergency operation shall be led through another system of pipes connecting to central blind sump. The blind sump shall have sufficient capacity to store transformer oil and fire fighting water for half hour duration.

Very hot (over 60℃) water shall be first cooled down to less than 60℃ in collecting basin by mixing with cold water before connecting to storm drainage system.

The maximum temperature, quality, quantity and location of drain water of individual equipment shall be tabulated and furnished to the Owner's representative.

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.

5.7.1.4 Sewage System

Salient points to be considered for sewage system,

- HDPE pipes conforming to IS: 4984 of material grade PE 80 having pressure rating PN6 shall be used for above ground level sewage system.
- For below ground level sewage system heavy duty uPVC pipes shall be used.
- Pipes connecting toilet facilities to manholes shall be minimum 100 mm.
- Pipes connecting various manholes shall be minimum 150 mm.

Sewers shall be designed for peak flow condition (3 times the average flow) and pipes flowing half full.

Minimum self cleansing velocity - 0.75 m/sec

Maximum velocity - 2.4 m/sec

Suitable manholes shall be provided to piped sewage lines at every 30 m intervals, at junctions and at change of gradient, alignment & diameter of pipe and shall be of masonry or RCC construction. Details of manholes shall be as per IS:4111 (Part-I). Minimum size of manholes shall be 1.0m x 1.0 m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.

Sewage from the buildings shall be let into septic tanks. Overflow from soak pits of septic tanks shall be sent to a central sewage treatment plant through a sewerage network. The treated effluent shall be utilized for the irrigation of the landscaped areas and horticulture.

The sanitary sewer system shall be independent of plant and storm drainage system. The treatment of sanitary sewage shall be through septic tanks and soak pits/leaching fields. The

number of septic tank shall be kept minimum and their location shall be away from plants, buildings and facilities. The size of septic tanks shall be designed based on fixture units and for a minimum storage of 5 years but not less than 2.0 CU.M.

All underground piping below concrete slab shall be HPDE minimum 100mm dia and for outdoors it shall be HDPE 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

Following minimum drainage slope shall be provided:
• Pipes of diameter less than 200mm : 1 (vertical) : 100 (horizontal)
• Pipes of diameter 200 mm & more : 1 (vertical) : 200 (horizontal)

Septic Tanks

For the treatment of sanitary sewage, a septic tank having a minimum of 3 chambers shall be constructed. Septic tank shall consist of the RCC tank with inlet and outlets therefrom, complete with all necessary earthwork and backfilling. The details of septic tank shall be as per IS:2470. The chambers shall be separated by walls with slits. Each chamber shall have one manhole cover for cleaning with mobile pump. Before the outlet in the last chambers, a screen board shall be provided to prevent the passage of floating matter into the discharge pipe.

Septic tank shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wire meshes and cowl.

Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed. After the Septic Tank has been tested to be watertight and the sewage system is checked, the tank shall be filled with water to its outlet before the sewage is let into the tank. It shall be seeded with well-digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge, small quantity of decaying organic matter such as digested cow dung may be introduced.

The volume of the septic tank shall be adequate for the sanitary sewage owing to the number of persons occupying the building, subject to the Owner approval.

Soak Pit

A soak pit shall be arranged at the location shown on drawings for the disposal of sanitary sewage from the outlet of the septic tank. The soak pit shall be constructed in-situ. It shall consist of a minimum 900 mm dia pit 1.0m in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6). The lower part shall be perforated and filled with brickbats.

Inspection opening of 700 mm x 700 mm shall be provided. The cover of the inspection opening shall be of cast-iron. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti mosquito measure.

5.7.2 INTER PLANT TRENCHES

All cable and pipe trenches shall be of RCC. Trenches located outside buildings shall be projecting at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.

Trenches shall be covered using precast RCC cover, each not weighing more than 65 Kg and shall be provided with a lifting hooks.

As far as possible in the open area trenches shall be avoided for running cables. Cable racks are preferred wherever possible.

5.7.3 ROADS & PARKING AREA

The roads and pavements shall be designed and constructed in accordance with the provision of the relevant IRC Codes and MOST (MORTH) standards.

The construction of rigid pavement including box cutting, edging, sub grade, WBM/dry lean concrete sub base, cement concrete pavement, wearing course, shoulder works, etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work in accordance with relevant codes and standards of latest editions of Indian Road Congress, MOST (MORTH) specifications and Bureau of Indian Standards in respect of design, construction, workmanship, quality and properties of materials, method of testing, tolerance etc.

Some of relevant available codes are listed here under:

1. Specification for road and bridge works of Ministry of Road Transport and Highways(Ministry of shipping & Transport (Roads wing)) Published by the IRC.
2. IRC 58 Guidelines for the design of plain jointed rigid pavements for highways.
3. IRC:SP 11 Hand Book of Quality Control for Construction of Roads and Runways.
4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.
5. IS:2212 Code of Practice for Brickwork.
6. IS:783 Code of Practice for Laying of Concrete Pipes.
7. IRC:SP-49 Guidelines for the use of dry lean concrete as the sub base for rigid pavements.
8. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard specification, any other standard practice as may be specified by the Owner shall be followed.

Sub-base shall be of granular material i.e. laterites, moorum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted sub grade. Granular base shall be of water bound macadam course (WBM) construction. Thickness of sub-base/base shall be designed as per relevant standards.

A separation membrane shall be used between concrete pavement slab and the sub base. Membrane shall be impermeable plastic sheeting of 125 microns thick laid flat without creases

The minimum thickness, minimum grade of concrete, minimum reinforcement for the RCC roads and Pavements shall be as follows.

a) 250 mm thick with M30 Grade mix, with double mat reinforcement of 8 tor @ 250 c/c both ways- For all roads except patrol road along the boundary wall.
b) 150mmmm thick with M30 Grade mix with single mat reinforcement of 8 tor @ 250mm c/c both ways for the patrol road along the boundary wall.

The above specified are minimum and indicative and the contractor shall provide roads as per functional and design requirements.

The joints, dowel bars, tie bars, joint filler, sealing compound, tolerances, curing, etc, shall be as per relevant IRC / MOST(MORTH) standards.

Shoulder provided on either side shall be in murrum construction of 150 mm compacted thickness.

The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for maneuvering of vehicles. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 30. Normally the roads shall have much flatter gradient. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.

All double lane roads shall have a minimum turning radius of 25 meters and all single lane roads shall have a minimum turning radius of 10 meter. However, for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also to be checked for to take largest vehicles and equipment which can reasonably be expected.

All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loadings. Number of such crossings shall however be kept to a minimum.

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

A turning area at blind ends shall be provided.

All roads shall be surfaced with gravel during the construction period. Occasional applications of a dust palliative material shall be used to minimize the dust problem during the dry seasons.

Bollards shall be provided along side all type roadways near equipment which requires protection. Spare duct banks shall be provided under all type roads spaced at 100 meter intervals.

Signs shall be provided for vehicle management and shall meet Indian standards. All signs shall be dual worded in both English and Tamil. Finished top (crest) of roads shall be 250mm above the surrounding grade level. The ruling gradient for roads longitudinal shall not exceed 1 in 20. Main roads and roads around the main plant shall be designed for movement of heaviest equipment of the plant.

California Bearing Ratio (CBR) method shall be followed for the design of roads as per IS:2720 (Part XVI). CBR test shall be carried out in remoulded soil samples under soak condition.

The shoulder shall be laid with slope of 1 in 30. Foot path shall be provided at both sides of the road as per requirement for the main road connecting security main gate to the main plant and administrative building.

RCC pipes of 150 mm diameter shall be provided below each road at every 50 m and 600 mm diameter at every 300 m and also at all turnings for maintenance purpose. RCC pipes shall be of Grade ‘NP3’.

All the culverts shall be designed for IRC Class' AA' loading and shall be checked for class' A' loading. The Equipment moving load shall also be properly considered.

Minimum width of RCC culverts shall be 1000 mm.

All buildings and facilities/components shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement and as directed by the Owner. Access roads shall also be provided in 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.

No underground service piping except for drainage and sewage system shall run directly below the road (including up to 1.0m from the edge of road) along its longitudinal direction.

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

The pre-cast concrete kerb stones shall be provided at both sides of the road and shall be made of concrete grade M20. The size of the kerb stones shall be 380 mm height, 200 mm width at bottom and 150 mm at top and 600 mm length.

Median of suitable width as per relevant standards shall be provided in the road connecting Security building near the main entrance to the main plant.

Parking Area

Sufficient pavement areas adjacent to buildings and facilities shall be provided for parking facilities as directed by the owner.

Parking area shall have PCC paving of M20, 150 mm thick laid over 150 mm thick compacted rubble soling shall be provided. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 150 mm with interstices properly filled with grits.

Top level of parking area shall be flushed with crown of the connecting roads with a cross slope. Parking areas shall be provided with rigid pavement and shall be provided with antiskid tiles.

Pipe Culverts

The drainage pipes unless otherwise shown on drawings or instructed by the owner, shall be made of RCC (Hume pipe) and shall be either Class NP2 or NP3. Pipe culverts shall be made of reinforced concrete pipe (Hume Pipe) and shall be of class NP2 as decided by the owner or shown in the drawing. All pipes shall meet the requirements of IS:458 and shall be procured from approved manufacturers with collars as per manufacturers Standard specifications. The Tenderer shall specifically mention the particular manufacturer's product he proposes to use.

For bedding concrete for laying the pipes, the maximum size of aggregate shall be 38 mm. Fine aggregate for concrete shall be as per IS:383.

Laying of Pipes

Laying of Hume pipes and collars shall be done as per IS:783. Pipes shall be laid either in trenches or on supports as per drawing and/or instructions of the owner. All pipe sections and collars shall be inspected carefully for defects before laying in the trenches. Broken or defective pipe shall not be used and shall be properly marked and removed from site as soon as the defects are detected. Pipes shall be laid true to line and grade as specified in the drawings and/or instruction of the owner The bedding of the pipes shall as per IS:783. The profile of cutting of trenches, free working space to be provided on each side of the pipe, etc. shall be decided at site by the owner as per site condition. 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, back filling of the trenches shall be done in layers of 150 mm, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the owner. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the owner. The filling shall be done as per specification.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them.

Under no circumstances the pipes shall be dropped into the trench or on supports from a height. The joints of pipes shall be grouted with 1:2 cement - sand mortar and the procedure of jointing shall be as per IS:783. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipes as consistent with the load expected to be transmitted from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under and around the curve of the pipe to form an even bed. Where the pipe is laid in trench in rock, hard clay, shale or other hard materials, the space below the pipe shall be excavated and replaced with an equalising bed of concrete (1:4:8 mix), sand or compacted earth as approved by the owner. In no place shall the pipe be laid directly on such hard material. If end protection wall is shown in drawing, the wall shall be constructed with first class quality locally available bricks from approved source. All civil works connected with the protection work, like concrete, brick masonry, plastering etc. shall be done as per relevant Indian Standards and in accordance with approved construction drawings. All materials used shall also conform to Indian Standards.

Foot Path

Foot path shall be provided at both sides of the road as per requirement for the main road connecting security main gate to the main plant and administrative building.

The sub-grade and sub-base of the foot path shall comply with the requirement for the sub-grade and sub-base of the roads. After the top layer/WBM course for the road width is laid and compacted, the existing surface at the shoulders of the road must be scarified. Fresh quantity of approved earth, which may be extracted from the surplus earth obtained by box cutting, shall be spread in layers for building up the berms. The layer of earth must be compacted by at least three passes of 8 - 10 tonne rollers. The edges must be well compacted by suitable means to prevent edge slips and the work shall be properly trimmed and dressed. The foot path shall be paved Pre-cast concrete tiles 400 mm x 400 mm x 80 mm or Cast in situ concrete as directed by the owner.

Interlocking Paving Tiles

Interlocking paving tiles shall be 80 mm thick and shall be made of concrete grade M20. Pattern and quality of the interlocking tiles shall be subject to the owner's approval. Laying of interlocking paving tiles shall be carried out as follows:

The sub-grade and sub-base shall be prepared as specified above for the subgrade and sub-base of roads. Layer of carefully screeded sand shall be placed of about 100 mm thickness well graded to line and levels as required. The interlocking tiles shall be laid on the sand screed in a herring bone pattern, with all edges fitted to the required shape. After a sufficient area of tiles has been laid the surface shall be vibrated with adequate vibrator. Then the whole surface shall be covered with fine sand and brushed into the open joints.

Pre-cast Concrete Kerb stones

The pre-cast concrete kerb stones shall be provided at both sides of the road and shall be made of concrete grade M20. The size of the kerb stones shall be 380 mm height, 200 mm width at bottom and 150 mm at top and 600 mm length.

5.7.4 FENCING

Fencing shall be provided in areas as listed in Section related to Description of Buildings, Structures and Facilities

Fencing shall comprise of 2.4 m high PVC coated galvanized chain link fence of minimum 8 gauge (excluding PVC coating) with mesh size 75 mm and galvanised barbed wire on inclined member to a height of 600 mm above the chain link fencing. 3 lines of 12 gauge high tensile spring steel wire

shall be provided for the entire length of fencing. Also 50 x 6 galvanised MS flats shall be provided at every fifth post sandwiching the fencing with post using GI nuts and bolts.

Top of toe wall shall be 200 mm above formation level. Toe wall shall be generally of RCC construction and shall extend 150 mm below the formation level and the fencing mesh shall be embedded inside toe wall by minimum 75 mm.

Fencing post shall be fabricated out of galvanised MS angle section and shall be spaced at a maximum spacing of 2.5 m with struts made up of galvanised MS angle at every fifth fencing post in addition to these at bends. Expansion joint shall be provided at every 60 m. 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 MS angles. All corner posts will have two stay posts and every tenth post will have a transverse stay post. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions

Steel entry gates shall be provided for all fenced areas. Gates shall be formed out of tubular section conforming to IS: 1161. Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

Gate shall be fabricated out of tubular sections conforming to IS : 1161 and shall be hot dipped galvanised. Outer frame shall be 65 NB (medium) tube and diagonal 50 NB (medium) tube 50 mm sq. welded mesh with 4 mm dia GI wire fabric shall be welded to 25 mm $\times$ 6 mm thick GI flat which in turn shall be welded to the outer tubular frame. The gate shall be provided with 20 mm wide $\times$ 80 mm dia flat M.S. roller at the bottom. The gate frame shall be fixed to GI tubular post or RCC post.

5.7.5 PAVING & GRADE SLABS

Paving in Switchyard and around NDCT shall be as described in respective sections.

5.7.5.1 RCC Paving

150 mm thick R.C.C paving, laid to a slope of 1 in 100 towards the nearest drain, with minimum 8mm dia reinforcement at 200 mm c/c both ways in top and bottom, shall be provided in the following areas. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC 1:4:8, 50 mm thick.

a) From Turbine building up to the farther edge of Chimney. The paving shall extend to a minimum of 5 m on either side from the outer most face of equipment / structures / Chimney / Condensate Storage Tanks in the either direction.

b) 5 m wide corridor outside both gable end widths of TG and De-aerator bays of Power House Building.

c) Ash silo area extending at least 10 m on all sides from outer periphery of the silos. This paving shall be designed for the loads coming from Ash trucks.

d) Fuel oil unloading area covering decantation ramp and platforms

e) Paved area not less than 5000 Sq.m at locations pointed out by owner for lorry parking near Ash silo area.

f) Paving around Store

Coal Stock Pile area

Coal Stock Pile area shall be paved as described below.

a) The under bed shall consist of well compacted WBM or Dry Lean Concrete of 100mm thickness designed as per MOST / MORTH standards.

b) Followed by a layer of PCC 1:4:8, 50 mm thick.

c) Top layer of 150 mm thick RCC paving, laid to a slope of 1 in 100 towards the peripheral drains, with minimum 8mm dia reinforcement at 200 mm c/c both ways in top and bottom

d) 300 mm coal dust shall be provided on top of the RCC slab as a cushion. Owner will provide the coal dust.

5.7.5.2 PCC Paving

PCC paving of M20, 100 mm thick laid over 150 mm thick compacted rubble soling shall be provided in the following area. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 150 mm with interstices properly filled with grits, followed by a layer of PCC 1:4:8, 50 mm thick.

a) Complete Transformer Yard, covering area between A-row of the turbine building up to the fencing of the Transformer yard.

PCC paving of M15, 100 mm thick shall be provided as paving inside the following areas. The paving shall be laid over well compacted ground and laid to slope towards peripheral drain.

a) Fuel oil tank farm

5.7.5.3 Stone Aggregate Paving

For auxiliary transformer yards, paving of stone aggregate of 100 mm thick using 20 mm size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.

5.7.5.4 Grade Slab with equipment (Indoor / Outdoor)

Minimum 200 mm thick of grade M20 with minimum reinforcement of 8 dia (HYSD) @ 200 c/c both ways top & bottom.

The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 225 mm with interstices properly filled with grits, followed by a layer of PCC 1:4:8, 50 mm thick.

SECTION 5.8

FINISHES

TABLE OF CONTENTS

5.8.1 GENERAL

The various finishes being used for this project are briefly described below.

5.8.2 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 screed 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.

5.8.2.1 False Flooring System

Removable type false flooring system shall be provided in computer rooms and control rooms if required as per equipment layout. RCC floor slab shall be sunk to a depth as required for the false floor system adopted.

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

Supporting Structure

The supporting structure shall comprise of fabricated jacks. Jacks shall be vertically true and located to conform to the size of the floor panels and shall be fixed to the RCC floor slab. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut.The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

Floor Panel

The false flooring panels shall consist of fire resistant phenol formaldehyde bonded particle board panels, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel shall have 0.05 mm. thick Aluminium foil which shall be fixed to the particle board with resin based adhesive.

Each floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq meter or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

Surface Finish

All removable panels shall have the top surface finished with 2 mm thick Anti static Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

Skirting

Skirting shall be of the same Anstistatic Vinyltiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

Installation

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

The false flooring system shall be checked specially for :

a) Level
b) Alignment of joints
c) Thickness of joints
d) Surface finish
e) Colour and texture

5.8.2.2 PVC Floor Finish

Two mm thick PVC as per IS: 3462 laid as per IS: 5318 over concrete under bed of 48 mm.

5.8.2.3 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 over all thickness of 50 mm.

5.8.2.4 Terrazzo Tiles

Tiles shall generally be of size 250x250x20 mm laid over concrete bedding to result in an overall thickness of 50 mm.

5.8.2.5 Granolithic Flooring

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 bunker bay, operating floor of pump house, permanent stores and other plant building areas where heavy duty flooring is required.

Granolithic flooring shall 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.

5.8.2.6 Heavy Duty Ceramic Tiles

Heavy duty anti skid ceramic tiles with matt finish shall be used in toilets, pantry, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and color. Dado in toilets and pantry, locker rooms etc shall also be of similar finish.

5.8.2.7 Acid/Alkali Resisting Tiles

Battery rooms and other areas coming into contact with acid / alkali vapours or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall comprise of potassium silicate mortar conforming to IS: 4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS: 4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specifications do not apply to D.M. Plant.

5.8.2.8 Integral Floor Finish

For cable vaults room, floors of wagon tripler 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.

5.8.2.9 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.

5.8.2.10 Acid / Alkali resistant Tiling / Brick lining

Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS: 4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, kerbs and sumps, all as per the acid / alkali proofing specialist Contractor's requirement.

For floor of neutralising pit the finish shall be as follows. Bitumen primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS: 4860.

For walls of neutralising pit, the same specification as per clause 2.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.

Special instruction to be followed for acid resistant lining in neutralising pit shall be as follows.

i) The structures shall be tested for water tightness.

ii) Surface on which lining is to be applied shall be prepared as per IS: 2395.

iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS: 4832 (Part II). Seal coat of ready made epoxy paint shall be provided at the joints to cover up any porosity.

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) Acid / alkali resistant treatment shall extend at least 1 metre on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 metres all round for outdoor installations.

In general, all concrete surfaces in contact with acid / alkali / corrosive environments shall be given protective treatment.

5.8.2.11 Polished Vitrified Tiles

Polished vitrified tiles shall be of 600mm x 600mm x 7.5mm 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
- Conference room
- Senior executive rooms.

5.8.3 SKIRTING / DADO

150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.

Toilets & locker rooms shall be provided with dado of 2250 mm high.

For main Control room and control equipment room minimum 5 mm thick decorative granite tiles shall be provided upto false ceiling level.

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.

Staircase wall shall be given dado of cast in situ terrazo to a height of 2100 mm.

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.

5.8.4 METAL CLADDING

5.8.4.1 Permanent colour coated sandwiched insulated metal cladding system and roofing system

Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6 mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm / sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness (DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

Galvanised M.S.sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanisation shall not be less than 180 gm / sq.m.

The permanent colour coated sheet shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability.

Inner sheet shall fixed directly to side runners and Z spacers made of at least 2 mm thick galvanised steel sheet of grade 375 as per IS: 277. Inner sheet shall be fixed at the rate not more than 1.50 m centre to centre to hold the insulation and external sheeting.

The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS: 8183, having a density of 32 kg / cu.m for glass wool & 48 kg / cu.m for rock wool.

For roof sheeting the specification remains same as that of side cladding except the thickness and galavanisation. The minimum thickness of roof sheeting shall be 0.8 mm with galvanisation rate of 275 gm/sq.m.

Prefabricated sandwiched polyurethane PUF panel system may also be used for side and roof sheeting.

5.8.4.2 Permanent colour coated (non-insulated) metal cladding system

Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S.sheets having 0.6 mm minimum base metal thickness (or High tensile steel sheet of 0.5 mm minimum base metal

thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS: 14246 and shall conform to class 3 for the durability. For roof sheeting the specification remains same as that of side cladding except the thickness and galvanisation. The minimum thickness of roof sheeting shall be 0.8 mm with galvanisation rate of 275 gm/sq.m.

5.8.4.3 Flashings, caps, trim closures etc

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

5.8.5 PLASTERING

All brickwork shall be provided with plastering on both faces and internal and external painting.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 12 mm thick in CM 1:5 and top 8 mm thick layer in CM 1:3 (Sand faced) with approved water proofing compound.

For internal walls 18 mm thick plaster in CM 1:4 shall be provided on the uneven side of the wall and 12 mm thick plaster in CM 1:4 on the even side of the wall.

Ceiling plastering of 6 mm thick with CM 1:3 shall be provided for all non-plant buildings.

All plastering work shall conform to IS: 1661.

Internal plastering on walls shall be done to cover surfaces from skirting level to bottom of roof slab in all areas including areas where false ceiling is provided.

The under coat shall be scratched or roughed before it is fully hardened to a mechanical key.

All drips, grooves, mouldings and cornices as shown on drawing or instructed by the owner shall be done with special care to maintain true lines, levels and profiles.

Suitable anti-spalling arrangements shall be adopted when plastering steel wall beams.

After the plastering work is completed, all debris shall be removed and the area left clean.

Neat cement finish:

After achieving a true plastered surface with the help of wooden straight edge, the entire area shall be uniformly treated with paste of neat cement at the rate of 1 kg/sq.m and rubbed smooth with a trowel (Aldeck smooth finish).

Curing:

All plastered surface after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

Plaster-of-Paris Punning

Inside surfaces of walls shall be provided plaster of paris punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.

The thickness of punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation. Before bulk work is taken up, a sample of punning shall be done on roughly 1 sq.m area and approval of Owner taken. The work shall then be completed as per approved sample.

This shall be done in the following areas

- All office blocks.
- Administrative building
- Central control room building
- Service building
- All air conditioned areas.

5.8.6 PAINTING

The following standards shall apply to the painting works.

IS:5	Colours for ready mixed paints and enamels.
IS:102	Ready mixed paint, brushing, red lead, non-setting, priming.
IS:123	Ready mixed paint, brushing, finishing, semigloss, for general purposes.
IS:1477	Code of practice for painting of ferrous metals in buildings.
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.
IS:2338	Code of practice for finishing of wood and wood based materials.
IS:2339	Aluminium paint for general purposes in dual container.
IS:2395	Code of practice for painting concrete, masonry and plaster surface.
IS:2932	Enamel, synthetic, exterior, a) undercoating, b) finishing.
IS:2933	Enamel, exterior, a) undercoating, b) finishing.
IS:5410	Specification for cement paint, colour as required.
IS:5411	Specification for plastic emulsion paint.

General requirements shall be as below.

External faces of walls, sunshades, etc.	-	Water proof cement based paint as per IS: 5410
Inside surfaces – all areas	-	Acrylic washable distemper as per IS: 428
Inside surfaces – Control room, Control equipment rooms, all air conditioned areas	-	Acrylic emulsion paint as per IS: 5411
Inside surfaces – plant buildings like D.G. house, Compressor house, pump houses, Ash handling pump house etc.	-	Acrylic distemper as per IS:428
Walls in DM Plant	-	Chlorinated rubber based paint as per IS: 9862

Walls above Dado in battery rooms	-	Chlorinated rubber based paint as per IS: 9862
All plastered ceilings	-	water bound distemper as per IS: 427
Oil canal and oil equipment room	-	Oil resistant paint as per IS : 161
All wood work	-	Fire resistant transparent paint as per IS: 162 over french polish as per IS: 348 or flat oil paint as per IS: 137.

Following general instruction for painting shall be followed.

a) For painting on concrete, masonry and plastered surfaces IS: 2395 parts I & II shall be followed.

b) For painting on wood work IS: 2338 part I & II shall be followed.

c) All paints shall be of best brand and make.

d) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.

e) All painting on masonry or concrete surfaces shall preferably be applied by rollers.

f) Thinner shall not be used with textured paint (Sandtex Matt etc) finish.

g) 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.

Preparation of Surfaces All surfaces to be painted shall be smooth, even and free from dirt or rubbish and shall be dry and protected from dampness. In general, all surfaces shall be free of any material which will adversely affect the adhesion or appearance of paint.	
Plaster surface	All defective plaster shall be cut out and trimmed. All holes in internal plaster faces shall be made good with approved material. All dirt and powdery substrate shall be removed by wiping with slightly damp cloth. Concrete surface All laitance shall be removed by wire brush . All holes, defects shall be filled and repaired by epoxy grouts.
New metal surface	All dust and/or mill scale etc. shall be removed with a wire brush or chipping hammer or grinding if necessary. The surface of the metal work shall then be primed with an approved metal primer before application of the undercoat.
Galvanised surface	Pre-treatment of the galvanised surfaces including etch-cleaning and coating shall be carried out as per requirement. Sweep blasting or emery paper may be used to roughen the galvanised surface to get better anchor pattern.
Wood surface	All iron mongery shall be removed prior to the preparation of surfaces and shall be re-fixed upon completion of painting. All knots and resinous parts in wood surfaces shall be treated by two coats of shellac varnish. All cracks and holes shall be treated by one coat of primer and filled with approved filler.

Structural Steel	Painting on structural steel shall be as described in Section related to Structural Steel.
Painting Systems	
Emulsion paints	Emulsion paints shall be used for internal cement plastering and internal fair faced concrete of walls and ceilings. All emulsion paints shall be washable. One coat of Acrylic primer sealer Two coats of filler based on alkaline resistant polyvinyl-acetate Two coats of polyvinyl-acetate emulsion flat finish
Oil Bound Distemper	Oil bound distemper (IS: 428), of approved make shall be used for internal cement plastering and internal fair faced concrete of walls and ceilings. Two or coats of distemper, as found necessary shall be applied to obtain even shade.
Water proof Cement Paint	It shall be made from best quality white cement and lime resistant colours with accelerators, water proofing agents and fungicides. The paint shall conform to IS: 5410.
Oil paints	Oil paints shall be used for wood surface and internal cement plastering and internal fair faced concrete in confined humid areas such as bathrooms. One coat of Acrylic primer sealer Two coats of filler based on alkaline resistant polyvinyl-acetate Two finish coats based on alkyd resins
Varnishes	Varnishes shall be used for wood surfaces and shall be of one of the following types • polyurethane varnish • synthetic varnish of linseed oil alkyd resin
Other systems of paints	Oil resistant paints shall be epoxy paint resistant to all types of oil.

Application of Paints

Before applying the paint, all prepared surfaces shall be dry and clean. All priming paints shall be applied by brush except for etch primer which may be applied by brush or spray. Paints shall be applied as evenly as possible to provide a smooth coating of uniform thickness. Damaged areas of priming coats or undercoats shall be made good before further coats of paints are applied. The various coats of paint shall be distinguishable from each other by their shade. The Contractor shall inform the owner in good time before starting to apply the next coat so that the owner shall have the opportunity of approving the previous coat. Painting systems shall not be carried out at temperature below 5^0 C or above 45^0C. Trial coats shall be prepared at the request of the owner. The Contractor shall, upon completion, remove all paint where it has been spilled, splashed or spattered on surfaces including sanitary fixtures, glass and hardware. It shall be removed without marring the surface finish of the item being cleaned.

5.8.7 ROOF

All the buildings having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS: 14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated galvanised M.S.troughed metal sheet decking of approved profile with

minimum base metal thickness of 0.8 mm and minimum trough depth of 38mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq.m. Dry film thickness of colour coating shall be at least 20 micron.

Roof of all buildings having R.C.C. frame work shall have cast in situ R.C.C. slab with conventional shuttering.

Roof of conveyor galleries, steel buildings and steam generator shall be of permanently colour coated galvnaised M.S. troughed metal sheet of approved profile. Minimum base metal thickness shall be 0.8 mm. The rate of zinc consumption for galvanising shall be 275 gm/sq.m. The external face shall have permanent colour coating of PVF2 paint of minimum DFT of 20 microns and inner surface shall be coated with silicon modified polyester paint with DFT of 20 microns.

5.8.8 ROOF DRAINAGE AND WATER PROOFING

For efficient drainage of rain water, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provided by sloping the structural framing system itself. Gradient may also be provided using screed concrete. But the average thickness of such screed concrete may be restricted to about 50 mm. In the case of metal roofing system the roof slope shall be 1 vertical : 5 horizontal.

Roof water proofing shall be made either by Seven course water proofing or using High solid content polyurethane based waterproof coating as per relevant standards.

Chequered cement concrete 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 1000 mm.

Seven course water proofing

i) Seven courses as per IS: 1346 using 3 layer of Type 2 Grade 1 glass fibre based felt as per IS: 7193.

ii) 50 mm thick foam concrete as per IS: 6598 for thermal insulation. 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 40 mm screed of M20 concrete.

iii) 15 mm thick cement sand plaster 1:4.

High solid content polyurethane based waterproof coating

Roof water proofing may also be provided using High solid content polyurethane based cold liquid applied waterproof coating of 1.5 mm as per ASTMC-836-89 and shall comprise of urethane pre-polymer extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous impervious jointless film, which is rubbery and elastic. The material shall come in a single pack system to site.

The material shall not be diluted. The coating shall have physical features like high viscosity, min. 80% solids, high resistance to impact, abrasion and cracking, superior tensile strength, min. 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to PUF insulation and roof substrates. The cured film should have a very low water absorption rate (0.5% maximum at ambient temperature after 7 days). The material shall not be older than 9 months after the date of manufacturing and packing.

Reinforcing layer of non-woven polyscrim cloth made of 100% polyester with minimum weight of 40 gsm/m^2. Fixing and laying shall be as per ASTMC -898-89.

Wearing course shall be 40 mm screed of 1:2:4 concrete as above cast in panels of 1.2m x 1.2m and reinforced with 0.56 mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered cement concrete tiles as above.

Equipments shall be installed on raised pedestals of minimum 300 mm height from FFL of roof to facilitate maintenance of roof treatment.

Haunched portions shall be treated properly.

The slopes and surface level shall be such as to allow quick draining of water without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The water tightness of the roof shall be tested by ponding the roof with 300mm height of water for 7 days and checking for any signs of leakage.

The Contractor shall furnish a performance guarantee of all the waterproofing treatment for a minimum period of five (5) years.

Number and size of rain water down take pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipe shall be HDPE, 150mm dia pipe conforming to class-3 of IS:4984. It is recommended that the minimum diameter of the pipe shall be kept as 150 mm and there shall be a minimum of two pipes provided on each gutter. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.

5.8.9 DOORS, WINDOWS & VENTILATORS

5.8.9.1 Standards

Unless otherwise specified herein. The following standards shall apply to the works.

Rolling shutter, grills, steel doors, aluminium doors and windows, ventilators, Louvers, suspended ceilings, roof and wall cladding etc.

IS:1038	Steel doors, windows and ventilators
IS:1361	Steel windows for industrial buildings
IS:1948	Aluminium doors, windows and ventilators
IS:1949	Aluminium windows for industrial buildings.
IS:3614	Specification for fire check doors
IS:4351	Specification for steel door frames
IS:6051	Code for designation of aluminium and its alloys.
IS:2108	Blackheart malleable iron castings
IS:6248	Specification for metal rolling shutters and rolling grills
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
IS:2835	Flat transparent sheet glass

IS:3548	Code of practice for glazing in buildings Builder's Hardware
IS:204	Tower bolts (All parts)
IS:205	Non-ferrous metal butt hinges
IS:208	Door handles
IS:281	Mild steel sliding door bolts for use with padlocks
IS:363	Hasps and staples
IS:723	Steel countersunk head wire nails
IS:1823	Floor door stoppers
IS:2209	Mortice locks (vertical type)
IS:2681	Non-ferrous metal sliding door bolts for use with padlocks
IS:3564	Hydraulically regulated door closures
IS:3847	Mortice night latches
IS:4992	Specification for door handles for mortice locks (vertical types)
IS:6607	Specification for rebated mortice locks (vertical type)
IS :6315 & IS:7197	Specification for floor spring

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, powder coated aluminium framework with glazing.

All doors of office areas and non-plant buildings shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.

For all air conditioned areas, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas.

Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

Doors in WC and shower shall be PVC doors

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. Both doors and frames shall be factory galvanised, primed and field painted.

All steel doors shall conform to IS 1308 and IS 4351.

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.

Rolling shutters upto 9 m^2 shall be pull & push manual operating type, from 9 m^2 to 12 m^2 shall be push & pull ball bearing type and above 12m^2 shall be mechanically operated. Rolling shutters shall conform to IS: 6248. Components shall be galvanised, factory primed and field painted.

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 for 2 hours. These doors shall be double cover plated type with mineral wool insulation.

Hollow extruded section of minimum 3 mm wall thickness and minimum 38 mm deep as manufactured by INDAL or equivalent shall be used for all aluminium doors, windows and ventilators.

Aluminium windows in ground floors shall have suitable aluminium grills.

All ground floor windows shall be lockable and provided with security grills of 12 mm square painted MS rods.

5.8.9.2 Flush Steel Doors

Steel doors and pressed frames shall be made of 18g steel sheets. Frames shall conform to IS:4351.

No joints shall be permitted in the steel sheets.

All steel doors shall be double-skinned construction with all necessary reinforcement for hinges, locks and other fixtures. The two skins of 18g minimum thick steel sheets shall be mechanically interlocked and bonded together to form an envelope, which shall be closed at the top and bottom with two steel channels, welded to the steel sheets.

Mineral wool or equivalent material approved by the Owner shall be provided as insulation over the whole interior area of the door and shall be fixed with a plastic binder such that no part of the door may become uninsulated due to shocks, blows or long and repeated use of the door.

All doors shall be fitted with necessary best quality hardware and fixtures conforming to relevant IS specifications and shall be capable of withstanding repeated use.

Three steel butt hinges of 100 mm length shall be provided for each door leaf. Steel frames shall be fixed to the masonry by steel sleeve anchor bolts M12 mm passing through holes of 25 mm diameter in the frame. Steel frames shall be fixed to the steel structure by screws.

The clearance of doors shall be 2.5 mm at jambs and heads.

Steel frames shall be provided with door closer fitted with rubber cushions.

External doors shall have an external weather stop.

All fire exit doors shall be provided with panic latch system with horizontal bar action parallel to the door face moving in the direction of the door travel to provide immediate exit in the event of fire or emergency whilst providing security against unauthorised entry.

Sign plates of anodised aluminium or galvanised steel shall be screwed to the door under the horizontal bar, on which the sign, “PUSH BAR TO OPEN" shall he printed.

The thickness of the normal steel door shall be 45 mm for both single and double doors.

All the above specified details shall be applied for normal steel doors, fire resistant steel doors and fire proof steel doors.

The contractor shall provide the Owner with following documents for the steel doors:

- Detailed shop and construction drawings as well as the door schedules and samples of

hardware. Detailed structural analysis of the proposed supplies.

- Test certificates proving conformity of the physical properties stipulated in this specification and relevant standards

5.8.9.3 Fire Resisting And Fire Proof Doors

Fireproof doors with panic devices shall be provided at all fire exit points as per recommendations of Tariff Advisory Committee (TAC). These shall conform to IS:3614 (Part I and Part II). Fire rating of doors shall be as per TAC requirement. However, minimum requirement shall be for two hours. Type of doors shall be double cover-plated type with mineral wool insulation.

5.8.9.4 Rolling Shutter (Hand Operated, Mechanical Gear Operated and Electrically Operated) and Grills

Rolling shutters shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108. They shall be designed to withstand a wind load of 200 Kg/m2 without excessive deflection.

The guides shall be either rolled or pressed deep channel sections 75 mm and 25 mm wide fitted with necessary fitting and fixtures.

The suspension shaft shall be formed from heavy duty tubes conforming to IS:1161 and of sufficient diameter so as to resist deflection due to weight of the rolling shutter. The deflection shall not exceed 5mm / metre width. The shaft shall be provided with CI pulleys and helical springs for counter balancing the weight of the shutter adequately.

The springs shall be approved high tensile flat springs conforming to Grade 2 of IS:4454. These shall be fitted inside the fabricated housing at either ends, which counter-balance the shutter curtain.

The ball bearings shall be double row self-aligning ball bearings fitted inside CI housing fixed on side brackets holding the suspension shaft at either end. The roller assembly shall be designed so as to be capable of producing sufficient torque to ensure easy operation of the rolling shutter in any position. The spring tension shall be adjustable by means of suitable adjustment holes drilled on the rims of the pulley.

The hood cover shall be made of 20 gauge sheets with necessary stiffeners and framework to prevent sag. The bottom lock plate shall be made of 5 mm thick M.S. plate and 95 mm wide, reinforced with angle/T iron of suitable section with 6 mm dia M.S. rivets interlocked with last stride of curtain.

The locking arrangement shall consist of sliding bolts at both ends of the bottom plate fitted to engage with suitable receiving pockets at the bottom of guide channels.

Unless otherwise specified, for overall area of rolling shutters up to 9 sq.m, pull and push type hand-operated shutters shall be used. For area between 9 and 12 sq.m, pull and push type shutters shall be provided with ball bearings. For area larger than 12 sq.m mechanical gear type or electrically operated shutters shall be supplied.

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.

5.8.9.5 Folding Steel Doors

The folding doors shall be used for the entrance of machine halls, workshops and similar. The unit shall be manufactured as a top hung folding door of edged steel sheets and steel sections. Clear height of the pass-gate shall be not less than 2.00 m.

Door leaves shall be manufactured with double flush skin of steel sheet, min 1.5 mm thick, edged and welded to the case. The case shall be stiffened with steel section frame. Thickness of the leaves shall not be less 60 mm.

The door shall be constructed for one way normal manual usage under subtropical conditions for exterior openings in accordance with the architectural design.

The insulation material inside the door shall be fire resistant.

The fixing of the door frame to the wall or steel structure shall be carried out by means of flat steel anchors, size not less than 250/40/4 mm and steel bolts, dia. 8 mm, either cemented into the wall or screwed to the steel structure.

Three anchors shall be provided per 2.5 m length with a minimum of six (6) anchors per door frame.

Joints between doorframe and construction shall be sealed with permanent elastic compound where the door has to be fixed to steel structure.

The door shall be furnished with heavy sturdy-built hardware of corrosion protected steel consisting of:

- Truck brackets
- Intermediate hinges with nylon washers
- Hangers with nylon wheels, ball bearing, lubricated for life incl. wheel centre pattern
- Flush handles outside
- Fold-aside butt hinges, min. three (3) per 2.5 m length
- Door guides with end and centre pattern
- Floor channel
- Furniture, bolts and screws with all fittings

The door and frame shall be galvanised and coated by epoxy paint over galvanizing.

5.8.9.6 Steel Windows and Ventilators

These shall conform in all respects to IS: 1038, IS:7452 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

5.8.9.7 Aluminium Doors, Windows, Glass Walls and Louvers

Aluminium sections for doors, windows and glass walls shall comply with IS:1948 and IS:1949. Aluminium doors, windows and glass walls as well as aluminium frames shall be powder coated in accordance with relevant Indian Standards.

All hardware shall be of concealed construction in the aluminium frame and shall be made of stainless steel. Sections of aluminium profiles shall not be less than 50 mm deep.

All doors shall be provided with door closer, door stops.

Aluminium alloys shall be of uniform quality, free from defects impairing strength and durability with regularity of surfaces and accuracy of right angles. Aluminium windows at high levels shall be fitted with mechanical devices of type approved by the Owner to allow for opening of such windows from the ground level.

Marble sills of 30 mm thickness shall be installed under the windows.

Door and window elements shall be fixed to the structure by means of separate rectangular hollow galvanised steel or aluminium frame.

Joints of door and window frames to the walls shall be covered with aluminium angle on each side and they shall be sealed with permanent elastic material in accordance with the manufacturer's instructions. For air-conditioned rooms, the aluminium windows shall have double glazing.

The Contractor shall provide the following documents for all aluminium profile constructions:

- Detailed shop and construction drawings including the doors and windows schedule
- Detailed structural analysis of the proposed supplies
- Test certificates proving the conformity of the physical properties stipulated in the specifications and the relevant Standards stated herein

5.8.9.8 Timber Doors

All doors shall be of solid core with minimum thickness of 44mm. The core shall consist of fully glued laminated board / block board of reverse straight grain timber strips each of which shall be continuous through the height of the door except for 150 mm rails top and bottom. The core shall be planed true overall to receive plywood facing.

All doors shall have 150 mm 1st class hardwood rails for the full thickness and width of core as well as around all openings to cover the end grains of the lamin boards. The plywood facing on both sides shall be well matched teak or commercial 3 ply veneering with vertical grains or cross bands having minimum thickness of 6 mm as per requirement. Hardwood lipping of the same timber as the face veneer shall be provided at all edges of the door as well as to the opening for glazing.

All doors shall be covered by natural veneer. Door frames shall be minimum 50mm thick and 125 mm wide. They shall be fixed to the RCC / masonry frames around the door by screws / hold fasts (MS strip lugs) and shall be provided with adequate rubber sealing. The minimum number of fixtures shall be five screws or three holdfasts on each side of the frame. Holes for screws shall be drilled with a rotary drill and filled with wooden plugs, rawl plugs or hold fasteners. Clearance of doors shall be 3 mm at jambs and heads. All hardware shall be heavy duty of non-corroding materials (stainless steel / anodized aluminium / oxidised copper / brass). Each door leaf shall be furnished with the following:

- Hinges preferably 140 mm high pivoted with ball bearings
- 1 Heavy door lock with profile cylinder for master-key system

- Stainless door level handles of 125 mm
- Stainless door handle plates or roses
- 1 Door stop sealed with PVC or rubber strips to reduce impact sound

5.8.10 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.

Double glazing shall consist of two 6 mm thick clear toughened safety glass conforming to IS: 2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.

For single glazed aluminium 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.

Wired glass

Wired glass shall be polished on both sides and shall be transparent, complying with IS:5437. It shall be square pattern wired. The wired glass will be used for doors and windows etc. and also used in fire resistant doors of up to 30 minutes resistance.

Putty for glazing to wood shall be linseed oil putty in accordance with relevant IS standards.

Glazing and fixing techniques for glass, handling and care on site shall be generally in accordance with IS:3548. Outer glazing shall be rain-proof. For metal and aluminium frames, structural U-channel gaskets of synthetic rubber (neoprene) shall be use as sealing strips.

5.8.11 FALSE CEILING AND UNDER DECK INSULATION

Main control room shall be provided with Aluminium false ceiling system (of approved make) closed type plain panels of approved colour, roll formed out of corrosion resistant aluminium alloy 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.

All other air conditioned area and other control rooms shall be provided with Gyp board false ceiling system of reputable make.

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 false ceiling system incorporating light fixtures, supply air diffusers, return air grills, fire protection sprinklers, fire detection systems, etc, ceiling looks aesthetically pleasing. Work shall be commenced only after approval of the layout by the Owner.

Aluminium false ceiling system

The panels shall be 0.8 mm thick, stove enamelled, aluminium sheets. Panels of closed appearance of 75 mm or 150 mm wide and length up to 6 meters could be used as directed by the Owner.

The suspension system shall be of sufficient strength and rigidity to carry the panels. The panels shall be supported by stove enamelled aluminium panel carriers. The rod hangers shall be made of galvanised steel. The joints between the panels and the light fixtures and air supply ducts shall be smooth and regular. Power driven fasteners shall be used for fixing the rod hangers in the reinforced concrete ceiling.

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses. All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All MS sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

Metal Grid Suspension System

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

Installation of Ceiling Panels

Installation of ceiling panels shall be strictly as per manufacturer's instruction. For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Owner.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and schedule of items, 6 mm thick cement : lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

No extra payment will be made for arrangement for lighting fixtures air conditioning diffusers access panels, etc. The rate shall include all cutting and wastage from standard size sheets boards, runners, etc.

Under deck insulation 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 HVAC requirement. Ceiling of air washer room also shall be provided with under deck insulation.

Under deck insulation shall comprise of 50 thick resin bonded mineral wool insulation mat conforming to IS: 8183. This mat shall be backed with 0.05 mm thick aluminium foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.

5.8.12 WATER SUPPLY & SANITATION

All material for plumbing and sanitary installation shall be suitable for their intended purpose and appropriately matched to each other. All material and structural components shall be standardised and shall meet the respective quality and dimensional requirements. The Contractor shall submit samples, description, catalogues and/or drawings showing all technical details, type, manufacturer etc. of the offered materials for Owner's approval.

All plumbing and sanitary works shall be executed by a licensed or authorized plumbing supervisor or a licensed or authorised plumber and shall be in accordance with the requirements of IS:1742 and other relevant codes.

For items such as earthworks, excavation, concrete, brick work, stonework, painting etc., relevant specifications for these shall apply, unless other wise specified. The diameter of pipes and fittings wherever mentioned shall mean the internal diameter or nominal bore, unless otherwise specified. The job shall include the cost of making necessary chases, holes etc, in walls, floors and in other places and also making good on completion of the works. Any damage caused to floors, walls etc. during execution of the sanitary and plumbing works shall be made good by the Contractor to the satisfaction of the Owner.

All sanitary fittings shall be procured from approved vendors and shall conform to the requirements of the relevant IS Codes listed above. The sizes shall be as specified in the drawings and where not specified, the same shall be as per owner's approval.

Glazed earthenware fittings shall be of reputed make, white colour and one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be of Chromium Plated (CP) brass of approved make. All wall fittings shall be fixed with wooden cleats and CP brass screws and washers.

Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank conforming to IS: 12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.

HDPE / Galvanized M.S. pipe of medium class conforming to IS: 1239 shall be used for internal piping works for potable water supply.

All sanitary appliances and fittings shall be inspected and tested as per the requirements of IS:1742. All defects and deficiencies detected shall be promptly rectified by the Contractor to the satisfaction of Owner.

An eye & face fountain (combined unit with receptacle) conforming to IS: 10592 shall be provided in battery room, DM plant and Chlorination plant.

Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 12 mm thick polished granite stone.

Laboratory sink shall be of white vitreous china of min size 600x400x200 mm conforming to IS: 2556 (Part-5) in laboratories and in Battery room.

Pipes And Fittings

Cast iron pipes and specials shall be of standard quality conforming to IS:3486.
Stoneware pipes shall conform to IS:651.
RCC pipes for underground sewer shall be P1 class conforming to IS:458.
Water supply lines of GI, PVC, HDPE shall conform to IS:1239, IS:4985 and IS:4984 respectively.
PVC fittings for water supply lines shall conform to IS:10124.

Installation

All execution will be done on the basis of approved drawings / instructions given by the Owner. Fittings shall be located and oriented to allow easy reach such that operation, maintenance, repairs and replacements of pipes, fittings and fixtures are conveniently possible.

Sanitary Appliances

All sanitary appliances shall be fixed in position rigidly on floor and walls as indicated in the drawings or as directed by the Owner. All appliances shall be from the approved manufacturer and of approved colour.

Indian Water Closet (IWC) - Squatting type

Squatting type water closet shall be fitted on trap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be levelled properly and set flush with the finished floor. The pan shall be connected to PVC low level push button / lever type cistern of 10 litre capacity. The flushing cistern shall be supported on a pair of CI cantilever brackets firmly embedded in the wall in cement mortar (1:4) or screwed to wall with suitable plugs. The flush pipe from the cistern shall be 32mm dia tested quality chromium plated (CP) pipe and connected to the pan inlet by means of hemp and putty joint.

European Water Closet (EWC) - Pedestal type

Pedestal type water closet shall be rigidly fixed on the finished floor by means of 75mm long brass screws with suitable plugs. The flushing cistern shall be PVC low level push button / lever type cistern of 10 litres capacity. The cistern shall be supported on a pair of cast iron or rolled steel cantilever brackets firmly fixed on wall with brass screws and suitable plugs. The flush pipe from the cistern shall be 40mm dia chromium plated with brass end cap / lining and fitted to the closet by means of rubber adapter. The closet shall be provided with double plastic seat cover conforming to IS:2548 with chromium plated hinges.

Urinals

Standing type urinals with suitable partitions shall be firmly fitted on finished wall by means of 50mm long brass screws and suitable plugs. Height of the lip from the standing point shall be as shown in the drawings. Urinals shall be fitted with automatic flushing cistern of 10/15 litres (2/3 urinals) capacity. Flushing pipes shall be of CP pipes of 25mm dia and connected to the urinal with 15mm dia PVC connector fitted with brass cap and lining at one end. The joint to the inlet of urinal shall be neatly finished with putty.

Wash basin

Wash basin shall be fitted in position true to level on a pair of cast iron brackets fixed to the wall with brass screws and plugs. The basin shall be fitted with 15mm dia approved quality CP pillar tap and 32 mm dia waste fittings. The type of waste pipe and their connections shall be as shown in the drawings or as directed by the Owner.

Sink

Stainless steel sink shall be levelled properly and fitted in position on a pair of cast iron cantilever brackets firmly embedded in the wall in cement mortar (1:4). The sink shall be fitted with chromium plated brass waste fittings of standard size. The type of waste pipes and their connections shall be as shown on the drawings or as directed by the Owner.

5.8.13 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 of sunshade from the wall shall be as below

Window openings	-	600 mm
Entrance doors / rolling shutters of all plant and non-plant buildings	-	1200 mm wide for upto 3.0 m high openings
	-	1500 mm wide for more than 3.0 m upto 6.0 m high openings
Administrative and Service Buildings door openings	-	750 mm wide

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.

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

Parapet, Chajjas over window and door heads, architectural facias, projections, etc., shall be provided with drip course ill cement sand mortar 1:3.

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 area as per standard norms.

Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

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 coordination with the Owner and only

after obtaining the Owner'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, nickelplated with six security pawl studs.

The keys shall be made of material approved by the Owner 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 Main keys 10 nos. per each building.
Single keys 3 nos. per each door

Room Designation Signs

The entrance to each room shall be furnished with a room designation sign on an anodised aluminium plate of 4mm thickness. Four horizontal grooves of 10 mm width at the lower end of the sign plate shall take plastic strips on which the designation will be printed in English language. At the upper portion the room number shall be engraved with a black background. The designation sign plates shall be screwed to the wall with non-corroding screws.

SCHEDULE OF FINISHES

5.8.14 Refer Annex – A

ANNEX - A

PROJECT	SUBJECT		SECTION
2 X 660 MW Udangudi Supercritical Thermal Power Project Stage - 1	Tender Enquiry Document for EPC Contract		- SHEET NO -

PLANT and NON PLANT BUILDINGS
INTERIOR FINISH SCHEDULE
THE NOMINAL THICKNESS of FLOOR FINISH WILL BE 50mm UNLESS NOTED OTHERWISE
FIRE PROof DOORS SHALL BE AS PER TAC REQUIREMENT.

SL. NO.	AREA DESCRIPTION	FLOOR FINISH	WALL PAINT / FINISH		CEILING FINISH	ROOF TREATMENT	DOORS	WINDOWS
			INTERNAL	EXTERNAL				
1	**MAIN POWER HOUSE BUILDING**							
A	Ground Floor: Maintenance Bay and Unloading Areas	Granolithic with Non-Metallic Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Steel Sliding Type / Rolling Shutters	Sliding / Fixed Type Aluminium Frame Work with 6mm Thick Glass
B	Ground Floor: General Area	Granolithic Flooring	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	
C	Mezzanine Floor (Excluding Chqd. Pl. Area	Granolithic Flooring	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
D	Operating Floor: Operating Area, Lay Down Area	Polished heavy duty cement concrete tiles (carborandum)	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
E	Operating Floor: General Circulation & Movement Areas	Glazed Vitrified Ceramic Tiles	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
F	Operating Floor: Heater Area	Polished heavy duty cement concrete tiles (carborandum)	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
G	Toilet	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper		PVC Frame with PVC Door	
2	**CONTROL & SWITCH GEAR BUILDING**							
A	Central Control Room	Glazed Vitrified Ceramic Tiles	Aluminium composite panel work.	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Double Doors (with Air Locked Lobby) of Powder Coated Aluminium Frame Work with Glazing (Double Swing / Sliding Type)	Glazed Aluminium Sliding / Fixed Type Windows
B	Conference Room, Senior Executive Room	Glazed Vitrified Ceramic Tiles	Acrylic Emulsion Paint	Water Proof Cement Based Paint	Acrylic Distemper		Pressed Steel Frame with Pre-Laminated Particle Board Shutters	
C	Battery Room	Acid / Alkali Resistant Tiles / Painting	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Water Proof Cement Based Paint	Chlorinated Rubber Based Paint		PVC Frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows
D	Switch Gear Room	Granolithic with Two Coats of Expoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Steel Sliding Type Door	Glazed Aluminium Windows with Wire Glass
E	Office, Electronic Cubicle Room, Computer Room, Common Areas & Corridor	Heavy Duty Ceramic Tiles	Acrylic Emulsion Paint	Water Proof Cement Based Paint	Acrylic Distemper		Powder Coated Aluminium Framework with Glazing	Aluminium Glazed Sliding Windows
F	Cable Room	Granolithic with Non-Metallic Floor Hardener	Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	
G	Laboratory Room	Heavy Duty Ceramic Tiles	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper		Aluminium Glazed Doors	
H	Records Room, Lockers Room	Glazed Vitrified Ceramic Tiles	Acrylic Washable Distemper	-	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	
I	Swas Room	Glazed Vitrified Ceramic Tiles	Acrylic Washable Distemper	-	Acrylic Distemper			
J	Toilet	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper		PVC Frame with PVC Door	
K	Pantry	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	-	Acrylic Distemper		PVC Frame with PVC Door	

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THE NOMINAL THICKNESS of FLOOR FINISH WILL BE 50mm UNLESS NOTED OTHERWISE
FIRE PROof DOORS SHALL BE AS PER TAC REQUIREMENT.

SL. NO.	AREA DESCRIPTION	FLOOR FINISH	WALL PAINT / FINISH		CEILING FINISH	ROOF TREATMENT	DOORS	WINDOWS
			INTERNAL	EXTERNAL				
3	**PUMP HOUSES**							
A	Clarified Water Pump House	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Pressed Steel Door Frame with Double Plate Flush Shutters / Steel Sliding Type / Rolling Shutters	Steel Frame with Steel Glazed Window
B	MCC Switch Gear Room	Granolithic with Two Coats of Expoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
C	Control Room	Glazed Vitrified Ceramic Tiles	Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
D	Cooling Water Pump House	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Pressed Steel Door Frame with Double Plate Flush Shutters / Steel Sliding Type / Rolling Shutters	Steel Frame with Steel Glazed Window
E	Raw Water Pump House	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
4	**OTHER BUILDINGS**							
A	Bunker Building	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Pressed Steel Door Frame with Double Plate Flush Shutters	Steel Frame with Steel Glazed Window
B	Chlorination Building	Acid / Alkali Resistant Tiles	Chlorinated Rubber Based Paint	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346		
C	Switchgear Rooms	Granolithic with Two Coats of Expoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Steel Sliding Type Door	Glazed Aluminium Windows with Wire Glass
D	DM Plant	Granolithic Flooring	Chlorinated Rubber Based Paint	Water Proof Cement Based Paint	Chlorinated Rubber Based Paint	Heavy Duty Water Proofing As Per IS:1346	Aluminium Glazed Doors / Steel Sliding Type / Rolling Shutters	Aluminium Glazed Sliding Windows
5	**GAS INSULATED SWITCHGEAR (GIS) BUILDING and SWITCHYARD CONTROL ROOM**							
A	Switchgear Rooms	Granolithic with Two Coats of Expoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Steel Sliding Type Door	Glazed Aluminium Windows with Wire Glass
B	Battery Room	Acid / Alkali Resistant Tiles	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Granular Finish	Chlorinated Rubber Based Paint	Elastomeric Water Proofing Treatment	PVC frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows
6	**SERVICE BUILDING and ADMIN BUILDING**							
A	Entrance Lobby, Reception, Portico and Lift Area	20 mm Thick Polished Granite Stone	20 mm Thick Polished Granite Stone for 2100 mm hieght and Acrylic Emulsion Paint above.	Granular Finish	Acrylic Distemper	Elastomeric Water Proofing Treatment	Powder Coated Aluminium Framework with Glazing	Glazed Aluminium Sliding / Fixed Type Windows
B	Office and Conference Room	Glazed Vitrified Ceramic Tiles	Acrylic Emulsion Paint	Granular Finish	Acrylic Distemper		Pressed Steel Frame with Pre-Laminated Particle Board Shutters	
C	Stores and Laboratories	Heavy Duty Ceramic Tiles	Acrylic Washable Distemper	Granular Finish	Acrylic Distemper			
D	Telephone Exchange Room	Heavy Duty Ceramic Tiles	Acrylic Emulsion Paint	Granular Finish	Acrylic Distemper			
E	Battery Room	Acid / Alkali Resistant Tiles	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Granular Finish	Chlorinated Rubber Based Paint		PVC frame with PVC Door	
F	Toilet / Pantry	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Granular Finish	Acrylic Distemper			
G	Locker Room	Heavy Duty Ceramic Tiles	Acrylic Washable Distemper	Granular Finish	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	

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PLANT and NON PLANT BUILDINGS
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THE NOMINAL THICKNESS of FLOOR FINISH WILL BE 50mm UNLESS NOTED OTHERWISE
FIRE PROof DOORS SHALL BE AS PER TAC REQUIREMENT.

SL. NO.	AREA DESCRIPTION	FLOOR FINISH	WALL PAINT / FINISH		CEILING FINISH	ROOF TREATMENT	DOORS	WINDOWS
			INTERNAL	EXTERNAL				
7	CANTEEN BUILDING							
A	General Area	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Granular Finish	Acrylic Distemper	Elastomeric Water Proofing Treatment	Main Entrance Door - Aluminium Glazed Swing Type with Two Leaves Opening Outside	Aluminium Glazed Sliding Windows. Fly Proof Mesh To Isolate
B	Kitchen	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Granular Finish	Acrylic Distemper			
8	GENERAL REQUIREMENTS							
A	Office Areas	Heavy Duty Ceramic Tiles	Acrylic Emulsion Paint	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Aluminium Glazed Doors	Glazed Aluminium Sliding / Fixed Type Windows
B	Toilets	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	PVC frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows
C	Pantry	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	-	Acrylic Distemper	Elastomeric Water Proofing Treatment	Aluminium Glazed Doors	Glazed Aluminium Sliding / Fixed Type Windows
D	Battery Room	Acid / Alkali Resistant Tiles	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Granular Finish	Chlorinated Rubber Based Paint	Elastomeric Water Proofing Treatment	PVC frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows

SECTION 5.9

CODES & STANDARDS

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5.9.1 GENERAL

The engineering & execution of all Civil, Structural & Architectural works shall be based on the latest edition or revision of the applicable portion of the following Codes and Specifications.

a) I.S.I Codes of practice
b) National building standard
c) Environmental protection agency
d) Indian Road Congress Standards
e) Indian Railway Standards
f) Statutory regulations of Tariff Advisory Committee
g) Rules & Regulations of local authorities.

In absence of any Indian Codes & Specifications for any portion of work, appropriate American / British Standards may be followed subject to prior approval of the Owner.

All the Indian Standards referred to shall be the latest revision (including all amendments issued thereto at the time of execution.

Reference of only some of the codes and various clauses of design criteria listed / indicated in this document shall not limit or restrict the scope or applicability of other relevant codes. All other codes / standards / relevant to a specific job, in addition to those mentioned in this specification shall be followed wherever applicable.

Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards may be substituted if available.

In case of any conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall govern unless specifically directed otherwise.

In case of any conflict between provisions of this specification (Civil) and other volumes of the specifications, the provisions that are more stringent shall govern unless specifically directed otherwise.

In case of any conflict between various provisions / clauses of this specification, the more stringent shall govern.

The Codes and Standards listed below are applicable for the design and construction of structures and buildings in general. Codes and Standards applicable for specific design and construction are also listed elsewhere in reference sections.

Specifications for materials supplied from India, the Indian Standard Specifications may be followed.

25.9.2 EARTHWORK

IS: 1498	Classification and identification of Soils for General Engineering Purposes
IS: 3764	Safety code for excavation work.
IS: 7293	Safety Code for working with construction machinery.

5.9.3 LOADS

IS: 875	Code of Practice for design loads (other than earthquake) for buildings and structures (All parts)

IS: 1911	Schedule of Unit Weight of building materials
IS: 6922	Criteria for safety and design of structure subjected to underground blasting.
IS: 1893	Criteria for earthquake resistant design of structure (All parts)
IRC Code	Bridge Rules of Government of India, Ministry of Railways (Railway Board)

5.9.4 FOUNDATIONS

IS: 1080	Code of Practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
IS: 1904	Code of Practice for design and construction of foundations in soils (General requirements)
IS: 2911	Code of Practice for design and construction of pile foundations (All parts)
IS: 2950	Code of Practice for design and construction of raft foundations
IS: 2974	Code of Practice for design and construction of machine foundations (All parts)
IS: 4091	Code of Practice for design and construction of foundation for transmission line towers and poles
IS: 8009	Code of Practice for calculation of settlements of foundations (All parts)
IS: 9556	Code of Practice for design and construction of diaphragm walls
IS: 11089	Code of Practice for design and construction of ring foundation
IS: 13301	Guidelines for vibration isolation for machine foundations

5.9.5 REINFORCED CEMENT CONCRETE

IS: 269	Specification for 33 grade Ordinary Portland Cement.
IS: 383	Specification for coarse and fine aggregate from natural sources for concrete
IS: 432	Specification for Mild steel and medium tensile steel bars
IS: 455	Specification for Portland Slag Cement
IS: 456	Code of Practice for plain and reinforced concrete
IS: 458	Specification for pre cast concrete pipes
IS: 1343	Code of Practice for prestressed concrete
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS: 1566	Specification for Hard drawn steel wire fabric for concrete reinforcement
IS: 1785	Specification for plain hard drawn steel wire for prestressed concrete
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement

IS: 1834	Specification for Hot applied sealing compounds for joints in concrete
IS: 2502	Code of Practice for bending and fixing of bars for concrete reinforcement
IS: 3370	Code of Practice for concrete structures for storage of liquids(all parts)
IS: 3414	Code of Practice for design and installation of joints in buildings
IS: 3935	Code of Practice for composite construction
IS: 4326	Code of Practice for earthquake resistant design and construction of buildings
IS: 4948	Specification for welded steel wire fabric for general use
IS: 4995	Criteria for design of reinforced concrete bins for storage of granular (All parts) and powdery materials
IS: 5525	Recommendation for detailing of reinforcement in reinforced concrete works
IS: 8112	43 grade Ordinary Portland cement
IS: 11384	Code of Practice for composite construction in structural steel and concrete
IS: 11682	Criteria of design of RCC staging for Overhead water tanks
IS: 12269	Specification for 53 grade Ordinary Portland Cement.
IS: 13620	Specification for Fusion Bonded Epoxy Coated Reinforcing Bars
IS: 13920	Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces
BS: 8007	British Standard Code of practice for design of concrete structures for retaining aqueous liquid

5.9.6 STRUCTURAL STEEL

IS: 800	Code of Practice for general construction in steel
IS: 802	Code of Practice for use of structural steel in overhead transmission line towers (All parts)
IS: 806	Code of Practice for use of steel tubes in general building construction
IS: 808	Dimensions for hot rolled steel beam, column channel and angle section
IS: 813	Scheme of symbols for welding
IS:816	Code of Practice for use of metal arc welding for general construction in mild steel
IS: 919	Recommendations for limits and fits for engineering
IS: 1024	Code of Practice for use of welding in bridges and structures subjected to Dynamic loading
IS: 1161	Steel tubes for structural purposes

IS: 1239	Mild steel tubes, tubular and other wrought steel fittings (all parts)
IS: 1363	Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) [All parts]
IS: 1364	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
IS: 1365	Slotted counter sunk head screws (dia range 1.6 to 20 mm)
IS: 1730	Dimensions for steel plate, sheet and strip for structural and general engineering purpose
IS: 1731	Dimensions for steel flats for structural and general engineering purposes.
IS: 2016	Plain Washers
IS: 2062	Structural steel (fusion welding quality)
IS: 3502	Specification for steel chequered plates
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage
IS: 3613	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels
IS: 4000	High strength bolts in steel structures – Code of Practice
IS: 4759	Hot dip zinc coatings on structural steel and other allied products
IS: 4923	Hollow Steel sections for structural use
IS: 7215	Tolerances for fabrication of steel structures
IS: 7280	Base-wire electrodes for sub-merged arc welding of structural steels
IS: 8500	Structural steel - micro alloyed (medium and high strength qualities)
IS: 8640	Recommendations for dimensional parameters for industrial building
IS: 9178	Criteria for design of steel bins for storage of bulk material (Al parts)
IS:9595	Recommendation for Metal arc welding of carbon and carbon manganese steel
IS: 12843	Tolerances for erection of steel structures

5.9.7 MASONRY

IS: 1077	Common Burnt Clay Building Bricks
IS: 2212	Code of Practice for brickwork
IS: 2185	Concrete Masonry units (All parts - Hollow & Solid concrete blocks)
IS: 3414	Code of Practice for design and installation of joints in Buildings
IS: 4441	Code of Practice for use of Silicate type chemical resistant mortars

IS: 4860 Acid Resistant Bricks

5.9.8 DOORS, WINDOWS & VENTILATORS

IS: 883 Code of practice for design of structural timber in building

IS: 1003 Timber paneled and glazed shutters (all parts)

IS: 1038 Steel doors, windows and ventilators

IS: 1361 Steel windows for industrial buildings

IS: 2835 Transparent sheet glass for glazing and framing purposes

IS: 1948 Aluminium doors windows and ventilators

IS: 1949 Aluminium windows for industrial building

IS: 2191 Wooden flush door shutters (Cellular and hollow core type)

IS: 2202 Wooden flush door shutters (solid core type)

IS: 3103 Code of practice for Industrial ventilation

IS: 3548 Code of practice for glazing in buildings

IS: 3614 Fire check doors

IS: 4021 Timber door, windows and ventilator frames

IS: 4351 Steel door frames

IS: 6248 Metal rolling shutters and rolling grills

5.9.9 ROOF AND FLOORING

IS: 809 Rubber flooring materials for general purposes

IS: 1195 Bitumen mastic for flooring

IS: 1237 Cement concrete flooring tiles

IS: 2210 Criteria for Design of R.C. shell structures and folded plates

IS: 3201 Criteria for the design and construction of precast concrete trusses

5.9.10 WATERPROOFING

IS: 1322 Bitumen felts for waterproofing and damp proofing

IS: 1346 Code of practice for waterproofing of roofs with bitumen felts

IS: 3067 Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings

IS: 2645	Specification for Integral Cement Waterproofing Compounds

5.9.11 WATERSUPPLY, DRAINAGE AND SEWERAGE

IS: 1172	Code of basic requirements for water supply, drainage and sanitation
IS: 1742	Code of practice for building drainage
IS: 2064	Code of practice for selection, installation and maintenance of sanitary appliances
IS: 2065	Code of practice for water supply in buildings
IS: 2527	Code of practice for fixing rainwater gutters and downpipes for drainage
IS: 2556	Specification for vitreous sanitary appliances (vitreous china)
IS: 5329	Code of practice for sanitary pipe work above ground for buildings
IS: 12251	Code of practice for Drainage of Building Basement

5.9.12 MISCELLANEOUS

IS: 1905	Code of Practice for structural use of unreinforced masonry
IS: 1641	Code of practice for fire safety of buildings (general): General principles of fire grading and classification
IS: 1642	Code of practice for fire safety of buildings (general): Details of construction
IS: 2210	Criteria for design of reinforced concrete shell structures and folded plates
IS: 2212	Code of Practice for Brickwork
IS: 2470	Code of Practice for installation of septic tank Part 1 - Design criteria and construction Part 2 - Secondary treatment and disposal of septic tank effluent
IS: 3067	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
IS: 6313	Code of practice for anti-termite measures in buildings
SP-6	Handbook for Structural Engineers (all parts)
SP-7	National Building Code of India
SP-16	Design Aids for reinforced concrete to IS: 456-1978
SP-20	Handbook on masonry design and construction
SP-22	Explanatory handbook on codes on earthquake engineering (IS 1893-1975 and IS: 4326-1976)
SP-24	Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete (IS: 456 -1978)

SP-25	Handbook on causes and prevention of cracks in buildings
SP-32	Handbook on functional requirements of industrial buildings
SP-34	Handbook of concrete reinforcement and detailing (SCIP)
IRC: 15	Code of Practice for construction of concrete roads
IRC: 37	Guidelines for deign of flexible pavements
IRC: 73	Geometric design Standards for rural (Non Urban) Highways Bridge rules of Government of India, Ministry of Railways (Railway Board)

SECTION 5.10.1

CHIMNEY

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5.10.1.1 GENERAL

This specification covers the general requirements for design and construction of reinforced concrete multi flue chimney of circular cross section including RCC shell, steel flue, internal & external platforms, staircase, appurtenances, fixtures, fittings, conduit and other embedments, lift, pressurised ventilation, lightning protection, aviation warning lighting etc., complete.

5.10.1.1.1 Works to be provided for by the Contractor

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following :

a) Furnish all labour, supervision, services, insurance, material, power, fuel, forms, templates, supports, scaffolding, tools, plants, construction equipment, approaches, transportation etc. required for the entire work.

b) Design and prepare working drawings for formworks, scaffoldings, supports, staging etc. and submit them for approval.

c) Prepare and submit for approval, as per approved schedule, detailed drawings for R.C. work in shell, hopper, platforms and ground floor and bending schedules for reinforcement bars, showing the positions and details of spacers, chairs, supports, hangers, openings etc.

d) Prepare detailed fabrication and erection marking drawings for steel and metal works and submit them for approval.

e) Prepare detailed shop drawings for various inserts, anchors, sleeves, frames, templates, anchor bolts etc. showing relative locations of their installations and submit them for approval.

f) Prepare and submit for approval the detailed schemes for operations like material handling, placement of concrete etc. and for items like approaches, services etc.

g) Design and submit for approval the mix proportions for concrete to be adopted on job.

h) Provide all incidental items not specified or shown on drawings in particular but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

i) Produce, if directed by the Owner, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

j) Provide all incidental items not specified or shown on drawings in particular but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

k) Produce, if directed by the Owner, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

l) Furnish samples and submit for approval the results of tests for various properties of the following materials :

- Ingredients of concrete
- Concrete
- Metal work components
- Acid proof bricks
- Castable refractories
- Insulation material
- Electrical Items.

5.10.1.2 CODES AND STANDARDS

All works under this Specification, unless specified otherwise, shall conform to the latest revisions/replacements including amendments, if any, of the following Bureau of Indian Standard Codes, Criteria, specifications, along with those mentioned therein. In case any particular aspect of work is not covered by Indian Standards, other standard specifications, as may be specified by the Engineer, shall be followed.

In case of any contradiction with the Standards given below and stipulations as per this Technical Specification, the more stringent one shall prevail. This specification shall be read in conjunction with the other Technical Specifications.

SI Units shall be adopted for all design and drawing work.

IS:6	Moderate heat duty fireclay refractories Group-A.
IS:104	Ready mixed paint, brushing, zinc chrome, priming.
IS:158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting for general purposes.
IS:195	Specification for fire clay mortar for laying fire clay refractory bricks.
IS:432(Part 1)	Mild Steel and Medium Steel Bars
IS:456	Code of practice for plain and reinforced concrete.
IS:800	Code of practice for use of structural steel in general building construction.
IS:808	Rolled steel beam, channel & angle sections.
IS:813	Scheme of symbols for welding.
IS:814	Covered electrodes for metal arc welding of structural steel.
IS:816	Code of practice for use metal arc welding for general construction in mild steel.
IS:817	Code of practice for training and testing of metal arc welders.
IS:818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS:822	Code of procedure for inspection of welds.

IS:823	Code of procedure for manual metal arc welding of mild steel.
IS:875	Code of practice for design loads (other than earthquake) for buildings and structures
IS:961	Structural steel (High tensile)
IS:1161	Steel tubes for structural purposes.
IS:1200	Methods of measurement of building and Civil engineering works.
IS:1239	Mild steel tubes. (Part-I)
IS:1367	Technical supply conditions for threaded fasteners.
IS:1526	Sizes and shapes for firebricks (230 mm series).
IS:1527	Methods of chemical analysis of high silica refractory materials.
IS:1528	Methods of sampling and physical tests for refractory materials.
IS:1608	Method of tensile testing of steel products.
IS:1730	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS:1731	Dimensions for steel flats for structural and general engineering purposes.
IS:1893	Criteria for earthquake resistant design of structures.
IS: 1904	Code of practice for Design & Construction of foundation in soils General Requirements
IS:1977	Structural steel (ordinary quality)
IS:2042	Specification for insulating bricks.
IS:2062	Structural steel (fusion welding quality).
IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming.
IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
IS:2395	Code of practice for painting concrete masonry and plaster surfaces.
IS:2629	Recommended practice for hot dip galvanizing of iron and steel
IS:2750	Steel scaffoldings.
IS:2950	Code of practice for design and construction of raft foundations.
IS:3043	Code of Practice for Earthing.
IS:3346	Method for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot-plate method).

IS:3495	Methods of tests of burnt clay building bricks. (Part-I to IV)
IS:3677	Unbonded rock and slag wool for thermal insulation.
IS:3690	Unbonded glass wool mats for thermal insulation.
IS:3696	Safety code for scaffolds and ladders.
IS:4014	Code of practice for steel tubular scaffolding. (Part-I & II)
IS:4457	Ceramic Vitrieous unglazed acid resistant tiles.
IS:4687	Gland packing asbestos.
IS:4832	Chemical resistant mortars.
IS:4860	Acid-resistant bricks.
IS:4998 (Part-1 1975 & 1998)	Criteria for design of reinforced concrete chimneys.
IS:5410	Cement paint, colour as required.
IS:5495	Sizes and shapes for firebrick (300 mm and higher series.
IS:8183	Specification for bonded mineral wool.
IS:10379	Code of practice for design and construction of ring foundation.
ACI 307	Specification for the Design and Construction of Reinforced Concrete Chimneys.
CICIND	Model code for chimneys.
ASTM	Standard specification for Liquid membrane forming compounds for curing

The Indian Electricity Rules

Civil aviation Rules and Regulations.

ACI Standards

The following is the list of publications shall also be referred to.

Manohar, S N "Tall Chimneys-Design and Construction", Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Pinfold, G M "Reinforced Concrete Chimneys and Towers", View Point Publication, Cement and Concrete Association, U.K.

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.

Vickery, B J and Basu, "The response of reinforced concrete chimneys to vortex shedding", R I Journal of Eng. Struct., 1984, Volume 6

ACI 307 - Standard Practice for the Design and Construction of Castin- place reinforced concrete chimneys

ASCE – 1975 "Design and Construction of Steel Chimney Liners". Task Committee on Steel Chimney liners, Fossil Power Committee, Power division, ASCE.

5.10.1.3 DESIGN REQUIREMENTS

5.10.1.3.1 General

The principal design parameters for the chimney shall be based on the number of flues, the fuel burnt, quantity of gas generated, probable composition of the flue gas, flue gas exit velocity, etc.

Height of the Chimney shall be 275m from FGL and number of flues shall be two numbers (one per each unit).

Flue shall be of corrosion resistant steel suspended from top.

The design shall be based on working stress method.

The design and construction of the chimney and its foundation shall conform to the requirements of all statutory rules and regulations of local and national authorities. Where such requirements are less conservative than the corresponding requirements of this specification, the latter shall govern.

The chimney and its foundation shall be designed to resist stresses due to the most critical combination of the following:

(a) Dead loads consisting of self weight of the chimney shell with or without lining, ladder, staircase, flue ducts, platforms, accessories and all other dead loads.
(b) Wind loads (both along-wind and across wind)
(c) Earthquake forces
(d) Temperature gradient across the chimney shell.
(e) Eccentric loads from corbels/platforms supporting the lining, soot hopper, etc.
(f) Live loads on platforms. Weight of equipment and materials and other live loads during construction. Live load of 500 kg/sqm shall be assumed for platforms. Design live load during construction and erection shall be considered as 1000 kg/sqm.
(g) Local moments due to ovalling.
(h) Forces from the elevator and operating equipment.
(i) Loads from flue duct supports.
(j) Construction loads such as those due to plant and equipment, stacked materials, live loads due to movement of plant, materials and personnel, etc.

Reference shall be made to IS:4998-Part 1 (1975 & 1992) for loading details and design of wind shield. For wind, IS:875 & for seismic, IS:1893 shall be referred to. In addition to the above codes, latest edition of all codes mentioned earlier shall be followed in the design and construction of RC chimney system.

For the foundation and portion of the shell below grade level, appropriate earth pressures, hydro- static forces, surcharge etc., as applicable.

Effect of adjoining tall structures such as boilers, cooling towers, future chimney etc on magnifying wind loading on the Chimney shall be studied in a wind tunnel before the designs are finalised. If needed, modifications shall be made in the design of wind shield and foundation. Wind tunnel studies are included in the scope of the contractor and shall be carried out by any reputed institute like IIT / SERC for evaluation of dynamic forces due to interference effect of other tall structures around the chimney.

In anticipation of an identical chimney might be located at about 200m away, magnification factor on account of aerodynamic interference shall be considered for the design of chimney from fig1 of IS 4998 Part-1.

A provision of 10% increase in the wind 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 the wind tunnel studies.

The total design stresses at a section shall include all secondary effects, viz. corbel effect, eccentric loading due to platforms, secondary moments due to p-Δ effect, etc. The total design stress in no case shall exceed the permissible stresses specified in clause 7.0 of IS:4998 (Part-I) 1975.

Permissible stresses in chimney shell shall be as per IS 4998.

Stress in concrete shall be restricted to 0.275 σcu under combination of "Dead load + wind load" against value specified in clause 7.1.1(a) of IS:4998(part1)-1975." as per ACI 307.

If the circumferential tensile stress in concrete due to wind induced ring moment exceeds the value specified in clause 7.1.1 (g) of IS:4998 (Part I) 1975, additional reinforcement shall be provided in 2 layers limiting the stress in reinforcement steel to value specified in clause 7.1.2(g) of IS:4998 (Part I) 1975.

The safety factor against over turning under worst combination of loads, shall not be less than 1.5 in any direction during construction and 2.0 after construction is complete. For the purpose of calculating safety factor against over turning, only 90% of the dead load as calculated from the dimensions and densities of materials with no soil over burden with full uplift force due to ground water shall be taken into account.

Increase in net safe allowable bearing capacity of soil shall not be allowed under wind and seismic loading. No tension shall be allowed in gross pressure under chimney working condition i.e. shell + lining complete.

For estimating the deflections of the chimney in lined and unlined conditions, the modulus of elasticity of concrete shall be as per the mean value specified in clause A-3.1 of IS: 4998 (Part-1) -1992. Maximum deflection of chimney at top shall be limited to H/500, where H is the height of chimney above foundation / pile cap level.

Stresses in the shell shall be within permissible limits at 10 meter intervals along the height of the shell or at every corbel level whichever distance is less and in addition at the critical locations across openings.

Air inlets, sloped up towards inside, shall be provided near the base with SS wire mesh cover over the openings so as to prevent dirt or tiny creatures entering the air gap. The number and size of the inlet opening in the shell shall have a total area of not less than two-third of the area of the minimum air gap at top of chimney.

Air outlets with stainless steel wire mesh mounted on stainless steel frame shall be provided at the top of the shell. These openings shall be suitably spaced and their total area shall not be less than that provided for air inlets. Suitable openings shall also be

provided in the concrete shell for intake and exhaust of air for ventilation and pressurizing system as per the requirements of supplier. Pressurized ventilation system shall be provided if necessary and this shall be decided during detailed engineering.

Corbels shall be designed to take the load of platform, lining, insulation, hopper, etc., supported on them. The continuity of the corbels shall be broken so as to prevent excessive temperature stresses developing in the shell due to localised thickening of the concrete section.

The maximum width of the openings in shell shall normally be limited to an angle of not more than 30° subtended at the centre of the concrete shell. Openings in the shell shall be provided for ductworks, access doors, ash channel and ventilation system etc. Opening size for the purpose of stress calculation shall be taken as 1.1 times the actual opening sizes. The total plan area of the openings shall not be more than 15% of the plan area of concrete shell at that location.

The analysis of the windshield for wind and earthquake forces shall be done as per the requirements of this specification.

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 raft during earthquake and wind.

The foundation shall be designed as a rigid member. The thickness of the foundation below the shell shall neither be less 0.09 times the diameter of raft or 0.40 times the overhang of the foundation beyond the shell whichever is greater. Foundation diameter to depth ratio shall also not exceed 12.

For the purpose of analysis and design, the following shall be assumed:

- The stiffness of the shell shall not be considered for the design of the foundation
- Shell is considered to be fixed to the foundation for the shell design.

Minimum temperature gradient of 20 degree C shall be considered for the shell design. However, actual gradient to be worked out as per IS 4998 Part 1. Temperature stresses may be calculated based on ACI 307.

In the secondary loading for chimney, effects due to insolation, foundation rotation and non verticality of chimney shall also be considered in the shell design.

5.10.1.3.2 Wind Load Analysis

Wind Speed

The basic wind speed (Vb) for the location of the project shall be as project information sheet. The estimation of wind speed/ pressures shall conform to the requirements of IS:875 (Part-3).

The mean probable design life of the structure may be taken as follows for arriving at the probability factor K1

a) 25 years for shell alone condition;
b) 100 years for completed chimney condition

Along Wind Response

This response shall be evaluated by the following two methods in accordance with IS:4998 (Part 1) 1998.

Method-1: Based on 3-sec gust wind.

Method-2: Based on Gust Factor Approach.

The higher of the forces obtained from the above two method shall be considered for design.

Across Wind Response

The across wind response shall be evaluated for the first two modes as per requirement of IS:4998 (Part 1)-1992.

Combination of Response

This shall be checked as under:

a) The critical wind velocity V_{cc} for across wind response shall be evaluated based on IS:4998 (Part-1) 1998

b) Knowing the height (Zc) at which Vcc acts, corresponding value of K2 is read from table 33 of IS:875 (Part 3) for the particular terrain category.

c) Response shall be evaluated for the above wind speed for along wind condition.

d) Response evaluated for across wind condition shall be vectorially combined with the response obtained above.

The response under wind load at any level to be used for design shall be the highest of the values, obtained from the above three analyses.

It is recommended that, the geometry and structural arrangement of Chimney so proportioned that, across wind effects are nullified and avoid requirement of strakes.

5.10.1.3.3 Seismic Analysis

Seismic design data parameters shall be as per project information data. Modal analysis shall be used and seismic acceleration spectra as given in IS:1893 shall be utilised.

5.10.1.3.4 Load Combinations

Various load combinations for calculation of stresses shall be as under:

a) Dead load + Wind load
b) Dead load + Earthquake forces.
c) Dead load + Temperature effect.
d) Dead load + Wind load + Temperature effect.
e) Dead load + Earthquake force + Temperature effect.
f) Circumferential stresses due to temperature effect.
g) Circumferential tensile stresses due to wind inducing ring moment.
h) 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 lining, whichever condition is more critical, shall be adopted for design. Across wind loads shall be combined with co-existing 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-existing along wind loads.

5.10.1.4 TECHNICAL REQUIREMENTS

5.10.1.4.1 Concrete

The grade of concrete for foundation shall be M30.

The grade of concrete in chimney shell, platforms etc., shall be minimum M30 and shall not be richer than M35.

The minimum cement content and max water cement ratio shall be as per Table 5 & 6 of IS 456.

Minimum thickness of wind shield shall not be less than 400 mm at top and 900 mm at junction of shell and foundation. Minimum cement content for concrete for different exposures shall be as per Table 5 & 6 of IS: 456.

The nominal concrete cover over reinforcement including links in the shell shall not be less than 50 mm. In foundations, the clear concrete cover shall be 75 mm. Where stipulations given in Table 16 of IS: 456 is more stringent, then the requirements as per 456 shall be satisfied.

Modular ratio shall be calculated as per Annexure-B of IS:456. Static modulus of elasticity of concrete shall be taken as 5000 x sqrt (f_{ck}) for instantaneous loadings, where f_{ck} is the characteristic compressive strength of concrete.

When slip forming is adopted, the slump shall be between 100 mm and 150 mm at the point of placement. If necessary, approved admixtures such as retarders/plasticizers to maintain the workability shall be used with the prior consent of the owner. Such admixtures shall be identified after preliminary tests to prove their satisfactory performance and compatibility with the particular type of cement envisaged to be used in the shell construction.

The maximum size of coarse aggregate, unless specified other wise, shall not be larger than 1/8th the narrowest dimension between forms nor larger than one half the minimum clear distance between reinforcing bars nor more than 40mm. However, for wind shield and roof slabs 20mm down graded aggregates shall be used.

While concreting shell at corbels and platform levels, care shall be taken to ensure that the dowels for corbels and platforms are initially bend within the wall thickness and concrete of specified grade for shell at that level is placed and well compacted. The dowels may be later exposed by chipping the shell surface only after the concrete is well set. On no account will the method by packing the area with sand or any other material be allowed for the purpose of exposing dowels at a late date.

Embedments to support staircase shall be provided in the shell.

Expansion anchors shall be used to attach conduits, lightning protection equipments, lighting fixtures and other light weight appurtenances.

5.10.1.4.2 Reinforcement

Generally the requirements specified in IS:4998 (Part 1) – 1975 shall be followed unless more stringent requirements are specified here-under. Vertical reinforcement (in the chimney shell) left projecting above the forms, shall be staggered and shall be so supported as to prevent the breaking of bond between the reinforcement and the freshly placed concrete. The vertical reinforcement bars shall be lapped or welded and these joints shall be staggered. Not more than 1/3rd of vertical bars shall be lapped at one section. Length of vertical bars should not exceed 6.0 metres.

While providing vertical reinforcement 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.

The minimum reinforcement in the foundation shall not be less than 0.12% on either face and on each direction of foundation.

Dowels, wherever provided, shall extend on either side of the construction joint by a length equal to the full development length of the bars in tension.

Special care shall be taken to ensure adequate vertical and circumferential reinforcement in thickened parts of the chimney shell and immediately above and below thickened parts. This applies particularly at corbels.

Jack rods where permanently embedded in concrete shall not be considered as reinforcement.

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 from design considerations.

Circumferential reinforcement shall be placed around the exterior of and securely wired or welded to the vertical bars. The minimum dia of circumferential steel shall be 10mm and shall be spaced at a center to center distance not exceeding 250 mm or shell thickness which ever is less.

In addition to the reinforcement determined from structural considerations as well as to meet temperature and other stresses, extra reinforcement shall be provided around and at corners of openings, generally in line with IS:4998-1975 and ACI 307. Additional reinforcement at the top of opening shall be calculated as per the method indicated in the textbook 'Reinforced concrete chimney and tower' by M.G.Pinfold. Minimum half the number of extra horizontal bars in shell around the opening to continue for complete circle all round for both faces and both sides.

The extra reinforcement shall extend past the opening by a length equal to ½ the width of the opening plus its development length in tension.

Foundation raft of the Chimney shall be provided with a layer of reinforcement at the top and the same shall not be less than 20 mm deformed bars at maximum spacing of 250 mm centers placed orthogonally. In addition, shrinkage reinforcement shall be provided in inner layers (layer spacing shall not be exceed 1.5 metres). The shrinkage reinforcement shall not be less than 16 mm deformed bars at 600 mm centres. In addition, vertical chair bars at 600 mm centers shall be provided to support these bars.

The minimum diameter of vertical reinforcing bars shall be 12mm and they shall not be spaced at more than 250 mm centers. Vertical bars shall be spaced uniformly.

Where vertical reinforcement is required to be lapped above openings, laps shall be allowed only after a height of B/2 above the opening for the whole section, where B= width of opening.

The reinforcement for corbels and dowels for platform reinforcement shall be of mild steel and of size not larger than 20mm diameter.

5.10.1.5 FLUE LINER SYSTEM

5.10.1.5.1 General

Clear space between flues in a multi-flue stack shall be 1000 mm after insulation is installed. Minimum space from inside of wind shield to flue shall also be 1000mm clear of insulation.

5.10.1.5.2 Transition Ducting

The number, size and location of flue opening in the shell shall be as per the requirement of boiler supplier and as shown in the drawing. 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 flue to the flange of the boiler vendor's duct including all auxiliary ducting as well as soot collecting hoppers. Soot hoppers shall be lined with SS grade 316L. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water.

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

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, flue gas pressure loading and thermal loading.

The plate thickness of the ducts shall be arrived at from minimum (i.e. codal) requirements, structural and corrosion allowances of 1.5mm. The minimum installed thickness of the mild steel ducts shall not be less than 10 mm in any case. Material of construction shall be mild steel conforming to IS-2062 Grade A.

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

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 inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluro-elastomeric fabric expansion compensator.

5.10.1.5.3 Steel Flues

The steel flues shall essentially be constructed from structural steel and shall be of the top 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 shell 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 of minimum 8 mm thick (excluding corrosion allowance). Minimum thickness for SS flue shall be 6mm.

Top 10 m length or length equal to 2 times the diameter of the flue or as required by the condensation characteristics of the flue gas, whichever is larger shall be provided in stainless steel grade SS316L for the liner.

The liner / stiffeners shall be fabricated from corrosion resistant steel type "COR-TEN B" having an ultimate strength of not less than 410 N/sq. mm and conforming to the requirement of IS:2062 (Grade A) unless otherwise specified.

The individual cans of the liners shall be jointed together by butt welding internally all round for full strength, after connecting the flanged portion of the cans with high tensile treaded fasteners conforming to IS: 1367.

Intermediate platforms shall be provided at intervals not exceeding 40 meters. These shall of chequered plate supported on steel beams. These platforms shall provide lateral restraint for the steel liners.

The minimum size of the angle stiffeners for the flues shall be 100x100x10.

5.10.1.5.4 Design of steel liners

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

The plate thickness of the ducts shall be arrived at from minimum (i.e. codal) requirements, structural and corrosion allowances.

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

The contractor shall test all welds in the presence of the OWNER to meet the following requirements:

i) The contractor shall test at random at least 10% of the butt welds by radiographic/ultrasonic testing methods.

ii) At least 10% of the fillet welds shall be tested at random by dye penetration tests.

iii) 100% of the root runs for butt welding shall be subjected to DPT after back gouging.

5.10.1.5.5 Flue Support Arrangement

The support brackets and bearing assembly shall be welded to the locally thickened portion of the flue and which in turn support the flue on the support platform. The arrangement shall cater for thermal movements of liner elements in a smooth and easy manner.

The support arrangement shall typically consist of the flue support bracket, which is connected to the shoe by a precision bolted connection. The bracket in turn is welded to a bearing assembly. The bearing assembly is later bolted to the support beams. The arrangement shall cater for thermal movements of linear elements in a smooth and easy manner.

The bearing assembly shall consist of 3 units and shall be fabricated as described herein.

- The first unit shall consist of a MS base plate on which a MS sole plate shall be welded & interfaces shall be machined. The sole plate shall be provided with a recess to seat a PTFE film conforming to BS:5400 dimpled on the upper surface and lubricated with silicon grease. This unit shall be bolted to the support beam, using restraint brackets. Four slotted holes shall be provided through base and sole plate to connect brackets which restraints movement of second and third units to 5 mm on either side.

- The second unit shall consist of a MS plate of adequate size and thickness connected to stainless bearing plate of adequate thickness with c/sk screws connected at the bottom. The stainless steel surface shall be placed on the PTFE surface of the first unit. On top of MS plate 3 mm thick lead sheet shall be provided. Stainless steel shall be of grade 316L.

- The third unit consisting of two layers of load bearing insulation blocks each with a minimum thickness of 50 mm, factory bonded by 100 mm long load bearing insulation dowels. MS cover plates of adequate size and thickness shall be provided at top and bottom of the insulation block with appropriate restraining guides of MS both at top and bottom to prevent movement of insulation block. A MS bearing plate of adequate thickness shall be welded to the bottom of the bottom cover plate, with exposed bottom surface machined. This plate shall rest on the lead sheet provided on the top of second unit.

The bearing assembly shall be levelled by use of suitable MS shims as required. Suitable restraint brackets and stop plates of MS shall be provided to avoid excessive movement, and keep the different units of the bearing assembly in position.

The insulation blocks shall be of natural grade fibre reinforced asbestos or an equivalent material which shall primarily consist of the following physical properties:

(a) Minimum compressive stress prior to onset of compression yield of not less than 12 N/sq.mm.

(b) Minimum shear strength of 30 N/sq.mm when tested in accordance with BS: 3497.

(c) Thermal conductivity shall not exceed 0.6 kcal/m/hr/ °C to a mean temperature of 200°C and coefficient of linear expansion not to exceed 1.2 X 10^{-5} per °C.

(d) Adhesive used for bonding purpose shall be material with equivalent high temperature properties as approved by the OWNER.

At flue restraint platforms, necessary restraint arrangement with load bearing insulation blocks and stainless steel bearing plates fixed to the insulation blocks shall be provided.

Restraint and support brackets shall be provided for the bottom supported portion of the flue which rests on the support platform provided at the base to cater for bearing and restraint requirements.

5.10.1.5.6 Insulation

The flue shall be insulated externally. The insulation shall be semi-rigid, mineral wool made from rock slag or fibrous glass bonded by a suitable resin binder 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 175 to 200 kg/cum for resin bonded rock wool. Maximum

coefficient of thermal conductivity shall be 0.062 Kcal / m/ hr/ °C at a mean temperature of 150°C.

The coefficient of thermal conductivity and packed density shall be tested according to IS 3677 and IS 3346.

The insulation thickness shall be chosen based on the maximum ambient temperatures, 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 emiissivity of 0.3 and the insulation cold face maximum temperature not exceeding 40°C. The draught of air by the flue liner and the air bending vented ot through the opening in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. However a minimum of 50 mm thick (2 layers of 25 mm) insulation shall be provided on the external face of flue.

The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450 mm c/c both horizontally and vertically. The studs shall be plated and be of a minimum thickness of 10 gauge. The studs shall extend a minimum of 25 mm beyond the thickness of insulation and 63 mm 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 galvanised 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 centres. Any form of lacing the mesh fibres together shall 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/cu.m. The top insulation shall be protected from the elements by means of stainless steel cladding, flashing and hood of grade 316L stainless steel of minimum thickness 6mm.

The insulation material shall satisfy the specific requirements and properties as outlined in this specification and IS: 8183, IS 3677 and IS 3346.

5.10.1.5.7 Expansion Compensator / Expansion Joints in Flues

The suspended portion of the flue shall be connected to the bottom supported portion of the flue 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.

Expansion compensators shall be provided at every 40m.

The materials used for the fabrication of the expansion joints shall be suitable for the flue gas conditions, and shall not deteriorate during transit, site handling, storage and installation. It shall consist of 3 layers as given below:

a. One inner layer of a heavy texturised glass fabric of minimum 10 mm thickness.

b. One layer of skived virgin PTFE Foil of 2 mm x 0.15 mm

c. A third layer of a Elastomer coated glass fabric. All the three layers are covered with textured glass fabric and stitched together at the ends.

The expansion joint shall be manufactured by a specialist having experience in manufacturing similar type of Joints. The contractor shall furnish outline proposals for the expansion joint during the bid stage along with the manufacturer's qualifications and experience for the Engineer review. On award of contract, full details of materials to be supplied along with fabrication drawings shall be supplied by the contractor for the Engineer approval.

The Contractor shall procure the units only after obtaining the Engineer 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 owner 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.

5.10.1.5.8 Other Accessories

Liner Hood/Cap

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

5.10.1.6 MISCELLANEOUS STEEL WORK

5.10.1.6.1 Hand railing

Hand railing shall be provided on staircase, internal and external platforms.

Handrail posts and rails shall be 32 NB pipes and shall conform to IS:1239 (medium) and hot dipped galvanised. The spacing of railing posts shall not be more than 1500mm centre to centre.

The height of hand railing shall not be less than 1250 mm. There shall be three hand rails at about 450 mm, 850 mm and 1250 mm respectively.

Open ends of pipes shall be plugged and welded. Bends shall be smooth without any sharp projections.

Toe protection of 100 x 8 mm flats shall also be provided. The entire hand rail shall be hot dip galvanized.

5.10.1.6.2 Internal Platforms

The internal platforms shall be provided at intermediate levels. Distance between two platforms shall not be more than 40 M. The platforms for the steel flue chimney include a grillage of M.S. beams provided for supporting the roof slab, supporting the flue cans, restraint platforms for flues and for access within the shell. Except for the roof slab, all the

platforms shall be provided with M.S. grating. The platforms shall be designed for self weight vertical/horizontal liner loads and a live load of 5 kN/m^2.

The platform shall be supported on a grid work of structural steel beams supported from the wind shield. Corrosion allowance of 2 mm (minimum) shall be kept in the design of girders.

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 beam shall be painted with 2 coats of zinc chromate red oxide primer and 3 coats of synthetic enamel paint of approved brand and shade after surface preparation as per IS:1477.

The support of the beams on the Wind shield should shall be so designed that only vertical load is transferred to the wind shield without any temperature effect and local torsional / local bending moment. The beams shall be supported on wind shield with elastomeric bearings designed as per IRC 83-Part 2

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

Handrails shall be provided.

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

5.10.1.6.2 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 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 galvanised with anti-skid nosing. Tread shall be minimum 250 mm wide. Riser shall not be more than 175 mm. 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 & its connections shall be designed for a live load of 5 kN/sq.m.

Handrails shall be provided.

5.10.1.6.3 Ladder

Steel cage ladder hot dip galvanised 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. Similar cage ladder shall also be provided for access to clean out door and platform at soot Hopper level

5.10.1.6.4 Doors

Clean Out Doors

Each flue shall be provided with clean out doors 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 properly sealed to prevent escape of hot flue gases. The door 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.

Access Door / Removable Cladding

Opening provided near the base of the wind shield for the purpose of flue can erection shall be closed using a removable type of colour coated galvanised aluminium sheet of minimum 0.6 mm thickness on structural steel framing which can be dismantled if required.

Within the cladding area, an access door of size 1000 x 2100 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. Door shutters shall be 45 mm thick of flush design and shall comprise of two outer sheets of 18 gauge steel sheets, rigidly connected and reinforced inside with continuous vertical stiffeners of 20 g, spot welded at spacing not exceeding 150 mm. 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 epoxy based primer and two finish coats of epoxy paint. The door shall be provided with suitable locking arrangement.

Rolling shutter

A chain operated rolling shutter of size 5.0mX6.0m conforming to IS:6248 shall be supplied and installed at the base of the chimney for the removal of ash from ash hoppers in case of emergency. The door shall be installed complete with guides, hood, hardware, weather baffles, combination end locks and wind locks mechanism and accessories as required for proper operation and weather protection. The doors shall be installed in accordance with the details and manufacturer's direction and Owners's approval.

5.10.1.7 ROOF SLAB & EXTERNAL PLATFORMS

5.10.1.7.1 Roof Slab

The chimney roof slab shall be of RCC suitably supported on steel beams. The roof shall be sloped towards rain water down take catch pits covered with C.I. 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. Roof slab structure shall be designed to serve as a lifting platform for supporting the weight of flues during erection.

The roof shall be provided with a hatch for access from the staircase which stops at the last flue support platform. The hatch shall have a single leaf door with a minimum thickness of 6 mm to cover a clear opening of 1000 mm x 1000 mm. The hatch shall include the door, metal kerb, draft seal, spring latch, hold-open device and all hardware. All joints shall be welded and ground smooth. The kerb 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 operable 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 the requirement of IS:158.

The roof slab shall be lined with acid proof tiles conforming to IS:4457. Bedding mortar shall conform to IS:4832 Part I and shall be of potassium silicate base.

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.

Handrail, as specified for external platforms shall be provided all around the roof slab along the shell periphery.

Galvanized M.S. / HDPE pipe conforming to IS: 1239 and of 150mm diameter rain water pipes shall be provided within the interior of the shell to remove rain water collected on the roof cap. Rain water inlet into the pipes at roof cap 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. All works including the manhole chamber outside the wind shield are covered in the scope.

5.10.1.7.2 External Platforms

No of outer platforms to be provided are also governed as per the requirements of aviation warning lights which are required to be provided at various levels so as to meet the requirements of IS:4998(Latest edition), I.C.A.O regulations and Instructions issued by the Director General of Civil Aviation. The minimum clear width of platforms shall be 1000mm. Live load of 500 kg/sqm shall be considered for the design of external platforms.

Cantilevered platform outside chimney shell shall be provided at 40 m intervals.

GI Hand railing shall be provided all around external platforms.

Radial gaps of 12 mm wide shall be provided in the external platform floor at 45°. A GI steel drain pipe of 100 mm internal dia flush with concrete shall be provided near the kerb for each segment of external platform to drain rain water.

The floor of the platforms shall have a slope towards the outer edge for draining water. 32mm dia GI drainage spouts shall be provided in platforms for drainage of rain water.

External platform may not be required, if aviation lights can be attended from within chimney.

5.10.1.7.3 Acid Drains and Manholes

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

The stainless steel pipes, bends, bolts, fixing sleeves, collecting sumps, etc., shall conform to relevant IS codes.

The sumps shall be of adequate size suitably 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.

5.10.1.8 MISCELLANEOUS FIXTURES & ACCESSORIES

5.10.1.8.1 Strakes

Strakes shall be provided, if necessary, from design point of view for controlling effect from vortex excited oscillation based on the wind tunnel study. Inserts shall be embedded in the chimney shell for wind strakes by the Contractor in case the same is not required at present. In this connection, recommendation indicated in Across Wind analysis section may please be followed.

The strakes shall be designed for a pressure of not less than four times the wind pressure computed at top of chimney.

Strakes, if specified, shall be made up of mild steel plates and rolled sections. The minimum thickness of strakes from plated material shall be 8mm. A corrosion allowance of 3.0 mm in the structural members shall be provided for, beyond the design values. All strakes, embedded parts, bolts, nuts washers etc., shall be hot dip galvanized using 900 grams of zinc per square meter of exposed area.

Fixing arrangement of strakes to the chimney shell shall ensure full fixity for the design load.

5.10.1.8.2 Elevator

Elevator shall be in accordance with the requirements spelt under Electrical Specification.

5.10.1.8.3 Sampling Ports

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 levels of ports shall be as per the 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.

Contractor shall also provide for the purposes of instrumentation other than the sampling ports mentioned above required number of conduits including pull wire, junction boxes and pull boxes, all securely tacked / anchored to the internal of the shall and S316 L plates below each pipe insert for fixing of measuring instruments.

5.10.1.8.4 Air Inlet/Outlet Openings

Air inlet and outlet openings shall be provided in the shell at the bottom and top respectively for ventilation of annular space between lining and concrete shell. These openings shall be closed on the outside with a stainless steel mesh (bird screen). The area of air inlet and outlet provided shall be equal. Louvers shall be provided for both air inlet & outlet openings.

5.10.1.8.5 Louvres

Air outlet louvres shall be provided as per the requirement of this specification near the top. The louvre fins shall be of Z-shape in cross section and made from anodized aluminum plates of a minimum thickness of 4 mm. The framework supporting the louvre

fins shall be made from extruded aluminium sections of minimum thickness 6 mm. The louvres shall be mounted in the form of panels. The fins shall be closely spaced to cut off any driving rain entering the chimney windshield. All panels must be approved by the OWNER before installation. To outside face of louvers, SS mesh on SS frame work shall be provided.

5.10.1.8.6 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.

At the centre of each 60° segment of each external platform 2 nos puddle flanged galvanised iron pipe sleeves of 75mm internal dia spaced at 400 c/c radially shall be provided for passing ropes during maintenance of the chimney.

2 Set of Brackets (lifting steel arms) shall be supplied by the Contractor. Each set shall consist of 1 no. bracket beam, 2 nos. vertical supports and 2 nos. 200 mm dia cast iron pulleys. All items and inserts such as bolts, nuts, plates, etc. shall be hot dipped galvanized. The lifting capacity of the bracket shall be 1000 kg and the minimum overhang from the edge of the platform shall be 1000 mm.

5.10.1.8.7 Enclosure walls

RC walls shall be provided at the grade level around staircase and elevator to make the enclosed space airtight and free from ash and dust for the comfort and safety of personnel who are required to go into the chimney for maintenance and inspection purpose. The RC wall shall rise from the grade level to the lowermost platform, which shall be RC slab on steel beams. The enclosure shall be airtight. All materials for the design of wall shall be as per relevant IS codes.

5.10.1.8.8 Lightning Protection System

For detailed specification of 'Lightning protection system', refer electrical section of this specification.

5.10.1.8.9 Aviation Obstruction Lighting System

For detailed specification of 'Aviation obstruction lighting system', refer electrical section of this specification.

5.10.1.8.10 MS insert plates for mounting of instruments for the measurement of amplitude of vibration and wind speed

For mounting of accelerometer and wind speed censors 600 x 600 x 20 thick, MS inserts with 25 nos. threaded (1/2" whitworth) holes shall be fixed on the outer circumference of the chimney shell with MS lugs as shown on the drawing. During casting, the holes shall be temporarily plugged to prevent concrete from filling in the holes. Two nos. of such inserts shall be fixed at the top of the chimney for mounting accelerometers and a set of

four nos. of such inserts shall be fixed at one-third and two-third heights of the chimney for mounting wind speed censors. A working platform of 1 meter width with safe guardrail shall be provided 1 metre below each level of these inserts as shown on the drawing. For laying of cables, the same cable tray used for illumination/ aviation light shall be utilised.

5.10.1.9 PAINTING

Three coats of acid and heat resistant paint conforming to IS:158 over a coat of compatible primer with a minimum total dry film thickness of not less than 150 microns shall be given to the following surfaces as per manufactures recommendations:

a) All faces of parapet above roof slab including handrails, embedments etc.

b) From the top to a distance of 1.5 times the outer diameter of the chimney shell at the top externally.

c) Entire inside surface of shell for full height.

Painting the external surface of the chimney shell below the portion covered above with two coats of synthetic enamel paint over 2 coats of primer as per manufacture's recommendation

The painting shall be in alternate bands of orange or red and white shade, each band with a band width of H/9 metes (H= height of chimney) and the band at the extremities being of orange or red shade. This shall be done after removing all lose and foreign matter to give a smooth and uniform finish. Spacing of the bands shall be as per ICAO guidelines.

External surfaces of chimney shell below GL and vertical & top surface of chimney raft shall be painted with two coats of bitumen paint.

External painting of shell shall commence immediately after the shell construction is completed and the concrete is well cured. The painting shall preferably be started from the top. This is to ensure visibility of stack to low flying aircraft at day time even during the period of construction of the internals of the chimney.

5.10.1.10 CONSTRUCTION / INSTALLATION

5.10.1.10.1 General

Excavation, backfilling etc., shall be carried out as per the relevant specifications.

Construction by slip-form Method

Slip-form construction will be encouraged if proposed by the Tenderer. 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.

The Tenderer should furnish at the time of submitting tender a brief but comprehensive statement indicating the planning & programme and method of work to be followed. The statement shall include the following.

- Type and description of Slip-form equipment and its accessories.
- Design of scaffolding and staging.

- Description of materials including admixtures to be used for construction.
- Manpower planning, construction spaces required, standby arrangement.
- Rate of Slip-forming.
- Proposed workability requirement of concrete and type of cement & admixture to be used.
- Quality assurance programme.
- Method of Transportation of material
- Method of curing and rectification of defects.
- Planned interruption, if proposed and activities during planned interruption. Treatment of construction joint.
- Contingency solution for unplanned interruptions.
- Time of completion.

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

5.10.1.10.2 Shell Construction

The Contractor shall prepare and submit a detailed quality assurance plan within one month of award of work. This plan shall include the following:

a) Design Criteria

The Contractor shall give the criteria to be adopted for design of various temporary works and the slip forms.

The Contractor's design calculations shall be based on normally accepted practice for the structural forms which the contractor adopts for staging.

b) Construction Method

This shall include at least the following:

i) Structural Analysis providing adequacy of jacks, slip forms and their supports and staging.

ii) The operations during planned interruptions such as retrieval of jack rods, resetting of form panels, etc., shall be stipulated.

iii) Method of preparing, transporting, pouring, vibrating and finishing concrete.

iv) Treatment at construction joints during unplanned interruptions.

c) Construction Equipment

The contractor shall furnish a detailed description of the following:

i) The type and number of equipment and facilities to be used for slip forming such as jacks, working platforms at various levels, yokes, walers, etc. There shall be at least a 50% standby capacity of jacks, jack rods, hydraulic pump, hose pipes etc.

ii) Provision including standby, of concrete mixing units and pumps to cater to the planned rate of progress rate of slipping.

iii) Material hoists and buckets for transport of concrete, reinforcement, scaffolding components etc.

iv) Curing arrangements consisting of pumps, pipelines, etc. There shall be at least 50% standby pumps.

v) Provision of precision survey instruments including lasers for verticality check. The laser instrument shall emit a long-range visible laser which has a self-leveling platform which electronically levels the instrument and has a fail-safe system that shuts off the beam when out of level. There shall be a standby of above instruments.

vi) Stipulation of power requirement for operation and details of night lighting shall also be specified. The contractor shall provide adequate standby diesel generating sets.

vii) Communication arrangements between ground and working deck.

5.10.1.10.3 Concrete

All concrete work shall be carried out strictly in accordance with the specification for concrete except as otherwise specified hereunder.

The source and type of the basic ingredients of concrete, viz., cement, aggregates, water and approved admixtures if any, shall be unchanged throughout the construction of the chimney shell, particularly in case slip forming technique is adopted for shell construction.

The maximum size of coarse aggregates, unless specified otherwise, shall not be larger than 1/8th narrowest dimension between forms nor larger than one half the minimum clear distance between reinforcing bars nor more than 40 mm. However, at corbels, heavily reinforced sections, congested areas and around openings the aggregate shall be 20 mm downgraded.

Natural gravel and rounded aggregates of acceptable quality shall be preferred to broken stone with sharp angular corners for slip formwork, in particular.

The water-cement ratio by weight shall be between 0.40 and 0.50 including free moisture in the aggregates, and the slump shall be between 100 mm and 150 mm. However, precise requirements in this regard shall be established from field tests and shall be subject to Engineer's approval.

For the worst weather conditions at site at the concreting point, the minimum slump shall be 50 mm. If necessary, approved retarders / plasticizers to maintain the workability shall be used with the prior approval of the Engineer. Such admixtures shall be identified after preliminary tests to prove their satisfactory performance and compatibility with the particular type of cement envisaged to be used in the shell construction. After identification and determination of dosage for varying weather conditions, the total quantity required for completing the work shall be procured prior to commencing slipforming.

If the Engineer so desires, the Contractor shall make immediate arrangements, through an approved agency, to undertake sonic tests to prove the quality of concrete. The quality of concrete shall be considered as satisfactory if it meets specification requirements and the sonic velocity is atleast 4000 m/s. If the tests prove that the quality of concrete is not satisfactory, then all costs associated with the tests shall be borne by the Contractor.

Particular attention must be given to concrete placement because of the thin wall section and the presence of reinforcing steel. Compaction of concrete shall be by vibration.

Small openings and pockets less than 600 x 300 mm can be formed by inserting blocks. Larger openings shall be formed using frames, which shall be formed well in advance of the sliding.

Horizontal bars should be fixed nearest to the face of the wall. These bars should be pre – bent.

Under no circumstances shall the point of discharge of the concrete into the forms be more than 1500mm above the concrete surface on which it is to be deposited. Also, not more than 2500mm height of chimney shall be concreted on any one day if permission is given to proceed with jump forms.

Concrete in the shell shall be poured in required minimum layers uniformly. The concrete in each lift (where jump form is used) shall be laid in one continuous operation for the full circumference of the shell so that there will be no vertical or inclined construction joints. Horizontal construction joints shall be maintained at uniform spacing throughout the height of the chimney.

The vibrator needle size should normally be restricted to 25 mm dia. Two numbers of standby vibrators units shall be maintained on top of the working deck at all times during the slip forming operation.

The vibrator poker shall only be lowered into the concrete to a depth corresponding to the height of the last placed layer of concrete.

During the first pouring when the forms are empty, vibration should be avoided or carried out with utmost care in order to prevent bending of the yokes.

To achieve good bond between the foundation and the first lift of the shell, or at horizontal joints caused by interruptions to sliding, an initial 5 cm layer of high strength cement grout shall be placed.

The slipping rate of the forms shall be such that the concrete, when exposed has already achieved enough strength to support the vertical pressure from the concrete still in the forms as well as to withstand lateral pressure caused by wind, inclination of walls, etc. The slipping rate shall be limited as mentioned in elsewhere in the tender. The minimum compressive strength of concrete immediately below the bottom of the form panel shall under no circumstances be less than 15kg/sq.cm.

It shall be ensured that no dragging of concrete occurs with the upward movement of the slip form. Twisting in the horizontal plane of slip form assembly and tilting in the vertical plane of the slip form assembly shall not be permitted. In case of such occurrences, the Contractor shall rectify the same to the satisfaction of the Engineer at no extra cost.

Mix design also should be so done that it has a slump of 50 mm at the point where concrete is placed under an ambient temperature of around 40oC. This will also keep vibration by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent or plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used. Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40 deg.C.

Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3600 Sq.Cm. per gram.

5.10.1.10.4 Staging and Form Work

The shuttering for the chimney shell shall be either steel formwork or steel framed plywood formwork of adequate thickness, proper surface texture and with requisite supports and battens to produce a shell surface which will be even, smooth and of uniform curvature and batter as per Drawing and free from all blemishes. The Contractor shall be responsible for designing the formwork, along with its supports etc. Contractor shall obtain the approval of the Owner for the design of forms, before assembling them. Approval of the Owner does not relieve the Contractor of his responsibility to ensure the soundness of formwork.

Design and erection of staging shall conform to the requirements of all relevant IS codes and National safety standards/regulations.

Contractor, at his own cost, shall prepare a detailed erection scheme. He shall submit to the Owner detailed drawings with supporting calculations showing all details of formwork, staging, scaffolding, member sizes, connection details and other arrangements for slipforming and for the concreting work and submit the same for review. Any suggestions/comments on the scheme/details conveyed to the Contractor shall be carried out by the Contractor at no extra cost. Scheme submitted for approval shall incorporate separate provision of material hoists and a passenger hoist.

Staging shall be designed for all possible loads that could be imposed on it such as self-weight, weight of ladder and timber platforms at all levels, weight of men, weight of construction materials and equipment, wind loads, seismic loads, etc.

Minimum live load on staging due to labour and personnel movement shall be considered at 300 Kg/m^2 Wind load shall also taken into account, wherever applicable. Factor of safety shall be minimum 3.0.

Special inspection hoist of approved make shall be provided by the Contractor for regular inspection, checking of scaffolding members, joints, etc. Fortnightly detailed inspection record shall be maintained by the Contractor and shall be produced to the Engineer whenever required for his verification.

Notwithstanding the approval from the Engineer, the Contractor will be solely responsible for the safety, security and proper functioning of the staging and formwork.

Installation of Formwork

All formwork shall be set to plumb and to line and level, or curvature or batter as per drawing. All shutters shall be adequately supported, to the satisfaction of the Owner, to prevent deflection under dead weight of concrete, imposed load of workmen, materials and plant and to withstand vibration. No joint in any props shall be allowed. The joints in formwork shall be watertight. Surface of formwork shall be oiled with approved quality mould oil which shall not stain the surface of the shell.

Tolerance

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

a) Out of plumb between two consecutive lifts : 3 mm.
b) Errors in level : 3 mm.
c) Errors in sectional dimensions : 5 mm.
d) Out of plumb in general : 1 in 1000 of height subject to a maximum of 200 mm.

However, the Contractor shall aim at improving upon this figure. Should the limitations exceed, the Contractor shall, if directed by the Owner, demolish that portion of work and recast at his own cost, to the complete satisfaction of the Owner. No tolerance shall be allowed between the two consecutive plates of the formwork either radially or vertically placed.

Stripping of formwork

Unless otherwise permitted in writing by the Owner, the minimum period of keeping formwork in position after the completion of pouring of concrete shall conform to relevant clause of IS:456. For the chimney shell the stripping time shall be 48 hours minimum.

Formwork shall be so arranged as to permit removal without jarring or damaging the concrete. Immediately after stripping of formwork, the Owner shall be informed by the Contractor. The Contractor shall ensure that the site is cleared of stripped shuttering nails or any other material which might hinder the inspection, so that the Owner can inspect the concrete surface.

Re-use of formwork

Before re-use, all forms shall be thoroughly scraped, cleaned, examined, repaired, and treated with mould oil as specified herein before. Formwork, declared unfit or unserviceable, by the Owner, shall not be used or reused.

5.10.1.10.5 Curing

Curing of concrete shall be accomplished by the application of a membrane curing compound to all concrete surfaces. The compound shall conform to ASTM C 309, Type I with white pigmentation and shall be applied by a sprayer. It shall have an efficiency index of not less than 90 percent when tested in accordance with ASTM C 156. The surfaces shall be thoroughly covered with the membrane immediately after the forms have been removed. No curing compound shall be used on the surfaces where future bonding of concrete is required. Manufacturer's instructions shall be followed for application of the compound.

The curing membrane shall remain intact for a period of at least two months.

Alternatively conventional curing using circumferential perforated pipes hung from the formwork may be adopted. The interior and exterior surfaces of the shell shall be kept moist for 14 days after exposure from forms as the chimney construction progresses upwards.

5.10.1.10.6 Steel and Metal Work in Chimney

General all workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the IS:800, and other relevant Specifications unless otherwise specified.

5.10.1.10.7 Fabrication

Rolled materials, before being used for fabrication, shall be straight and shall be within the tolerance laid down in the IS:1852. Straightening, if necessary, may be done by mechanical means and if required, by applying localized heat, the temperature of the material not exceeding 60 degree C locally. Cutting of mild steel members shall be effected by power saw or gas cutting. If gas cutting is used, allowance shall be made in working out the effective length, based on the shop drawing and templates. Care shall be taken in gas cutting so that the member does not bend or warp. The edge of the member

shall be prepared, if gas cut edge is required for welding. Holes shall be drilled with power drill. Arrangement shall be made for clamping the member to be drilled so that the member is not displaced while drilling is in progress. When two or more separate members are to be drilled together, all the parts shall be clamped together. After drilling they shall be separated and burs shall be removed with power driven hand grinder. Bolt holes shall not be formed by a gas cutting torch.

The Contractor shall establish a full-fledged fabrication shop at site including proper cutting, bending, welding, testing and proper handling facilities. Complete fabrication shall be carried out at site.

The individual cans of the liners shall be joined together by butt welding internally all-round for full strength after connecting the flanged portion of the cans with high tensile steel threaded fasteners conforming to IS: 1367. It shall be ensured that the joints are accessible from internal platform during erection to facilitate welding.

The contractor shall arrange inspection of welds in the presence of owner's representative as described below.

a) 100% of the welds shall be subjected to visual inspection to detect visual imperfection.

b) At least 10% fillet welds shall be subjected to Dye Penetration Tests (DPT) at random.

c) 100% of the root welds for butt welding shall be subjected to DPT after back gouging.

d) 10% of butt welds chosen at random shall be subjected to radiographic/ultrasonic tests. All welding/weld testing procedures shjall in general follow AWS standards.

5.10.1.10.8 Assembly

Riveting, bolting and welding shall be carried out as per requirements laid down in IS:800. Shop assembly of elements of steel members/structures, if required and/or asked for by the Engineer, shall be arranged so as to check the accuracy of fitness. Necessary temporary supports like, props cross bracings etc. shall be provided to keep the parts in place both for mock up and at the time of erection. Each steel piece shall bear erection marking., written in paint.

5.10.1.10.9 Painting

If steel and iron members are to be painted as per contract, it shall be done as per requirement laid down in IS:800. A coat of shop painting shall be applied to all steel and metal work, unless stated otherwise. Unless otherwise specified, all steel members which are specified for painting shall be painted first with two coats of red oxide zinc chromate primer confirming to IS:2074 and then with two coats of synthetic enamel paint / aluminium paint / acid resistant paint of approved quality and colour.

All paints shall be of make and shade as instructed and approved by the Engineer. Necessary test certificates, manufacturer's literature and samples shall be submitted to the Engineer, for his approval before bulk purchase is made.

The metal surface which are to be painted shall be prepared properly by rubbing, washing, treating prior to application of paint as per paint manufacturer's specifications and as per relevant IS Specifications.

The total minimum DFT of paint provided on structures located outside windshield shall be 190 microns and on inside 125 microns.

5.10.1.10.10 Galvanizing

All structural steel including threaded bolts, nuts and washers, unless specified otherwise in contract, shall be double hot dip galvanized in accordance with IS 2629 and IS:6159 or American Society for Testing and Material Specification ASTM 123.

All members to be galvanized shall be cleaned thoroughly, to the satisfaction of the Engineer, by the process of pickling. Pickling shall be carried out an acid bath containing sulphuric or hydrochloric acid of suitable and adjusted concentration and temperature. Pickling process shall be completed by rinsing the members thoroughly in warm water. Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath and it shall meet all the requirements when tested in accordance with IS 2633 and IS 4759. The zinc coating shall be of uniform thickness with an acceptable minimum value of 610 gms/m² for structural steel and 500 gms/m² for bolts, nuts and washers. If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage and if so directed the galvanizing may have to be redone in the similar manner stated above.

5.10.1.10.11 Erection

Erection of structural members shall be done as per requirements of IS:800. The Contractor shall submit to the Engineer the scheme for erection of steel flues, erection equipment to be deployed, equipment and accessdories complete for approval. Contractor shall make sure that there are adequate spares for the erection equipments and at no cost will a delay be permitted due to inferior or faulty erection equipment.All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members providing temporary supports, bracing, fasteners, bolts, nuts etc. shall be the responsibility of the Contractor.

Contractor shall furnish necessary details such as number of jacks he proposed to use, their supporting arrangement, collars, rod hangers, high tensile steel cables/rods to lift or suspend the flue, temporary staging arrangement and fixing details. The capacity of the jacks, cables etc. shall be double the actual load proposed to be lifted/borne by them.

It is suggested that the liner be installed in required heights. This height is indicated so as to facilitate welding at each access platform level. The top portion of liner is first installed at ground level, hoisted and placed on the support platform. After ensuring that this portion is well supported, the second set of liner is erected at ground level, hoisted and welded to the already placed linear portion and so on. This would enable requirement of jacks and cables of smaller capacity and easier handling.

Contractor shall ensure that deviations shall not exceed the specified tolerances spelt out herein below for fabrication and erection of steel flues. The permissible deviations from the true form are as under:

a) Internal diameter shall not differ from the true or design diameter by more than +20 mm in the horizontal plane.

b) Horizontal centre of any section shall not deviate more than 12 mm from the shell vertical centre line in any 15 m height and never more than 1:2500 of heights plus 12 mm at any level considered.

c) Locally, the variation of the bent plates from true circular form should not exceed the plate thickness. All measurement/checking shall be done by a segmental circular template having the design radius and chord length of 0.15 times the design radius.

5.10.1.10.12 Painting of Concrete Surfaces

The concrete surfaces which have been cured by membrane curing compound shall be painted only after the curing membrane peels off by itself. In case the membrane remains intact even two months after its application, the same shall be removed by mechanical means as per the manufacturer's recommendations.

The surface preparation, method of application, time interval between coats etc. shall be strictly as per the manufacturer's recommendation. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval before commencement of work.

5.10.1.10.13 Acid Resistant Brick Lining

The chimney shall be lined with acid resistant bricks as specified. The bricks shall be fine grained in texture, dense, homogeneous, sound, true to shape, flat and free from flaws and other manufacturing defects. Standard and shaped bricks shall be used as required depending on the radius. No broken bricks shall generally be used.

Prior to despatch of bricks from manufacturer at least five (5) samples of the lot to be despatched shall be tested at an approved laboratory and test reports submitted to OWNER for approval and permission for despatch of material.

The Contractor shall provide sample for visual inspection and approval. For testing purposes, the Contractor shall select, at random, bricks from the stack, in the presence of the Engineer. The sample bricks thus collected, shall be sent to the approved laboratory for testing of bulk density, compressive strength, flexural strength, acid resistance, thermal conductivity and water absorption and shall meet the requirements given in the specification. The cost of testing and any other incidental expenditure shall be borne by the Contractor and the rate should include such tests. The Contractor shall submit to the Engineer the original test results for his scrutiny and approval.

The bricks are to be laid with one course of header followed by two courses of stretchers and so on or as directed by the Engineer. The radial joints shall be broken in each course. Provision shall be made for differential vertical expansion at the lining support. The lining thickness shall be as shown in the drawing or as specified. Lining shall be strapped with circumferential and vertical hot dipped galvanised steel bands (welded/bolted junctions) having minimum dimensions of 75 mm x 6 mm and 50 mm x 5 mm respectively, both spaced at one meter centres on the exterior of the brick work throughout the full height of the lining.

The mortar for acid resisting brickwork shall conform to IS:4832 (Part 1) - Silica type with potassium silicate liquid binder. Provision shall be made for differential vertical expansion at the lining support. The Contractor shall furnish test certificates confirming the acid resisting properties for acid resisting bricks from an approved laboratory for owner's approval before bringing them to site.

In the case of Acid Resistant Brick lining, the mortar joints shall be cured with 25% dilute HCl for a minimum period of 3 days and as per manufacturer's specification after which exposed face shall be thoroughly cleaned with water.

5.10.1.10.14 Safety

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

- Safety helmets and belts to be provided to all supervising staff and workers.
- Safety nets to be provided below both inside and outside platforms as instructed by Owner.
- Handrailing and toe guard to be provided around all openings and platforms.
- Regular maintenance of equipment, checking of hoists, scaffoldings etc.
- Passenger hoist must have multiple ropes.
- 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 slipform method of construction.
- Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

5.10.1.10.15 Tolerances

Permissible construction tolerances should be limited to the following:

Variation in wall thickness	(-) 5 mm, (+) 25 mm
Variation from Design Diameter	(+) 25 mm or (+) 12.5 mm per 3 m dia. whichever is larger, but in no case more than (+) 75 mm.
Out of Plumb in General	1 in 1000 of height subject to a maximum of 200 mm.

5.10.1.11 QUALITY CONTROL

Equipment and Materials

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 works covered under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expense.

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

It shall be ensured by the Contractor that work shall proceed uninterrupted even in the event of power failures. As such, adequate number of diesel operated equipment (such as concrete mixers, vibrators, etc.) shall be provided by the Contractor, as an alternative arrangement, in case, electrically operated equipment are proposed to be brought to site.

All materials supplied by the Contractor shall be of the best quality and shall conform to this specification. Approval in writing shall be obtained from Engineer, before any alternative or equivalent material is proposed to be used by the Contractor.

Contractor shall furnish Manufacturer's test certificate for the materials supplied by him. Where such certificates are not available, and where the Engineer so desires the specimen from the materials supplied to site shall be got tested at a recognised and approved testing laboratory at Contractor's cost.

Climbing or slip-forms shall be controlled by linked hydraulically operated jacks that are reversible, driven by an electrically operated pump and with provision for manual operation in the event of a break down.

For slip-form operation two level platform shall be provided on the inner as well as outer side. All safety requirements shall be met by provision of handrails, lighting etc. Safety nets shall also be provided below the platforms.

Whenever defects in concrete is noticed after any particular lift, work shall be stopped and non destructive testing shall be carried out to verify the strength and soundness of concrete. Reputed agencies as approved by the Engineer shall be entrusted with the work. Additional destructive tests on concrete cores taken from the affected areas shall also be carried out, if found necessary. All costs towards these tests shall be borne by the Contractor.

One hoist for passengers/supervisory staff and one for transport of goods shall be provided by the Contractor. These hoists shall be operational not later than the time when construction first reaches 10 m and should be available throughout the construction period. Access between various working levels shall be provided by an approved system of ladders. Under no circumstances shall staging or scaffolding be relied upon to provide such access.

Physical Checks

Some of the mandatory physical checks which shall be carried out by the Contractor, are as under :

a) The twist or rotation of the slipform every 15 minutes.

b) Level of top of jacks every thirty minutes.

c) Verticality with the help of lasers atleast once in 4 hours.

d) Inside and outside diameters/dimensions and wall thickness, once in each shift of 8 hours.

e) Level of top of form panels once initially and subsequently after each shift.

f) Level of working platforms once initially and subsequently after each interruption.

g) Batter of the form panels and yoke legs once on erection and subsequently after each interruption.

h) Condition of jack rods for ovality, indentation, buckling, moving out of alignment, etc., before fixing each rod.

i) Bracing of jack rods passing through openings.

j) Live load on working deck to avoid accidental overloads.

k) Workability of concrete at mixer and at point of placement, once an hour.

l) Temperature of concrete, once in 4 hours.

SECTION 5.10.2

NATURAL DRAUGHT COOLING TOWERS

TABLE OF CONTENTS

5.10.2.1 GENERAL

This specification covers the general requirements of engineering for material, design, supply, manufacture, construction, testing and commissioning for satisfactory performance of natural draught cooling tower(s) including all associated appurtenances and equipments as well as electrical works.

5.10.2.2 CODES AND STANDARDS

The latest version of the following codes shall be adopted for analysis, design and construction of Cooling Tower.

A. Materials

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

B. Codes of Practice

i	IS:456	Code of practice for plain and reinforced concrete.
ii	IS:800	Code of practice for general construction in steel.
iii	IS:875	Code of practice for design loads (other than (part 1 to part 5) earthquakes for building and structures).
iv	IS:1080	Code of practice for design and construction of simple spread foundations.
v	IS:1343	Code of practice for pre-stressed concrete.
vi	IS:1893	Criteria for earthquake resistant design of structures.
vii	IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
viii	IS:2629	Recommended practice for hot dip galvanising on iron and steel.
ix	IS:2911	Code for practice for design and construction of (part 1 to 4) pile foundations.
x	IS:2950	Code for practice for design and construction of (part 1) raft foundation.

xi	IS:3043	Code of practice for earthing.
xii	IS:3370	Code of practice for concrete structures for (part 1 to 4) storage of liquids.
xiii	IS:11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
xiv	IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
xv	BS:4485 (All parts)	Specification for water cooling towers.
xvi	BS:8007	B.S.Code of Practice for design of Concrete structures for retaining aqueous liquid.

The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order.

a) Bureau of Indian Standards.
b) British Standards Institution.

Wherever the above Standards are in conflict with the stipulations of this specification, the latter shall govern.

5.10.2.3 GENERAL REQUIREMENTS

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.

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 hand railing, 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.

5.10.2.4 CONCRETE

Portland Pozzolana Cement / Slag cement shall be used for all concrete works. Same brand of cement shall be used as far as possible throughout the construction of the entire structure to enable to achieve uniform colour and surface finish throughout the shell.

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

	Structural Concrete	Minimum Grade
a)	Foundations	M30
b)	Basin	M30
c)	Diagonal Columns	M40
d)	Shell	M35
e)	Precast works (Fill Supporting Structure)	M30

The minimum cement content per cubic meter of concrete as per Table 5 of IS: 456 for 'Very severe' exposure for super structure, basin and foundation:

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

5.10.2.5 REINFORCEMENT STEEL

Reinforcement for the shell shall be corrosion resistant steel.

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

5.10.2.6 STRUCTURAL STEEL

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 900 gm/sq.m and comply with the requirements of IS:2629 and IS:2633. In addition, galvanising 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.

5.10.2.7 LOADINGS

5.10.2.7.1 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 as per BS4485, Part 4, or based on wind tunnel studies, whichever is higher.

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. The wind tunnel test shall be completed and report submitted for approval within 6 months of award of contract.

Magnification factor of 1.43 may be considered in the preliminary design in the absence of wind tunnel test reports.

5.10.2.7.2 Earthquake Load

The coefficient of horizontal acceleration shall be for seismic zone as per IS:1893

5.10.2.7.3 Dead Load

For assessing the self weight of the structure, the specific weight of the concrete shell shall be taken as 25 kN/cum. 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.

5.10.2.7.4 Constructional Loadings

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

5.10.2.7.5 Miscellaneous Loads

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

a) Thermal restraint loads
b) Subsoil deformation.

5.10.2.8 LOAD COMBINATIONS AND PERMISSIBLE STRESSES

All structural components except stairs of the cooling tower shall be designed by working stress.

The structure shall be designed for the worst load combinations as per IS 456 and IS 11504.

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

Since cooling tower is a wind predominant structure, increase in permissible stresses shall not be allowed. Increase in safe bearing capacity for design of foundation under wind load combination shall also not be permitted.

5.10.2.9 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 annular pile cap shall be provided for cooling towers.

All lateral force shall be resisted only by piles. Effect of pile cap & basin wall shall not considered for resisting lateral load transferred from superstructure.

The foundation structure shall be designed for loads indicated in 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 20 KN /sq.m at the ground / grade level.
d) In case of subsoil with varying degrees of stiffness, non uniform settlements due to the varying stiffness have to be determined. The redistribution of stresses 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.

5.10.2.10 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 towards a collecting sump for effectively draining the water to permit de-silting / de-sludging. 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 out 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.

A minimum of 300 mm 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.

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 stop logs and screens.

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

Screens shall be out of 8 gauge 25mm clear opening GI crimped wire netting welded to frame of structural steel section/flats. Screens 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. 3.3.1 and Cl. 3.4.1 of IS:3370 (PART II). Minimum thickness of structural concrete elements shall be 230mm.

The basin and channel walls shall be designed for a minimum surcharge load of 20 kN/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 225mm wide approved quality PVC ribbed water stops conforming to relevant standards 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, PCC paving of M15 grade, 100 mm thick shall be provided for a width of 1.0m sloping away from the basin. Dry rubble soling of 150mm thickness shall be provided below the PCC.

Similar paving shall be provided for a width of 7.0 m from the raker columns around the cooling tower.

Pressure relief valves shall not be provided in the basin raft.

5.10.2.11 TOWER SHELL

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

5.10.2.11.1 Thickness

The tower shell shall have a minimum thickness of 200mm.

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

5.10.2.11.2 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
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.

5.10.2.11.3 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 Ld where Ld 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 2Ld or 80 times the diameter of the bar.

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

The minimum clear cover to shell reinforcement shall be 50mm.

5.10.2.11.4 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.

5.10.2.12 FILL

For detailed specification refer to the Mechanical section of this document.

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

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

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

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

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

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

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

b) Loading due to scaffolding for the erection crew if so envisaged to be supported.

c) loading of personnel during maintenance of pipe work and sprinkler system. The appropriate parts of the pack support structure shall be designed to support a point load of 1.5 kN at any position.

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

5.10.2.14 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:

5.10.2.14.1 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.

Stairs shall give access to the water distribution system through hot dip galvanised steel doors. All access doors shall be of size minimum 1200 mm wide and 2100 mm height, minimum.

5.10.2.14.2 Platforms

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

5.10.2.14.3 Walkways

Walkways having a minimum clear width of 1.20 m shall be provided allround 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.

5.10.2.14.4 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.

5.10.2.14.5 Hand railings

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

Hand railing 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.

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

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

5.10.2.15 PAINTING TO CONCRETE SURFACES

5.10.2.15.1 Inside Cooling Tower

All concrete surfaces in direct contact with sea water / water spray shall be applied with tar extended two component coating system.

a) Basin floor.

b) Internal and external 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.

g) Internal and external surfaces of the drain chamber.

h) Complete internal surface of the shell for at least 2 meter at the top and bottom and for at least 1 meter on the outside of the shell at top and bottom.

i) All concrete surfaces which are in contact with the earth.

High Performance Moisture Compatible Corrosion Resistant Coating System shall be as per technical specifications of Central Electrochemical Research Institute, Karaikudi (CSRI affiliate institute), Tamilnadu, PIN-630006.

The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

The coating system shall confirm to the following:

Properties of Paint

Base	High Performance Moisture Compatible Corrosion Resistant Coating System CECRI know-how system
Volume Solids	70 %
Specific Gravity (ASTM-D-1475)	1.25 ± 0.1
Dry Film Thickness (ASTM-D-1186)	160 ± 10 µm per coat
Coverage	4 – 4.5 sq.m per litre

Touch Dry	2 Hours
Recoating	24 Hours

Properties of Coating

Salt Spray (ASTM-B-115)	2000 Hours
Resistance to sea water (carried out upto 6 months)	Passes
Coating Resistance (carried out upto 6 months)	10^9 Ω cm^2
Adhesion (ASTM-D-4541)	4.5 kN minimum
Flexibility (ASTM-3363	1/8 " passes
Elongation	33 %
Impact (ASTM-G-14-04)	45 cm passes

Paint material and its application method shall be obtained from any manufacturer who has been granted license by CECRI, Karaikudi for technical know-how for High Performance Moisture Compatible Corrosion Resistant Coating System.

The application method of coating shall be got duly approved by CECRI, Karaikudi.

5.10.2.15.2 Outside Cooling Tower

Two (2) coats of Aliphatic acrylic protective coating system to concrete shall be applied to exposed outside the cooling tower as per the following specifications.

The coating system shall confirm to the following:

Adhesion (ASTM-D-4541-02)	3.3 N/mm^2
Water vapour permeants (ASTM-D-1653)	> 20 gm/sq.m/day at 75 % R.H. at 25^{o} C
Electrochemical polarization test	3 volts constant applied voltage for rebar in cylindrical specimens in 3.5% NaCl.
Efficiency factor, after 34 days	
Chloride penetration	Efficiency factor of minimum 10
Rebar weight loss method	Efficiency factor of minimum 15

The system should have minimum seven (7) years successful usage history in Indian conditions.

5.10.2.16 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.

5.10.2.17 LIGHTNING PROTECTION

For detailed specification of lightning protection system refer electrical section of this specification.

5.10.2.18 AVIATION WARNING SYSTEM, LIGHTING AND POWER RECEPTACLES

For detailed specification refer to the Electrical section of this document.

SECTION 5.10.3

ASH POND

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5.10.3.1 GENERAL

Ash disposal ponds shall be formed by constructing earthen bunds around ash disposal area as shown in Plot Plan.

Area and final design height of the bund shall be as per Mechanical specification. Contractor shall construct the starter bund upto 5 m.

Other structures inside the pond like intake well, approach trestles, etc shall be designed considering future height extension of the bund.

While planning the ash ponds, contractor shall ensure that the maximum possible area can be utilised for the formation of the bunds leaving necessary corridor along the periphery for routing ash slurry pipeline, maintenance road, toe drains etc.

Bunds shall be designed as homogeneous earth bund. Suitable soil may have to be identified by Contractor either by excavating inside the pond area or from borrow pits outside the plant. Up stream slope of the bund shall be protected by HDPE sheet with brick lining, where as the down stream side slope shall be protected by turfing.

Internal drainage shall be taken care by providing sand chimney, sand blanket and rock toe on the downstream side.

Floor of the pond shall be generally levelled and shall be made impermeable by providing HDPE liner with earth protection above.

The top width of the bund shall be 6000 mm. Width of the starter bund at the bottom shall be based on design.

The top of the bund shall accommodate 4000 mm wide carriage way with WBM finish. Suitable Vehicular turn around space shall be planned at every 500 m centre to centre over the bund.

5.10.3.2 DESIGN CRITERIA

5.10.3.2.1 Ash Bund

The bund shall be designed to be suitable under all conditions to which they may be subjected to, including self weight, vertical loads, lateral loads, water pressure, seepage and draw down, seismic effects etc for the ultimate stage of raising of the bund. Raising of the bunds of the settling ponds shall be by upstream method of construction.

The bunds shall be of homogenous earthen construction. Earth used shall conform to classification GC, CL or CI. Earth may be from inside of the pond or from approved borrow pits. It is the responsibility of the Contractor to identify suitable source of earth in adequate quantities. The source and type of earth shall be same for the full length and height of starter bund.

Earth available at site may be used, if it meets specification.

The design of the bund shall in generally follow the provision of IS 8826. Stability analysis shall in general follows IS 7894.

Construction of the bund shall generally commence about 750 mm below the general ground level after the ground is clear of all roots, stumps, organic and vegetable matter. Loose pocket if any shall be removed and rectified to ensure fairly uniform bearing capacity.

The bunds shall have a top width of 6000 mm. Slope on the down stream side shall be a minimum 1 vertical to 2.5 horizontal. Slope on the upstream side shall be minimum 1 vertical to 2 Horizontal Free board above full reservoir level shall be calculated as per IS 10635. However minimum free board shall be 1000 mm. A 3000 wide berm shall be provided approximately for every 5 meter height of the bund.

The design of bund shall ensure that the phreatic line shall not meet downstream face of the embankment. To ensure this adequate internal drainage arrangement shall be provided as described below

i) Sand chimney a minimum of 500 mm thickness upto 1 m below the top of bund.

ii) Sand blanket of a minimum 500 mm thick at ground level connecting chimney to rock toe.

iii) Rock toe to a minimum height of 1000 above the outside ground level with a top width of 1 meter and side slope of 1 vertical to 1.5 horizontal. The rock toe shall extend to the full depth of bund below ground level. The Rock toe shall consist of 75 to 450mm HBG (Hard Blue Granite).

iv) 200 mm thick coarse aggregate filter comprising 75mm thick 40 mm metal and 125 mm thick 6 to 25 mm metal ,150 mm thick coarse sand filter and 150 thick fine sand filter between sand blanket and rock toe.

The embankment shall be safe against failure due to “piping”. The design shall ensure that the exit gradient is less than 1 in 7. The gradient shall be calculated by drawing flow net.

Down stream face shall be protected by turfing with turf. A toe drain of minimum internal width of 1000 mm and minimum depth of 600 mm shall be provided at the side of the rock toe along the periphery of the bund to drain the seepage from rock toe and rain water from the surface drains. The toe drain shall be of RCC. The drain shall be constructed in a minimum slope of 1 in 750 and shall lead the water to the nearest water course.

To lead out the rain water on the downstream side, surface drains formed out of brick paving 75 mm thick minimum 600 mm wide and 150mm deep shall be provided at at about 100 Meters c/c along the length of the bund. The brick shall be pointed using cement Mortar 1:3. The surface drain shall be connected to the toe drain through the filter and rock toe.

IS 8237 shall also be followed for guidance while designing slope protection.

The upstream slope shall be protected by providing HDPE Liner. The lining shall have a 150 mm sand cushion at the bottom. The liner shall be protected by providing one layer of Fly ash brick 75 thick over a 150 mm thick sand spread over the HDPE Liner. The joints between the back shall be filled with CM 1:4 after curing the brick paving for 3 days. The HDPE Liner shall be properly anchored at the top of the bund, at the berms and at the bottom of the bund with appropriate embedment with PCC in continuous trench.

Pond floor shall also be lined to prevent seepage of ash into ground water as per the requirements of environmental authority. The lining shall be with HDPE Liner, with bottom sand cushions of 150 mm and top sand cover of 150 mm.

The HDPE Liner shall be 750 micron thick and of black colour. Jointing, lapping anchoring at top and bottom and other constructional details shall be as per the manufacturer’s instruction.

The HDPE Grade-1 (i.e High Modular Mass High Density Polyethylene- HMHDPE) film of width not less than 6 m conforming to IS: 10889 shall be used.

The basic properties shall be as follows:

Sl No.	Property	Test Method	Unit	Expected value
1	Polymer of natural film	IS 7328 IS 2530	--	HDPE 4 2fa
2	Density	IS 8543 (Part 1 /Sec 2)	gm / cc	0.94
3	Carbon Black Content	IS 2530	%	2 to 3
4	Tolerance in thickness	IS 10889	%	±20
5	Tensile strength at break	IS 10889	Kg/sq.cm	300 (MD) 250 (TD)
6	Elongation at break	IS 10889	%	300 (MD) 300 (TD)

MD = Main direction

TD = Transverse direction

5.10.3.2.2 Water Escape Structure (Discharge Shaft)

The decanted water collected in stilling ponds shall be discharged through water escape structure, to the forebay of the pump house of the Ash water recovery system.

The discharge shaft shall be sized to handle full out flow from the pond including rain water.

The shaft shall be designed as water retaining structure limiting crack width to 0.1 mm. Minimum grade of concrete shall be M25 for the shaft and foundation. The structure and foundation shall be designed to support the load of the ultimate height of the shaft. The contractor shall conduct necessary geo-technical investigation at the location of the water escape structure to decide on the type of foundation considering the ultimate load on the structure.

From the discharge shaft water shall be led out through a 900 mm inside diameter precast concrete pipe of class NP3 with R.C.C encasement of min 250 mm all-round to protect the pipe from the super imposed earth load. The invert level of the pipe shall be kept 250 mm above the bottom of the shaft and shall be given adequate slope to ensure discharge matching the inflow into the shaft.

The shaft shall be provided with G.I rungs of 25-mm dia at 300 mm c/c for access during maintenance. Stop Log arrangement to block the vents during maintenance shall be designed and provided. At the top of the shaft removable platform with G.I gratings shall be provided for operation and maintenance.

A steel bridge shall be provided over ash pond upto decantation well and with steel trestle and concrete foundation.

The bridge shall be designed in spans not exceeding 20 m with R.C.C piers to support intermediate spans. Bridges shall be of structural steel with pre-cast R.C.C deck slab for ease in dismantling and re-erection. As the height of the bund is increased, these bridges shall also be dismantled and re-erected.

The location of the discharge shaft shall be such that the edge of the foundation shall be 5000 mm clear of the upstream toe of ultimate stage of the bund.

5.10.3.2.3 Energy Dissipating Structures

Along the upstream slope of the stilling ponds the ash slurry shall be discharged through pipes at intervals. The pumped slurry shall erode the lining and the bund proper if proper energy dissipating steps are not provided. The energy dissipating structure shall confine the flow from the pipe to an R.C.C.trough about 1500 wide projecting about 600 mm from the slope surface with R.C.C steps extending from the top of the bund to the toe where a water cushioning sump 1000 deep and 1500 x 1500 in plan shall be provided for water overflow. Grade of concrete shall be a min of M25.

5.10.3.2.4 Road way on top of bund

4000 mm wide carriage way with WBM finish with 230 thick granular sub base and 200 thick WBM layer shall be provided at the top of the bund. The carriage way shall be sloped in one direction toward downstream side where surface drains are provided. Guard stones shall be provided at 3000 mm c/c on either side of the bund.

5.10.3.3 CONSTRUCTIONAL ASPECTS

As soon as contract is awarded the contractor shall conduct precision Theodelite survey along the alignment of the bund and the entire pond area. Levels shall be obtained at every 5 m levels and contour plan of the area shall be prepared. In addition contracts shall prepare longitudinal section along the route of the bund along the centre line of the starter bund and cross section at every 10 m intervals along the centre line of the starter bund covering full width of the starter bund and further extension of the bund. These cross sections shall from basis for calculation of earth work for the bund.

Contractor shall carry out detailed geotechnical investigation along the centre line of the bund to ascertain the soil profile and ground improvement if necessary below the bunds. At each of the bore, hole necessary field test shall be conducted to arrive at the soil properties at various depths. Samples shall be collected form the bore holes at various levels to conduct laboratory test to arrive at strength characteristic of the soil based on the site and field investigation the contractor shall submit a detailed report to Owner for his review and approval. Design of the bund and other connected structure shall commence only after the geotechnical report submitted by contractor is approved by Owner.

Ground improvement may be done, necessary.

After marking the location and extend of the bund accrately the entire ash disposal area shall be cleared of all vegetation stumps, roots, and other objectionable matters.

The bund shall be of homogenous type using earth of classification mentioned under design criteria.

Along the alignment and width of the bund soil shall be removed to a minimum depth of 750 mm to form the formation level of the bund. The foundation bed shall be cleared of all loose material and rolled using 10 passing of 10 T rollers.

Material shall be placed in layers of not more than 150 mm in thickness after compaction. Moisture content of the bund shall be carefully controlled so that the bund shall be consolidated to a compaction grade of 95% as per AASHO modified proctor compaction Test.

Compaction shall be done with 8 to 10 tonne vibratory rollers. Rolling shall commence on the outer edge and progress towards inside. Minimum number of passes for roller shall be 10. A uniform compaction equivalent to 95% proctor density with moisture content of (-) 1% to + 3% from optimum moisture content shall be achieved in each layer.

It is recommended that the width of the bund on construction shall be about a meter extra on each side from the centre line and later trimmed to the correct slope. This shall ensure uniform compaction of the bund as a whole

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out as required by owner. Field density test by sand replacement method or core cutter method shall be conducted for every 500 m^3 of fill with at least one tests per shift.

Before compaction the following checks shall be conducted on material

i) Gradation – one test every 3000 m^3 of fill or one per shift

ii) Moisture content – one test every 5000 m^3 of fill or one per shift

During compaction following checks shall be conducted to ensure

i) That the layer thickness of the material is as specified.

ii) That the fill is compacted by the specified number of passes of the specified machinery

That no excess rutting or weaving of the fill occurs during compaction.

After compaction following frequency of tests is recommenced

i) Field density – every 500 m^3 fill or at least one per shift

ii) Permeability - every 10000 m^3 or once in 7 days

iii) Triaxial shear strength – every 3000 m^3 at least one per shift

SECTION 5.10.4

SWITCHYARD AND GAS INSULATED SWITCHGEAR (GIS) BUILDING AND SWITCHYARD CONTROL ROOM

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5.10.4.1 GENERAL

Civil & Structural work associated with Switchyard comprising of indoor Gas Insulated Switchgear (GIS) building, switchyard control building and out door equipment such as towers, gantries, lighting poles, lightning masts, equipment support etc. cable trenches, paving, fencing etc.

5.10.4.2 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS / IEC standards including amendments, if any, except where modified and /or supplemented by this specification. Some of the applicable standards are listed below:

Structural works

IS : 800 - Code of practice for general construction in steel

IS : 802 - Code of practice for use of structural steel in overhead Transmission Line Towers

IS : 1161 - Steel tubes for structural purpose.

Fabrication of structures

IS:802 : Code of practice for use of structural steel in overhead transmission line towers

IS:808 : Rolled steel beams, channels and angle sections

IS:813 : Scheme of symbols for welding

IS:1161 : Steel tubes for structural purposes.

IS:1367 : Technical Supply Conditions for Threaded Steel Fasteners

IS : 209 : Zinc Ingot

IS:1367 : Technical supply conditions for threaded steel fasteners

IS:1573 : Electroplated coatings for zinc on iron and steel

IS:1852 : Rolling and cutting tolerances for hot-rolled steel products.

IS:2016 : Plain washers

IS:2062 : Steel for general structural purposes

IS:2633 : Methods of testing uniformity of coating on zinc coated articles

IS:3063 : Spring washers for bolts, nuts and screws

IS:4759 : Hot dip zinc coatings on structural steel and other allied products

IS:6610 : Heavy washers for steel structures

IS:6639 : Hexagon bolts for steel structures

IS:7205 : Safety code for erection of structural steel work

IS:7215 : Tolerances for fabrication of steel structures

IS:12427: Threaded Steel Fasteners – Hexagon head Transmission Tower Bolts

Civil works

IS : 456 - Codes of Practice for plain and reinforced concrete.

IS : 802 - Code of Practice for use of structural steel in overhead (All Parts) Transmission Line Towers.

IS : 1893 - Criteria for earthquake resistant design.

IS : 1080 - Code of practice for Design and Construction of simple spread foundation.

IS : 4091 - Code of Practice for Design and Construction of Foundations for transmission line towers and poles.

IRC:6 - Indian Road Congress – Standard Specification and Code of practice for Road Bridges.

IRC:37 - Indian Road Congress - Guidelines for the Design of Flexible Pavements

Gate & fencing

IS:1161 Steel tubes for structural purposes.
IS:2721 Galvanized steel chain link fabric.

Levels

Top of pedestals for foundation of structures	:	300 mm above FGL
Top of cable trench	:	150 mm above FGL
Top of paving	:	100 mm above FGL

5.10.4.3 LOADING

5.10.4.3.1 General

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
(j) Loads due to conductor tension due to broken wire conditions and shield wire, producing worse effect.

5.10.4.3.2 Dead Loads

Dead loads consist of the weights of the complete structure and equipment, conductors, insulators strings, bus bars etc. The unit weight of structural steel shall be considered as 78.5 kN/cum for computation of loads. Unit weight given in IS:875 (part-I) shall be made use for other materials.

5.10.4.3.3 Imposed Loads

Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable tray loads, erection loads, operation/ maintenance loads etc. The loads considered shall not be less than that specified in IS:875 (Part II).

5.10.4.3.4 Seismic Load

Seismic forces shall be as per IS:1893 : 2005. Particular attention is drawn to calculation of the design base shear as per relevant clause of the code while using response spectrum method.

5.10.4.3.5 Equipment Load

Static loads of major equipment shall be based on the manufacturer's data of the specified equipment and shall be considered in design in addition to the live load.

Weight of equipment, ducts, conduits, etc. supported by structure shall include maximum possible loading conditions i.e. flooded conditions and associated impacts, test loading, anchorages and constraint effects.

5.10.4.3.6 Wind Loads

Wind load shall be in accordance with IS : 802 (Part 1/Sec1):1995).

The wind pressure on the Towers, Conductor, Ground wire and Insulator strings shall be in line with Clause 8 and Clause 9 and Sub Clauses thereof IS:802 (Part 1 / Sec 1) : 1995.

The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered for design. Wind shall always be assumed to act perpendicular to the Conductor / Rigid bus for structural analysis purposes.

Diagonal wind / inclined wind shall be considered for isolated self-supporting structures like lighting and lightning masts, poles only. Switchyard structures, which are interconnected either by beams or rigid buses, need not be analysed for inclined wind loading.

5.10.4.3.7 Other Loads

a) Short Circuit Forces in combination with seismic forces along with other normal forces shall be considered for the structural analysis of tower / structures. Short circuit forces and wind forces shall not be considered simultaneously

b) Other loads shall be as per IS : 802 (Part 1 / Sec 1) : 1995, broadly classified as,
   1. Climatic Loads
   2. Failure containment loads
   3. Construction and maintenance loads

These loads shall be computed in line with Clause 12 and Sub - Clauses thereof of IS : 802 (Part 1 / Sec 1) : 1995.

c) Anti-Cascading checks, Tension limits, broken wire condition and Strength Factors related to Quality shall be as per IS - 802 (Part 1 / Sec 1): 1995.

5.10.4.4 DESIGN OF STRUCTURES

Three-dimensional analysis shall be carried out for structures like towers and girders while two-dimensional analysis may be adopted for equipment support structures, using standard software package like STAADPro. Any non-standard software used shall be validated with manual calculations and shall be used only with the approval of Owner.

Switchyard structures shall be designed for the worst combination of dead loads, live loads, wind load conditions as per IS: 802, seismic loads, loads due to deviation of conductor, loads due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including snap in case of bundled conductors, etc.

The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition.

Short circuit forces and wind forces shall not be considered simultaneously.

The terminal/line take off gantries shall be checked for ± 30 deg. deviation of conductor in both horizontal and vertical planes.

Permissible stresses, slenderness ratios of members, minimum thickness of steel members, net sectional area of tension members and bolting and framing shall be as per IS : 802 (Part 1 / Sec 2) : 1992.

Wind & Seismic forces shall not be considered simultaneously in any load combination.

The design of structure shall be based on the condition where stringing is done only on one side i.e. all the three conductors broken on the other side. A factor of safety of 2.0 under normal and broken wire condition and 1.5 under combined short circuit and broken wire conditions shall be adopted for design.

Vertical load of half the span of conductors/ string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with the tools shall be considered as 150 kgs for the design of structures.

Terminal/line take off gantries shall be designed for a minimum conductor tension. The distance between terminal gantry and dead end tower shall be taken as 200 meters. The design of these terminal gantries shall also be checked considering ± 30 degree deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

The girders shall be connected with lattice columns by bolted joints.

All pipe support used for supporting equipment shall be designed for the worst combination of dead loads, erection loads, wind loads/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bar as per IS:806. The material specification shall be as per IS:1161 read in conjunction with IS:806.

If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.

Foundation bolts shall be designed for maximum tension occurring when 0.9 times minimum Dead Loads are combined with lateral loads.

Lighting mast shall be of required height shall be provided. Lighting masts shall be provided with a structural steel ladder. The ladder shall be provided with protection rings. Two platforms shall be provided for mounting of lighting fixture. The platforms shall also have protection railing. The details for mounting lighting fixtures would be as per the approved drawings of lighting fixtures

Supporting structures for equipment may either comprise of pipe supports or lattice structural steel supports as per requirement. The pipe supports shall be designed as per IS: 806 and IS: 1161. The lattice steel supports shall be designed as per IS: 802.

Minimum thickness of galvanized lower member shall be as follows:

Members	**Minimum thickness (mm)**
Leg members, ground wire peak members/ main members	5
Other members	4
Redundant members	4

Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

The minimum bolt diameter shall be 16 mm.

5.10.4.5 STRUCTURES

All structural steel shall be of tested quality and shall conform to IS:2062. Steel tubes where used for equipment support structures shall conform to IS:1161.

In addition to heavy washers conforming to IS:6610, spring washers conforming to IS:3063 shall be provided at all bolted connections. Bolts shall conform to IS:12427.

All steel structure for the Switch yard shall be hot double dip galvanized structure with welded / bolted connections at shop and bolted connection at site.

All bolts and nuts shall also be galvanised.

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

Towers, beams etc shall be trial assembled at shop, keeping in view the actual site condition, prior to dispatch to erection sites o that they can be conveniently pre-assembled before erection or conveniently assembled during erection.

Each tower shall be provided with step bolts not less than 16 mm diameter and 175 mm long spaced not more than 450 mm apart, staggered on faces on one leg extending from about 0.5 meters above ground level to the tower. The step bolt shall conform to IS:10238. Ladders on towers with lighting appliances shall be provided with safety guards.

Galvanizing

All steel structure for the Switchyard shall be hot double dip galvanized structure with welded / bolted connection at shop and bolted connection at site. All bolts and nuts shall also be galvanized.

The amount of zinc coating for galvanising of Switchyard structures shall be 910 gm./sq.m. for structural members and for bolts, nuts and washers. The same for other non-structural items like fence posts, gates, handrails etc. shall also be 910 gm./sq.m.

Galvanizing of the towers shall be as per IS:4759 and 2633 and as given in the following paragraphs.

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

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

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

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

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

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

CONTRACTOR shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damage, CONTRACTOR shall at his own cost adopt scrapping and regalvanising the member to satisfy the specific requirements.

5.10.4.6 FOUNDATIONS

Foundations for switchyard structures shall be reinforced cement concrete.

The type of foundation system, i.e. isolated, strip, or raft to be adopted shall be decided based on the structure, loading arrangement, load intensity and soil strata based on the soil investigation report recommendation. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level.

All foundations shall be designed for the most critical load combination of dead loads, live loads, inertia forces, wind and seismic loads, short circuit forces and secondary effects such as shrinkage, rise and fall in temperature, swelling and shrinking pressure of soil etc. and other relevant loading from service condition arrived based on detailed structural analysis of the Switchyard gantry structures, equipment superstructures etc.

Foundations for rail track for positioning and jacking of Transformer / reactor shall be provided.

For switchyard foundations anchor bolt with mechanical anchorage shall be provided and cast along with foundation concrete. Bolts in pockets shall not be adopted. Foundation for all

switchyard towers shall be designed on per IS:4091. Contact between foundation and the soil strata shall be ensured for all conditions and combinations of loading.

Foundation for all towers equipment support structure, equipment, railroad and poles shall be designed as per the recommendations of IS : 4091. The structural design of the foundation shall be done as per limit state method of design as given in IS:456

The structural design of the foundation shall be done as per limit state method of design as given in IS:456 and considering the following partial safety factors on working load:

- Normal and broken wire condition 1.5
- Broken wire condition with short circuit forces 1.2

The stability of the foundations shall be checked against overturning, bearing on soil, uplifting, sliding etc. For checking the stability the following factor of safety shall be used:

- Normal and broken wire condition 2.2
- Broken wire condition with short circuit forces 1.65

Normally, all the four legs of tower / gantry structures column / equipment supporting structures shall be supported on a common foundation until and unless the leg spacing of structures at foundation level and soil conditions permit isolated foundation under each leg of the structure.

The pedestal provided for the towers shall be designed for combined action of axial forces viz. compression and tension and bending moments due to horizontal shears in both the longitudinal and transverse directions.

The centroidalP axis of the tower leg shall coincide with the axis of the pedestal. The design of the foundation shall take into consideration the additional forces resulting from eccentricity introduced due to any reason.

The bottom raft / pad shall be designed both for bearing pressure as well as dead load of foundation and over weight of earth. The actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections.

The presence of surface / sub soil water shall be considered in the design of all foundations and underground faculties.

5.10.4.7 TRENCHES / PAVING / FENCING

Trenches

Cable trenches with suitable drainage arrangement with pre-cast RCC covers of removable type, sump pits, oil drainage piping, oil pits, cable tray supports, grounding, etc., shall be constructed in switchyard and transformer areas.

Trenches shall all be of RCC construction. Trench wall shall project 150 mm above the paved / graded level to prevent ingress of storm / rain water.

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

Paving

The complete area within the fencing shall be provided with a mild slope towards peripheral RCC drains which in turn shall be connected to the plant drainage system.

Entire switchyard area shall be provided with 100 mm thick paving using M15 grade PCC.

Fencing

Fencing (with main gates and wicket gates) around switch yard area shall with PVC coated GI chain link fencing of minimum 8G (excluding PVC coating) of mesh size 75 mm and of height 2400 mm above toe wall with 600 mm high galvanised anticlimbing device with barbed wire (8 rows) such that total fence height of 3 m above toe wall is achieved.

5.10.4.8 GAS INSULATED SWITCHGEAR (GIS) BUILDING and SWITCHYARD CONTROL ROOM

Gas Insulated Switchgear (GIS) Building

General arrangement of Gas Insulated Switchgear (GIS) building shall be as per GIS vendor requirements.

Switchyard Control Room

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

Provision shall be made for integration with Stage – II of the power plant extension.

General

The following facilities shall be provided.

1. Control room (Air-conditioned)
2. Relay panels room (Air-conditioned)
3. Battery room
4. UPS and Battery Chargers Room (Air-conditioned)
5. Data room (Air-conditioned)
6. Communication room (Air-conditioned)
7. LV Switchgear room
8. Engineering Room (Air-conditioned)
9. Tariff metering room (Air-conditioned)
10. Cable spreader room
11. Maintenance engineers room (15metreX5metre) (Air-conditioned)
12. Store cum tool room in ground floor
13. Mini Conference Room (5 metreX5metre) (Air-conditioned)
14. Toilet (Men & Women)
15. Pantry Room
16. Room for HVAC

The required furnitures such as Chairs, Tables, Almirahs shall be provided.

Cladding shall be of brick wall and the same shall be supported on RCC beams and plinth beam such that unsupported length is not more than about 3 m.

Pleasing architecture shall be provided for the building.

All partition walls in the ground floor shall be of single brick wall.

Wall around cable vault shall extend up to the ceiling. Cable vault shall be provided with two flush type sheet steel doors. Wall around stores, AHU and stair case also should extend up to ceiling.

Roof shall be accessible by stair.

Stores and AHU room shall have flush type of sheet steel door. Door in AHU room shall be made air tight. Stair case shall have fire proof, automatically closing glazed aluminium door in the first floor. On the ground floor also similar doors shall be provided. Main entrance shall be aluminium glazed double leaf swing door of adequate size with fixed sheet glass glazing in powder coated aluminium frame work on either side.

Separate rolling shutter entry shall be planned for panel movement with a hatch and lifting arrangement / beam on the first floor.

Entry to the air-conditioned area shall be through air lock lobby with aluminium glazed automatic sliding door of adequate size.

All partitions shall be of powder coated aluminium framing with 6 mm sheet glass up to false ceiling. The external partition separating A/C area and non A/C area, above the glazed partition shall be provided in brickwork. All internal partitions in the A/C area shall extend up to the false ceiling.

All doors in Aluminium glazed partition shall be single leaf glazed aluminium swing door.

Control room on the switch yard side shall have continuous fixed glazing in aluminium frame work above 900 mm high Brick wall. For other rooms, aluminium glazed sliding windows may be provided.

False ceiling with aluminium ceiling system shall be provided in the A/C areas.

Under deck insulation shall be provided above the false ceiling on the ceiling as well as for walls as per HVAC requirements.

Roof shall be laid to slope of 1 in 100 using screed or by sloping the top of slab. Heavy duty waterproofing shall be provided as per specification.

In the first floor, stair case shall be given brick enclosure. At least two doors shall be given from the control room to move out during emergency.

Suitably sized porch shall be provided at the main entrance of the control room.

SECTION 5.11

EARTHWORK AND ROCKWORK

TABLE OF CONTENTS

EARTHWORK AND ROCKWORK

5.11.1 GENERAL

This section applies to all earth and rock work required for the construction of buildings, any types of structure and burying service lines in the ground. The contractor shall satisfy himself as to the ground conditions on the site including the nature of the strata to be excavated, obstructions, possibilities of flooding and such like and shall allow for all provisions necessary to carry out the work in the most suitable manner when submitting his tender.

Generally, all buildings and structures must be founded on bearing strata which means that all excavation work for foundations shall meet the requirements of structural analysis based on the results obtained from the soil investigation and of the available information and instruction given in writing by the Owner.

Furthermore, this division applies to excavation works in connection with pavement, roadwork and landscaping as far as earth and rockwork is concerned and deals with the handling and disposal of the materials to be re-used or taken to soil dumps on or off site.

Excavation shall be done to the required dimensions and shall be finished according to the specified lines and slops, in a way acceptable to the Owner. All necessary precautions shall be taken to cause the minimum possible alteration or disturbance to the material lying under and adjacent to the excavation final lines.

5.11.2 STANDARDS

Unless otherwise specified herein, the following standards shall apply to the works covered here under.

IS:1498 Classification and identification of soils for general engineering purpose.
IS:2720 Method of test for soils (All Parts).
IS:3764 Excavation works – Code of safety.

IS:4081 Safety code for blasting and related drilling operations
IS:7293 Safety code for working with construction machinery.
IS:9759 Guideline for de-watering during construction.
IS:10379 Code of practice for field control of moisture and compaction of soils for embankment and subgrade.

5.11.3 FILL MATERIALS

The fill materials used and source are to be examined and approved. Excavated materials can be used if they fulfill the requirements.

Select fill:

Select fill shall have the following properties:

- Well graded (uniformity index not less than 5), non-cohesive and nearly silt free (silt content not greater than 5%; up to 10% tolerated, except below footings of structures), salt free (content less than 3%), soils free of organic matter (limit 2%).
- Decomposing or compressible materials shall not be used.

All materials shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time. It shall be free of highly plastic clays, of all materials subject to decay, decomposition or dissolution, and of cinders or other materials which will corrode

piping or other metal.

The intention is to use select fill below plinth, floors, roads, parking areas etc.

Ordinary fill:

Ordinary fill shall have the following properties:

i) Natural inorganic soils: salt content not greater than 5%, organic matter less than 3%. For other properties see under 'Select fill'.
ii) The intention is to use ordinary fill for non-built areas.

Special fill:

Special fill material shall be gravel or crushed rock (for other properties see under 'Select fill'). The intention is to use special fill e.g. as sub-base material for tanks and roads.

Rip-rap / Rockfill

Rip-rap must be of a size suitable for the place where it is to be used, as determined by the speed of the current, wave height and depth of water. Rip-rap shall be of deformable and yielding construction, using round stones if the intention is to safeguard the underlying ground against scour. If the rock infill is to be used as a foundation for structural components, the aim should be to secure effective bedding of angular stones under water. The stones must be weather and waterproof.

5.11.4 EXCAVATION

The works shall be excavated either by hand or by use of excavating plant and tools acceptable to the Owner. Excavation by hand may be required close to existing installations and/or underground services, but subject to special instruction of the Owner. The contractor shall carry out all kind of earth and rockwork for the following particular works as defined hereafter (where applicable):-

i) Clearing and grubbing
ii) Excavation of top soil
iii) Open cut excavation
iv) Backfilling
v) Safety precaution during earthwork
vi) Mining or underground excavation (if required)
vii) Grading
viii) Replacement of material
ix) Trench excavation for service lines
x) Embankments
xi) Archaeological findings

The excavation for the foundations can be done by machines, if the underground is not disturbed by this procedure. In every case, the last 20 cm above the foundation level are to be excavated by hand.

5.11.4.1 Safety precaution

The contractor shall be responsible for all necessary safety measures.Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides etc shall be to the Contractor's debit. The additional moving of soil resulting from such damages will not be paid for.

5.11.4.2 Over excavation

If somewhere, and for any reason, excavation are executed beyond the established design level, the contractor shall at his own expenses backfill with lean concrete to Owner's approval, the volume corresponding to over-excavation. Contractor shall not receive payment for over-excavation not ordered.

5.11.4.3 Pitwall Stability

The excavated pit sides, walls or slopes have to be stable and established with respect to safety regulations:

IS:1200 (Part 1) Method of measurement of building and engineering work
IS:3764 Safety code for excavation work

5.11.5 STOCKPILES AND DISPOSAL

Excavated material from the works selected by the Owner for re-use shall be placed immediately in its final position, if possible, or otherwise may be stockpiled or deposited on site as directed by the Owner.

The contractor shall not have the right either to additional payment or to claim because of work involved in stockpiling materials, re-use of for carting to the waste disposal areas. Soil unfit for re-use shall be removed to sites approved by the Purchaser and shall not be permanently deposited elsewhere. The contractor shall trim and form the edges of spoil to profiles and levels as directed by the Owner.

The placing of materials within the waste disposal areas shall be made in layers not exceeding 0.50 m in thickness in order to obtain an appreciable degree of compaction by means of transportation equipment and/or if required by appropriate compaction equipment.

All traffic to or from the waste disposal areas shall run over the surface of such areas in order to achieve compaction.

5.11.6 PREPARATION OF FOUNDATIONS

All rock surfaces on which or against which concrete is to be poured shall be carefully cleaned and roughened to the Owner's satisfaction. The rock surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material. Rock faults, depressions and fractures shall be cleaned to a depth equal to their widths and to sound rock at both sides. Immediately before concrete placing, all rock surfaces shall be thoroughly cleaned by means of air and water jets, wire brushes, sand jets or by any other devices necessary to clean the foundation and keep it free of water, but shall be moistened prior to placing concrete.

All earth surfaces against which concrete is to be poured, shall be clean and free of any detrimental impurities, organic matter or unsuitable material. Immediately after excavation, all such surfaces shall be moistened and treated as directed by the Owner and then protected by means of a lean concrete layer. No concrete is to be poured until formation is inspected and approved by the Owner.

5.11.7 BACKFILLING

Foundations and structures shall be backfilled as shown on the drawings with approved material compacted in layers not exceeding 250 mm by suitable equipment until optimum stability has been obtained to the satisfaction of the Owner. Compacting shall be carried out with special care by means of pneumatic or mechanical rollers or other compactors of a type previously approved by the Owner.

Density requirements as per standard Proctor Test shall be in accordance with relevant parts of IS:2720 and all tests shall be made by/on under the supervision of Purchaser at contractor's own expenses, at optimum moisture content:-

a) Backfilling of foundations and under grade slabs - 98%
b) Under roadways and parking areas - 95%
c) Embankment - 95%

The thickness of fill layers, number of passes and type of equipment to be used shall be proposed to the Owner after compaction tests have been made. Surfaces receiving fill layers shall, if smooth, be previously scarified to obtain a good key between the new fill layer and the sub-grade. Backfilling of foundation work with approved materials shall be carried out only after foundations have been inspected by the Owner.

5.11.8 SOIL REPLACEMENT

The material to be used for replacement of soil shall not contain soluble or swelling components such as clays, or organic matters. Sand gravel mixtures of favourable grain size distribution shall be used in exchange.

Prior to the commencement of work, three samples shall be taken from the anticipated borrow area and tested in respect of IS:2720 or Proctor density, optimum moisture content, grain size distribution and content of soluble matters. These three samples shall cover the approximate variation of materials to be expected within the borrow area.

The fill material shall be placed in horizontal layers of not more than 250 mm in compacted thickness. The fill moisture content shall be controlled and adjusted in order to achieve a maximum of compaction. Fresh water shall be used for watering of soils.

The fill material shall be compacted by vibratory roller (min. weight 20T.). The minimum required degree of compaction shall be as defined under "Tests and Properties". One Proctor and three density tests shall be made at every fourth fill layer prior to continuation of filling work. The testing location will be indicated by the Owner. The contractor shall either provide all required laboratory facilities and staff to perform the tests or he shall co-operate with an experienced soil testing laboratory, subject to the approval of the Owner.

The results of the tests shall be made available to the Owner within 24 hours of the tests. Filling work may be continued in case all tests performed show satisfactory results.

5.11.9 PIPE BED PREPARATION

Pipe beds shall be constructed to guarantee the uniform transmission of loads. The bearing section for supported profiles shall cover at least an arc of 90°. Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template supported at the desired grade, to fit the lower part of the pipe exterior.

Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than one quarter of outside pipe diameter with a minimum allowable thickness of 200 mm if not otherwise specified.

Where a firm foundation is not possible at the grade established due to soft, spongy or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected materials as approved by the Owner, properly compacted to provide adequate support for the pipe.

5.11.10 BLASTING

The contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosives as per Explosives Rules 1940, corrected up-to-date.

Explosives used for blasting shall be stored in clean, dry, well ventilated magazines to be built for the purpose. Fuses and detonators shall be stored in separate magazines. Detonators and explosives shall be transported separately to the blast site. Explosive shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Only the quantity of explosive required for a particular amount of firing to be done shall be brought to the site of work. All surplus explosives left after filling the holes shall be removed at least 400 metres from the firing point.

A wooden tamping rod shall be used to push the cartridge into the shot hole. Metal rod or hammer shall not be permitted on the site of the works. The charges shall be pressed firmly into place and not rammed or pounded. The explosive shall be fired by means of an electric detonator placed inside the cartridge and connected to the firing cable. 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 and to keep the lead wires short circuited until ready to fire.

Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling. The locations and depths of the holes shall be chosen so that the bed rock below the design level is not shattered and voids, fissures and cracks below this level are not formed. The rock pieces so blasted shall be neatly stacked at allotted places. 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 300 metres radius from the firing point, or as required by statutory regulations at least 45 minutes before the firing time by sounding a warning siren.

The area shall be encircled by red flags. All the operations shall be carried out by competent and experienced licensed supervisors. The number of shots fired at a time shall not exceed the permissible limits. Cases of the misfired unexploded charges shall be exploded by drilling a fresh hole alongside the misfired hole (but not nearer than 600 mm from it and by exploding a new charge. The workmen shall not return to the site of firing until at least half an hour after firing. When blasting is conducted in the neighborhood of roads, structures, buildings or any place which requires controlled blasting, only shallow shot holes shall be drilled. These holes shall be filled with a light charge of explosive and the blast controlled by placing steel plates with gunny bags filled with sand or earth over the holes and covering them with wire net fixed to the ground, so as to ensure that the blasted materials do not scatter.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc., shall be taken during blasting operations.

Drilling pattern, charge of explosive for blasting and controlled blasting may be obtained by engaging Government authorized explosive consultant.

5.11.11 DUST CONTROL

The contractor shall use all means necessary to control dust on roads, construction areas and borrow pits. Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

5.11.12 DEWATERING DURING CONSTRUCTION

Prior to the decision for the method and technique to be applied, a comprehensive knowledge of the soil and ground water conditions have to be obtained from the results of the soil investigation

and/or information given in writing by the Owner. All costs for ground water control for keeping the construction pits dry shall be included in the relevant excavation items of the lump sum except otherwise indicated.

The method and technique shall be based on the IS:3764.

The scope of supply includes the installation of all equipment, plants, pipes, machinery, etc and its removal after completion including operation & maintenance of the equipment during the construction period.

Where ever necessary, cofferdams, sheet piles, pump sumps, equipment and channels, troughs, inlet gutters, pipes and any other works required for the water control and discharge shall be part of the scope of supply. The dewatering system shall be designed and installed in such a way that alteration and extensions can be made at any time throughout the operating time, if necessary. Reserve units shall be kept ready for service when failure of any of the installed units occurs. The contractor has to consider the possibility of a temporary failure of any pump, diesel engine and/or the electric power service and shall install emergency power units with sufficient capacity to feed the necessary power to the installed unit at the moment of failure. The contractor shall submit to the Owner, the detailed method of the envisaged pumping system for dewatering, the pump capacity and the standby reserve units. The contractor shall adjust the system if required by the Owner.

The contractor must ensure that any dewatering works will not cause any interference to his own work and to those of other contractors working elsewhere on site or at structures under construction. Any damage occurring during the above mentioned period shall then be made good by the contractor at his own expense.

During the foundation works, the excavated areas, foundation levels, and pits are to be kept free of water down to at least 0.50 m below the foundation level.

All equipment, instruments, machineries, tools, pipelines, etc required for execution of the water control shall be in good repair and shall be kept in good working condition throughout the operation period.

5.11.13 FOUNDATIONS

This clause describes all foundation works which are to be performed so as to ensure the bearing of all loads without detriment for and damage to the structures. The contractor has to choose up-to-date methods and equipment to ensure this in accordance with relevant internationally recognized standards.

The soil conditions met during the foundation works especially in the foundation level are to be checked, recorded and compared with previous known or investigated results. If essential differences occur, which could be detrimental to the structures, the contractor has to inform the Owner and to propose further measures. Foundation works in such areas are to be continued only after approval of such measures by the Owner.

If there is any doubt about the soil quality or if discrepancies appear with regard to the previous decisions or investigations stated by the Owner, then additional measures are to be taken after consulting the Owner (e.g. additional excavation and lean concrete fill).

Immediately prior to concreting any footing, the contractor has to verify the specified soil conditions below the foundation level by a sounding.

For soil improvement works i.e. execution of special foundations (except replacement method) only specialised contractors (or sub-contractors) are acceptable subject to providing proof of experience in successful execution of such works in the form of a detailed description and

references. Together with the description and the references a detailed execution programme including quality control measures relating to the actual site conditions is to be transferred to the Owner for approval.

PAINTING SPECIFICATION FOR CIVIL BUILDINGS – COASTAL

S.No.	Location	Description
1	Metal and Timber Joinery	Two component high build, self priming, rust encapsulating, modified epoxy coating. Min VS 80%.
2	All Ceiling	Oil bound distemper (Office rooms) White Washing - all areas.
3	Internal wall surfaces	Oil Bound distemper
4	Control room/office	Acrylic Emulsion.
5	External faces of walls	Cement based Water proof paint
6	Walls of battery room and other acid/alkali spillage areas	1. Primer -1 coat of 50 microns - Two pack Polyamide Epoxy Primer with Zinc phosphate Pigment for concrete application. Min VS 48%. 2. Top coat - 1 coat of 125 microns - Two component self priming, high build polyamine adduct cured epoxy coating having excellent chemical resistance. Min VS 60%.
7	Cooling Tower External	
	a. Steel sections	i) Blasting to SA 2.5 ii) 1 x 75 microns - Inorganic Zinc Silicate as per SSPC Paint 20 Level 2. iii) 1 x 150 microns –Two components high build epoxy intermediate pigmented with lamellar micaceous iron oxide. Min VS 65%. iv) 1 x 75 microns - Two component high solids, Glossy, Acrylic Aliphatic Polyurethane paint, Min VS of 57%, Gloss retention of 90% after exposure to 2000 hrs under QUV B 313 lamp
	b. Concrete sections	1. 1 x 50 microns - Epoxy Polyamide Primer 2. 1x 500 microns-Two components high build high solid, engineered epoxy coating. Min VS 87%. - Typical dft - 500 microns per coat. Condensation as per IS 101 - 9000 hrs, Salt spray as per ASTM G 85 - 8000 hrs.
8	Chimney external	i) 1 x 50 microns Concrete Epoxy Polyamide primer followed by ii) 2 Coats of 50 microns of Acrylic Aliphatic Polyurethane paint

3.5.0 Miscellaneous

1. No. diesel bunk with tank of capacity 12 KL and metered filling facility to be provided near stores and all the approval and license to be arranged by the contractor.

Udangudi 2 X 660 MW Super Critical Power Project

Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
	Tender Volume / Section	Clause No.	Page No.			
Pre Bid Reply						
1.	Vol. - II Section 2.0, Sub Sec 2.3 (Condenser system)	ANNEX 2.3.1	11 of 12	Temperature rise of cooling water in condenser at TMCR condition (°C) : Not exceeding 8.5	Temperature rise across condenser and Design temperature range for cooling tower are different. Kindly clarify.	There is no contradiction in the specification. Bidder to follow specification.
	Vol. - II Section 2.0 Sub Sec 2.13 (PI system)	ANNEX 2.13.1	18 of 21	Design temperature range (°C) : 10		
2.	Vol. - II Section 2.0 Sub Sec 2.3 (Condenser system)	ANNEX 2.3.1	11 of 12	**Maximum** cooling water inlet temperature (°C) : 33	Cooling water inlet temperature for condenser is specified as 33°C (Maximum) whereas cold water temperature for cooling tower is fixed to 33°C. please clarify if condenser cold water inlet temperature can be optimized for temperature lower than 33 °C.	Bidder to follow specification.
	Vol. - II Section 2.0 Sub Sec 2.13 (PI system)	ANNEX 2.13.1	18 of 21	Cold water outlet temperature (°C) : 33		
3.	SEC-2.15 / VOL-II	1 of 33	2.0.0	Nitrogen Injection based FPS	Nitrogen injection based fire protection system is not considered in transformer area as HVWS system will be provided for the same. Please confirm.	Bidder to follow specification.
4.	SEC-2.15 / VOL-II	2 of 33	2.0.0			
5.	SEC-2.15 / VOL-II	7 of 33	3.0.0	Automatic clean Agent Fire Suppression System	Automatic clean Agent Fire Suppression System is considered for Central Control Room, Control Equipment Room, Computer Room, and UPS Room only. Please confirm.	Bidder to follow specification.
6.	SEC-2.15 / VOL-II	3 of 33	3.0.0	Comprehensive pump house	Customer to confirm, if a separate dedicated FWPH is to be considered.	The fire water pumps shall be located in Desalinated water cum fire water storage tank pump house. The pump house consists of three compartments (One dedicated for fire

Pre Bid Reply

Sl. No.	Enquiry Specification: Tender Volume / Section	Clause No.	Page No.	As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
						water storage-capacity as per TAC – Refer Vol-II, Sec-2, 2.14, pg 25 of 34)
7.	SEC-2.15 / VOL-II	9 of 33	3.0.0	Booster Pump house	Booster pump house shall be located near the Boilers. Please confirm.	Noted. However this will be reviewed during detailed Engineering
8.	SEC-2.15 / VOL-II	10 of 33	3.0.0	FDA – MFAP	suitable redundancy shall be provided in the panel & in case of failure of main processor, the panel shall work in degrade mode of operation. Please confirm.	Redundancy shall be provided in the panel and in case of failure, the backup processor shall take over the operation in bump less mode.
9.	Vol-II Sec. 5	13/13	5.7.5.1	Coal Stock Pile area shall be paved as described below. a) The under bed shall consist of well compacted WBM or Dry Lean Concrete of 100mm thickness designed as per MOST / MORTH standards. b) Followed by a layer of PCC 1:4:8, 50 mm thick. c) Top layer of 150 mm thick RCC paving, laid to a slope of 1 in 100 towards the peripheral drains, with minimum 8mm dia reinforcement at 200 mm c/c both ways in top and bottom d) 300 mm coal dust shall be provided on top of the RCC slab as a cushion. Owner will provide the coal dust.	We propose no paving in coal stock yard. The entire area is graded and compacted as per NTPC practice. If paving to be provided as per specification, we request customer to arrange coal dust.	Paving is to be provided as per specification. Clause 5.7.5.1.(d) already mentions "Owner will provide the coal dust."

Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
	Tender Volume / Section	Clause No.	Page No.			
Pre Bid Reply						
10.	Vol-II Sec. 5	19/38	5.2.14.4	Covered shed (with metal sheeting) for the stock pile shall be provided for area as per Mechanical specification	As the covered shed is not generally provided for the storage area hence we request customer to review the requirement for covered shed in coal stock pile.	Bidder to follow specification.
11.	Vol-II Sec. 5	20/38	5.2.14.7	The tunnel shall be provided with RCC Ventilation duct.	We propose GI ventilation duct as specified in mechanical specification. Please confirm.	GI ventilation ducts shall be provided inside the RCC tunnel a per Vol-II Section-2 Sub section 2.10.9
12.	Vol-II Sec. 5	20/38	5.2.14.6	For Reclaim hopper sloping surfaces 5 mm thick stainless liner of grade SS 409M shall be provided	We propose 50 mm thick guneting. Please confirm the acceptance.	Bidder to follow specification.
13.	Vol-II Sec. 5	2/6'	5.10.3.2	Up stream slope of the bund shall be protected by HDPE sheet with brick lining, …Floor of the pond shall be generally levelled and shall be made impermeable by providing HDPE liner with earth protection above	Please review the requirement of HDPE liner. We propose LDPE liner. Please confirm.	Bidder to follow specification.
14.	Coal flow diagram 00-1115112-M-007,R-0 Notes	6	-	The scope of contractor in JNT-1 as BCN 1A/B,CSU,SW,PW,DFDS…..	Please clarify that vibrating feeder and the discharge chute below surge hopper shall be in Port 's scope or in Internal CHP's scope.	Please refer to the Coal flow diagram 00-1112140-M-007,R0, the scope demarcation is already indicated below the surge hopper. Please refer clause no. 10a volume II sec1 page 15 of 164, surge hopper shall be provided with flanged connection. Scope starts from the surge hopper flange connection.

Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
	Tender Volume / Section	Clause No.	Page No.			
Pre Bid Reply						
						From the above two clarification, It is clear that the vibrating feeder and the discharge chute below surge hopper are in contractor's scope.
15.	Vol.II	2.0	4.0.0 (12)	4/15	Covered shed for 270m shall be provided for two stockpiles. Stacker cum, reclaimer shall move inside the covered shed. Accordingly shed height shall be constructed. Width of the shed shall be constructed considering the dozer movements.	Customer is requested to furnish the width and height of coal shed to be considered to make all bidders at par. In absence of this different bidder will consider different data.	The functional requirements for shed is based on the stock piles and Stacker cum Reclaimer height. Hence bidder shall arrive the width & height accordingly.
16.	Vol.II And Coal flow diagram 00-1115112-M-07,R0	2.0/2.10.14	7.0	1/1	5 Nos. of ERH with 20 MT storage capacity…..	We propose 2 Nos. of ERH with 50 MT storage capacity and below each ERH there shall be one vibro feeder of 500 TPH capacity. Please confirm your acceptance.	Bidder to follow specification.
17.	Vol.II	2.0	2.10.2.1(2.0)	2/2	Crusher capacity rated/design:1815/2000	As per standard engineering practice and followed for many projects we request customer to accept the rated/design capacity as 1650/1815 TPH. With the rated capacity of 1650 TPH of crusher, it will have 10 % margin over the downstream conveyor which is sufficient.	Bidder to follow specification.

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18.	Vol.II	2.0	2.10.3.1(2.0)	2/2	Screen capacity rated/design:1815/2000	As per standard engineering practice and followed for many projects we request customer to accept the rated/design capacity as 1650/1815 TPH. With the rated capacity of 1650 TPH of screen, it will have 10 % margin over the downstream conveyor which is sufficient.	Bidder to follow specification.
19.	Vol.II	2.0/2.10.13	1.0.0	1/3	Flap gates of non-jamming type with curved blade design with electric actuator (and provision for manual operation…….	As per standard engineering practice followed for many projects, we propose motorized flap gates with flat surface design. In case of curved blade design flap gates provenness and guarantee of the equipment is not there. And also customer is requested to furnish the list of vendors who is manufacturing this kind of flap gates. Please confirm for acceptance of flat motorized flap gate.	Specification calls for curved or straight blade design and follow tender specification
20.	Coal flow diagram 00-1115112-M-007,R0	-	-	-	JNT-1	Customer is requested to furnish the floor details in JNT-1 to know about the elevation details for BCN 1A/B etc.	This shall be furnished during detailed engineering.
21.	Coal flow diagram 00-1115112-M-007,R-0	-	-	-	JNT-4 –future provision	Customer is requested to furnish the no. of floors to be considered for future provision for estimating the size of JNT-4. We are not considering any equipment for future provision.	Refer Vol. - I, Section 1.0 Page 17 of 191

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22.	Coal flow diagram 00-1115112-M-007,R-0	-	-	-	JNT-7 –future provision	Customer is requested to furnish the no. of floors to be considered for future provision for estimating the size of JNT-7. We are not considering any equipment for future provision.	Refer Vol. - I, Section 1.0 Page 16 of 191
23.	Vol.II Coal flow diagram 00-1115112-M-007,R-0	2.0	3.0.0	3/15	Bypass chute will be provided to bypass screen and crusher.	Coal flow diagram 00-1115112-M-007,R-0 does not show any provision of bypass chute to bypass screen and crusher. Please clarify the contradiction. We feel that bypass chute is not required as (-) 25 mm coal cannot be assured from jetty for bypassing to the bunker.	Bidder to follow specification.
24.	Vol.II	2.0	4.0.0(10)	4/15	Rated system capacity of all the system shall be 3000 TPH and design capacity shall be margin of 10%.	Since the future provision is envisaged in JNT-7 for coal feeding to the stage-II(2X660 MW) so we propose to consider coal handling system of 1500 TPH(Rated) and 1650 TPH(Designed) from JNT-7 up to the coal bunker. And with the worst coal consumption at 100 % BMCR, CHP is working only for 12 hours. In the present situation, CHP is rated/designed for 3000/3300 TPH up to the coal bunker and in this case considering worst coal consumption at 100% BMCR, CHP will be working only for 5.7 hours in a day for 2X660 MW units. Customer is requested to review the CHP capacity beyond JNT-7 which will reduce the capital cost of the plant.	Bidder to follow specification.

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25.	Vol. II	2.0	5.4.0	5/15	Independent handling facilities shall be provided for each crusher.	Since 4 Nos. of crushers are envisaged in crusher house for this project then please clarify whether 4 Nos. of electric hoist will be required for handling these crushers or 2 nos. of Electric hoist shall be provided in such a way that each will handle 2 crushers.	Bidder to follow specification.
26.	Vol. II	2.0	6.3.3.14	12/15	Reversible stacker/Reclaimer	Please clarify the requirement of type of stacker cum reclaimer.	Referred clause shall be read as stacker cum reclaimer.
27.	Vol. II	2.0	2.0.0	1/9	The inclination of all conveyors above the ground level shall not exceed 12 degree for crushed coal and uncrushed coal…..	Please review the specification requirement for inclination of all conveyors for crushed and uncrushed coal. Requirement of 12 degrees is very much on lower side. As per CEMA or IS we can go for 16 degree angle of inclination for crushed coal.	Bidder to follow specification.
28.	Vol. II	2.0	1.1.0	1/13	Bottom ash handling system…..	As per tender specification both scrapper chain conveyor and Jet pump system have been asked below BA hopper. As per standard engineering practice followed in many projects either scrapper chain conveyor or jet pump system shall be provided. Having jet pump and scrapper chain conveyor together will result in high water consumption, very high power consumption and the high capital cost. Customer is requested to review the system and confirm for the acceptance of either scrapper chain conveyor or jet pump system. Both the system together below BA hopper will not have any advantage.	Bidder to follow specification.

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29.	Vol. II	2.0	2.4.0 (b)	5/13	No. of slurry pumps in series shall be selected based on the total disposal distance.	Please furnish the maximum disposal distance and static head to be considered for sizing and deciding the no. of FA slurry pumps.	Bidder to refer the plot plan (Drg. No.: 00-1115112-G-001) for distance & accordingly design the pump head. For static head: Refer Vol II sec 1.0 page 21 of 191 clause 2.5.0 wherein " For ash pond, the required area of the land will be about 120 acres considering the bund height of 25m for both fly and bottom ash above finished ground level".
30.	Vol. II	2.0	2.1.0	3/13	adequately sized sloping pipe (for transporting slurry by gravity) duly assisted by jets (nozzles) placed at strategic locations for easy slurry flow.	Eco ash slurry shall be conveyed to BA hopper through sloped pipe. Jetting nozzles are not required. Please confirm	Bidder to follow specification.
31.	Vol. II	2.0	2.5.0 Ash water recovery diagram ...Drg no. 00-1115112-M-018-R0	5/13	BA overflow and recovery water from ash pond to clariflocculator.....	As per drawing and tender specification BA overflow is to be disposed all the way from BA hopper area of both the units to clariflocculator at ash pond (Approx 1.5 km) .We request customer to relocate clariflocculator near ash water pump house. It will save BA overflow pipe, reduction in BA overflow pump head and drive rating, clear water pump requirement (As clear water from clariflocculator can be discharged by gravity to ash water tank). Please confirm your acceptance for the above. It will save cost and power	Bidder to follow specification.

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					consumption.	
32.	Vol. II	2.0	3.1.0	6/13	stack hoppers	Ash handling system for stack hoppers shall be provided only if Bidder is offering stack hoppers in the chimney. Incase stack hoppers are not offered then ash handling system below stack hoppers shall also be not applicable. Please confirm your acceptance.	Bidder to follow the specification. However this may be decided during detailed engineering.
33.	Vol. II	2.0	3.8.0 (s)	10/13	Ash disposal lines from ash slurry Pump House up to the entry into the ash pond shall be routed on pipe rack. concrete pedestals are provided only in the area as mentioned in plot plan.	We understand from the plot plan that ash slurry pipes shall be laid on concrete pipe pedestals from coordinate 222 E /138 N to the ash pond and above the ash pond. Please confirm. Also Please clarify whether all sides of ash pond shall be garlanded with all 5 streams of ash slurry pipes or at Y junction at the toe of ash pond (895 S / 222 E) two pipes shall be carried on one side and three pipes shall be laid on the other side of ash pond. Please clarify the actual requirement of garlanding as it is having huge price implication.	Confirmed as per plot plan. Also note that wherever road crossing exists, pipes shall be routed through culvert. Bidder to follow the specification.
34.	Vol. II	2.0	2.6.7	6/13	All vacuum pump shall be located near the first field of ESP in proper building, necessary handling arrangement to be provided.	Vacuum pump house near the 1st field of ESP hopper is subject to the space availability as there will be buffer hopper tower. So alternatively 1W+1S vacuum pump shall be provided in front of every ESP pass and only shed over the vacuum pumps shall be provided. This is followed for all NTPC projects. Please confirm your acceptance.	Shed is not acceptable. All vacuum pump shall be located near the first field of ESP in proper building, necessary Handling arrangement to be provided as per bidder referred clause. Bidder to follow

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						specification
35.	Vol. II	2.0	3.6.0	8/13	Ash water tank capacity:1 hour	As per standard practice followed for so many projects ash water tank storage capacity shall be ½ hour. Please confirm your acceptance.	Bidder to follow specification.
36.	Vol. II	2.0	3.1.0	6/13	Capacity for various equipment like Clinker grinder, jet pump, scrapper chain conveyor, FA and BA conveying stream capacities ...	Customer is requested to consider sizing of AHP equipment like Clinker grinder, jet pump, scrapper chain conveyor, FA and BA conveying stream capacities and other equipment considering the evacuation criteria given in the tender specification for ash collection data furnished. Please confirm.	Bidder to follow specification.
37.	Vol.II	2.0	2.5.0	5/13	Ash water Recovery system	Recovery system capacity shall be considered based on BA slurry disposal system unit only. FA slurrification shall not be considered for this calculation as it is only an emergency operation. Please confirm.	Bidder to follow specification.
38.	Vol.II	2.0	Sub section 2.11.13	1 /2, 2/2	Fly ash branch segregation valves and fly ash feed valves.....	Material of construction of fly ash feed valve, fly ash intake/material handling valve and fly ash branch segregating valve for vacuum and pressure system as well as interconnection valves at silo top/fly ash pressure transportation lines, will be the same as supplied in North Chennai project of TNEB. The MOC of valve body and dome shall be as follows: Body : CI (180-210 BHN) Dome : CI (220 BHN)	Bidder to follow specification.
39.	Vol.II	2.0	2.3.0	4/13	FA slurrification	We assume that there shall be 1 working and 1 standby jet pump below each FA silo and 50 % of FA shall be considered for slurrification. Please confirm.	Refer Vol II sec 2.0 Sub section 2.11.0 clause 3.0.0 wherein "fly ash generation for each unit

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					Or Please specify the percentage/tonnage of FA to be Slurrified from the FA Silos in emergency condition.	is mentioned in terms of percentage. Operating time of Fly ash silo to ash slurry pump and ash slurry sump to ash pond (4W+4S)- 8h in a shift i.e. continuous basis. FA jet pump and FA slurry pump shall be designed accordingly.
40.	Vol.II	2.0	Sub section 2.11.4	1/2	Specified linear chain speed of the SCC…	Please review the specified linear chain speed of the SCC. A speed of 0.3-0.8m/min seems very much on the lower side.	Noted. This will be reviewed during detailed engineering stage. However bidder to limit the speed within 1.5m/min.
41.	Vol.II	2.0	-	-	Static lift	Please furnish the static lift for Ash pond needs to be considered for Ash slurry pump head calculation.	For static head: Refer Vol II sec 1.0 page 21 of 191 clause 2.5.0 wherein " For ash pond, the required area of the land will be about 120 acres considering the bund height of 25m for both fly and bottom ash above finished ground level".
42.	Vol.II	2.0	Sub section 2.11.7,clause 2.0.0 Ash	1/5	Ash slurry pumps for bottom ash and fly ash slurry….	As per flow diagram each series of ash slurry pump shows 2 no. of ash slurry pumps.2nd stage of pump is shown in dotted so assumed as future provision. Please clarify. As per clause 2.0.0 each set shall comprise of 2 ash slurry pumps having a	Number of pump in each series shall be minimum 2 having a provision of 1 more additional pump in future as per clause 2.0.0. along with related

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		disposal system, Drg no. 00-1115112-M-010-R0			provision of 1 more additional pump in future. Please clarify the requirement of no. of stages of ash slurry pumps for fly ash as well as bottom ash.	provision in switch gear
43.		Bottom Ash handling system ,Drg no. 00-1115112-M-008-R0		2w+2S scrapper chain conveyor for each unit….	2W+2S scrapper chain conveyor below boiler for each unit will be difficult .As per standard practice and also in line with 2X660 MW Ennore SEZ we want to propose 1W+1S scrapper chain conveyor for each unit. Accordingly, no. of clinker grinder and jet pumps shall be provided. Please confirm.	Bidder to follow specification.
44.	Vol.II 2.0	Sub section 2.11.0	3/13	One lot of water piping…..	Please furnish if any coating requirement is there for sea water application. Tender specification does not say anything regarding coating for water pipes.	Refer piping specification Section 2.20
45.	Clause 3.1.0, Vol. II, Section 2, Page : 3 of 22, 2.5 Power Cycle Pumps & Accessories			Each boiler feed water pump drive turbine shall include: i) Complete lube oil and control oil system.	Customer to kindly clarify whether combined lube oil system can be used for both the BFP drive turbines of one unit of 660 MW. This will give substantial space utilization.	Bidder to follow specification.
46.	II / 1	11.5.2	67 of 191	Altitude - Finished Ground Level (FGL) refer clause 6.0.0	Altitude of FGL is considered as 6.0m above Mean Sea Level. Please confirm.	FGL = RL 3.300 MSL = RL 0.000
47.	II / 1	6.1.2	30 of 191	Finished grade level (FGL) shall be RL (+) 3.300 m above MSL.		
48.	II / 1	Annex 1.1	123 of 191	**Coal Parameters:** The steam generator shall be designed for the following conditions: Best Coal – 100% Imported Coal Design Coal – 70% Imported & 30%	In tender wide range of coal is specified (Best coal HHV of 5700 kcal/kg to Worst Coal HHV of 4350 kcal/kg). The optimum Steam generator design and performance will be achieved for the limited range of	The best coal, worst coal and design coal shall be as per specification and the design of boiler &

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				Domestic Coal Worst Coal - 50% Imported & 50% Domestic Coal	coal specification. Hence kindly review and confirm the range of coal analysis furnished in tender. Coal analysis as specified in tender is arrived based on the assumption of homogeneous blending**. Kindly confirm**.	auxiliaries shall be suitable for the same. The blended coal analysis shall be considered based on weighted average.
49.	Annex 1.1	II / 1	123 of 191	**IMPORTED COAL**	Variation between specified HHV of Imported coal (5700 kcal/kg) and calculated HHV based on Dulong formula (5952 kcal/kg) is not in acceptable limits. Kindly review and confirm	Bidder to consider the specified HHV.
50.	Annex 2.1.1	II /2 /2.1	55 of 66	**COAL MILLS** Number of Mills (N) corresponding to maximum 90% mill loading. N+1 : 100% BMCR with worst coal N+2 : 100% BMCR with design coal (preferred total Number of Mills 8 (Min))	As per the current industry practice the following criteria shall be followed. Please confirm. N+0 : 100% BMCR with worst coal N+1 : 100% BMCR with design coal (Total number of mills will be based on satisfying the above criteria) Kindly confirm.	Bidder to follow specification.
51.	Annex 2.1.1	II /2 /2.1	54 of 66	**SUPERHEATERS AND REHEATERS** Maximum average flue gas velocity in sections/tube banks with transverse tube pitching 600mm or less and with 25% excess air at economiser outlet, m/s = 10 (The maximum localized velocity across the cross section shall not exceed 12m/s) **ECONOMIZER** Maximum average flue gas velocity through inter-tube space of the economiser banks (the gas velocity shall be calculated considering 25% excess air at economiser inlet)m/s = 8	The specified velocity limits in the specification are normally used in high ash Indian coal design. Considering blended coals for this project, Maximum average flue gas velocity of 12m/s shall be used for SH/RH/ECO considering 20% excess air at economiser outlet. Please confirm.	Bidder to follow specification.

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52.	Annex 2.1.1	II /2 /2.1	56 of 66 58 of 66 58 of 66	**Air-heater air-in-leakage** **PA Fans:** 15% of primary air leakage in RAPH or Guaranteed value whichever is higher **FD Fans:** 10% of secondary air leakage or actual guaranteed value whichever is higher **ID Fans:** 10% combined primary and secondary air leakges into flue gas side of RAPH or actual guaranteed values whichever is higher	In Trisector Airheater system, the air leakage from the secondary side will be very less i.e., not more than 1% of gas entering AH at BMCR. Hence Predicted leakage is sufficient for the FD fan sizing. Kindly confirm In Trisector AH system, FD fan leakage is very less and Primary air leakage is percentage of total gas flow entering AH. Hence 10% leakage or actual whichever is higher will be considered for PA fan & ID fan sizing. Kindly confirm.	Bidder to follow specification.
53.	Annex 2.1.1	II /2 /2.1	53 of 66	**Steam Generator** Reference ambient dry bulb temperature °C = 32 Reference ambient Relative Humidity % = 65	For PA Fan sizing the following are considered in line with Reference ambient conditions for Steam Generator. Ambient dry bulb temperature °C = 32 Ambient Relative Humidity % = 65 Kindly confirm.	For fan sizing Bidder shall consider Reference ambient dry bulb temperature °C = 32 Reference ambient Relative Humidity % = 65
	Annex 2.1.1	II /2 /2.1	56 of 66	**PA Fan:** Ambient Condition - 32 deg C with 67% relative humidity		
54.	Annex 2.1.1	II /2 /2.1	53 of 66	Loss due to Unburnt Carbon (%) Guaranteed unburnt combustible content in fly ash shall not be more than 1.5% by weight. Guaranteed unburnt carbon loss for boiler efficiency shall not be more than 1%	Guaranteed unburnt carbon loss for boiler efficiency shall not be more than 1%. Kindly confirm.	Bidder to follow specification. Bidder to note, as per Cl: 11.11.3.2, Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.). shall be considered.
	11.11.3.2 (g)	II / 2 / GTS	72 of 191	Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.)		
55.	5.3.0	II /2 /2.1	18 of 66	Minimum load with separator dry shall be 25% BMCR.	As per OEM design experience, minimum load with separator dry shall be 35% BMCR. Kindly confirm.	Bidder clarification noted.

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56.	5.5.0 5.20.3	II /2 /2.1	20 of 66 45 of 66	For maintenance and inspection of SH, RH and Economiser. Minimum 1.5 m clear cavity height between two sections / banks of heat transfer surfaces sections of economizer for personnel access. In the steam generator enclosure, minimum 1.5 m clear cavity height shall be provided in between the horizontal banks, sections of economizer, superheater and reheater for maintenance purpose.	As per standard design practice of OEM, minimum 1.0 m clear cavity height shall be maintained. Kindly confirm.	Bidder clarification noted.
57.	5.21.6	II /2 /2.1	49 of 66	At flue gas duct entrance into the chimney, a damper shall be provided to separate the Steam Generator air flue gas side from outside during shutdown.	Since ID Fan Outlet Guillotine Gates are already provided between ID Fans and Chimney, therefore, damper at entrance to Chimney is not required since system is already isolated by ID Fan Outlet Guillotine Gates. Kindly confirm.	Bidder to follow specification.
58.	5.21.6 Page: 49 of 66 Vol.II, Section 2, 2.1 SG & Aux. System			At flue gas duct entrance into the chimney, a damper shall be provided to separate the Steam Generator air flue gas side from outside during shutdown.	Since ID Fan Outlet Guillotine Gates are already provided between ID Fans and Chimney, therefore, damper at entrance to Chimney is not required since system is already isolated by ID Fan Outlet Guillotine Gates. Kindly confirm.	Bidder to follow specification.
59.	Vol II Section-1.0, General Technical Specification	11.7.0	67 of 191	Test Uncertainties The guaranteed performance parameters shall be without any tolerance values and all margins required for instrument	Test results shall be reported as per ASME PTC-6 2004.	Bidder to follow specification.

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				inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.		
60.	Vol II Section-1.0, General Technical Specification	11.11.2.1 (vii)	68 of 191	All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Owner	Calibration in a Laboratory of National /international repute shall also be acceptable, provided that the laboratory is certified for the respective calibration purpose (e.g. acc. to ISO 17025 or NABL) or at Bidder's NABL accredited calibration center.	Bidder to follow specification.
61.	Vol II Section-1.0, General Technical Specification	11.11.2.1 (x)	69 of 191	...Preliminary test reports shall be submitted to the Owner after completing each test run...	We understand that raw data/hard copies of logged data shall be provided to employer after completion of tests at each load point. Kindly confirm.	Bidder to follow specification.
62.	Vol II Section-1.0, General Technical Specification	11.11.2.1 (xi)	69 of 191	In the event of OWNER agreeing to conductance of such tests after three months, **for reasons not attributable to the OWNER, as assessed by the Owner, no factor for ageing shall be considered for computing performance of the equipment.**	Period of Ageing shall be calculated from date of first synchronization. Ageing is a natural phenomenon irrespective of operation of the machine, in line with code. **Hence, this line to be deleted.**	Bidder to follow specification.
		11.11.6(4)	93 of 191	....Period of ageing shall be considered from the date of successful completion of initial operation to the date of conductance of PG test, **In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered.**		Bidder to follow specification.
63.	Vol II Section-1.0, General Technical Specification	11.11.6 (6-i)	93 of 191	Guarantee Turbine Cycle Heat rate test at 693MW (105% rated load) corresponding to the heat balance diagram specified in tender specification	Heat rate guarantee is only at TMCR condition. This is in line with Gross Turbine Cycle Heat Rate guarantee specified under Clause no. 11.11.3.1 section Guarantees Under Category-I of Vol II Section 1.0 of General Technical specification.	Noted.

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64.	Vol II Section-2.0, 2.2 Steam Turbine & Aux. System	3.4.0	5 of 27	60% BMCR HP bypass valve (minimum 1 x 100% or 2 x 50 % Capacity) and corresponding LP bypass steam conditioning valve (capable of handling steam flow to HP bypass valve and spray water used in the HP bypass system) with spray water valves,.....	As per Bidder's understanding, The HP/LP Bypass System shall be designed and sized for 60% BMCR flow at rated steam conditions.	Bidder to follow specification.
	Vol II Section-2.0, 2.2 Steam Turbine & Aux. System	4.1.0	8 of 27	The HP/LP Bypass System shall be designed to handle 60% of BMCR flow and sized for 65% BMCR flow at rated steam conditions.		Bidder to follow specification.
65.	Vol II Section-1.0, General Technical specification	11.11.5.3(10-b)	84 of 191	Total cooling water temperature rise in condenser with design cooling water flow and CW inlet Temperature of 33 Deg.C under.....	As per Bidder's understanding, Maximum cooling water Temperature is 33 Deg.C & Bidder is free to optimize this value based on overall plant optimization.	Bidder to follow specification.
	Vol II Section-1.0, General Technical specification	11.5.2(g)	67 of 191	CW Temperature -33 Deg.C		
	Vol II Section-2.0, 2.3 Condensate System	Annex-2.3.1	11 of 12	Maximum cooling water inlet temperature- 33 Deg.C.		
	Vol II Section-2.0, 2.13 Plant Cooling Water System	Annex-2.13.1	18 of 21	Cold water outlet temperature -33 Deg.C		
66.	Vol II, Section 6.0, Technical Schedules	2.0(1.2.2)	63 of 302	Performance Guaranteed 100% TG MCR heat balance No.: ---------- (Heat balance diagram containing the values for Pressure, Temperature, Flow and Enthalpy at the entry and exit of each equipment shall be enclosed) a) 1.5% make up b) 0% make up	As per Bidder's understanding, HBDs will be generated in line to clause no. 19.2.1 (B) of Vol. II Section 1, General technical Specification for following cases: Heat and Mass balance diagram same for 100% TMCR condition (0% and 1% makeup), VWO condition (0% and 1% makeup), 60% TMCR **(~~constant~~** and sliding pressure operation), All HP heaters out condition, **~~Auxiliary steam condition~~** and house load operation with HP-LP Bypass in operation	Bidder shall furnish the HMBD as per specification requirement. Make-up shall be 1%. For Auxiliary steam condition and house load operation with HP-LP Bypass in operation, Bidder shall submit the HMBD for information
	Vol II, Section 6.0, Technical	2.0(1.2.6)	63 of 302	TG VWO with 1.5% makeup & design condenser back pressure heat balance No. -------- (Heat balance diagram		

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	Schedules			containing the values for Pressure, Temperature, Flow and Enthalpy at the entry and exit of each equipment shall be enclosed)	HBDs for **Auxiliary steam condition** is not clear. TANGEDCO to elaborate.	purpose.
	Vol II, Section 6.0, Technical Schedules	2.0(1.2.3)	63 of 302	Guaranteed 75% TG MCR output heat balance No. ---------- (Heat balance diagram containing the values for Pressure, Temperature, Flow and Enthalpy at the entry and……		
	Vol II, Section 6.0, Technical Schedules	2.0(1.2.4)	63 of 302	50% TG MCR heat balance No. . ---------- (Heat balance diagram containing the values for Pressure, Temperature, Flow and Enthalpy		
67.	NA	NA	**NA**		Power Cycle piping valves : Spares of power cycle piping valves is not indicated in mandatory spares list. Customer to kindly clarify whether the same is required or not? If require may kindly provide the list along with require qty.	Bidder to follow specification. Refer volume –II section-1.0 page 155 of 191.
68.	VOL-II Sec 1.0 General technical specification **Annex-1.4: Mandatory Spares**	HP bypass system (1)	Sheet 130 of 191	Complete set of internals required to form HP by pass valve with servo motor except valve body– **require Quantity=1 Set**	For each 660 MW unit, 2 Nos. of HP Bypass valves are supplied. Set of all internals required to complete one valve and one full actuator without feedback transmitter and without final control elements is offered Customer to kindly confirm.	Bidder to follow specification wherein the complete set of HP bypass valve with feedback transmitter and final control element shall be included.

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69.	VOL-II Sec 1.0 General technical specification **Annex-1.4: Mandatory Spares**	HP bypass system (2)	Sheet 130 of 191	Complete set of internals required to form HP bypass spray control valve with servo motor except valve body– **require Quantity=1 Set**	For each 660 MW unit, 2 Nos. of HP Bypass spray control valves are supplied. Set of all internals required to complete one valve and one full actuator without feedback transmitter and without final control elements is offered. Customer to kindly confirm.	Bidder to follow specification wherein the complete set of HP bypass spray control valve with feedback transmitter and final control element shall be included.
70.	VOL-II Sec 1.0 General technical specification **Annex-1.4: Mandatory Spares**	HP bypass system (3)	Sheet 130 of 191	Complete set of internals required to form HP bypass spray isolation valve with servo motor except valve body. – **require Quantity=1 Set**	Set of all internals required to complete one valve and one full actuator without limit switch assembly and without final control elements is offered. Customer to kindly confirm.	Bidder to follow specification wherein the complete set of HP bypass spray isolation valve with limit switch assembly and final control element shall be included.
71.	VOL-II Sec 1.0 General technical specification **Annex-1.4: Mandatory Spares**	HP bypass system (4)	Sheet 130 of 191	Complete assembly of pump with motor for oil unit– **require Quantity=1 Set**	For each 660 MW unit, 2 Nos. of Pump with motor are used. 1 No. Pump with motor assembly is offered. Customer to kindly confirm.	Bidder to follow specification. Wherein "Complete assembly of pump with motor for oil unit– **require Quantity=1 Set** " shall be provided.
72.	VOL-II Sec 1.0 General technical specification **Annex-1.4: Mandatory Spares**	HP bypass system (5)	Sheet 130 of 191	Accumulator bladder – **require Quantity=2 Nos.**	Two different sizes of accumulators are used in oil unit of HP bypass system. 1 no. bladder for each size is offered. Pl confirm.	Bidder shall supply 2 nos. for each size.

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73.	VOL-II Sec 2.0 Detailed technical specification-mechanical **Sub Section no-2.2: Steam Generator & AUX. System**	5.7.0	Sheet 22 of 27	Each bypass station shall comprises a quick acting stop valve and a pressure control valve on steam line(operated by separate actuator), a desuperheater, a stop valve and a control valve on spray water injection line(operated by separate actuator)	1. Stop valves at the upstream of HP Bypass valve are undesirable as they prevent pre-heating of HP Bypass valve. In case, the isolation valves are kept closed, the HP Bypass valve operation will not be effective as envisaged by the system requirement. In case they are provided, they must be kept locked fully open to keep the HP Bypass valve at correct pre-heating temperature for operational readiness. 2. Our HP Bypass valve is a combined pressure reducing and desuperheating valve and hence, separate desuperheater is NOT provided. Pl confirm	Bidder to follow specification.
74.	VOL-II Sec 2.0 Detailed technical specification-mechanical **Sub Section no-2.2: Steam Generator & AUX. System**	5.7.0	Sheet 22 of 27	The valve stem should be protected against contact with the hot fluid.	Stem is a regulating member in HP Bypass valve and will come in contact with hot fluid. Customer to kindly confirm.	Bidder to follow specification.

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75.	VOL-II Sec 2.0 Detailed technical specification-mechanical **Sub Section no-2.2: Steam Generator & AUX. System**	5.7.0	Sheet 22 of 27	The HP/LP Bypass System shall be designed to handle 60% of BMCR flow and sized for 65% BMCR flow at rated steam conditions. Bypass valves shall be capable of handling at least 120% of the stated maximum flow at the full open condition for HP valves	3% margin is provided while sizing the HP Bypass valves. Sizing the valves for a capacity of 120% of the stated maximum flow will affect the control range of the valve, especially under low flow conditions. All the projects we supplied the HP bypass valves (around 200 projects of various capacities ranging from 110 MW-500 MW) have been sized with 3% extra margin only. Customer to kindly confirm.	Bidder to follow specification.
76.	VOL-II Sec 2.0 Detailed technical specification-mechanical **Sub Section no-2.2: Steam Turbine & AUX. System**	Annex 2.2.1	Sheet 27 of 27	**HP Bypass valve/Spray Valve** Design Code - ANSI	HP Bypass valve and HP bypass spray valves are designed as per German standards. Pl confirm.	Bidder to follow specification.
77.	Vol-II/ Sec 2.0 / Cl.3.2.1 / Pg. 6 of 34			For sea water quality refer Volume II, Section 1, Annex – 1.3. However, contractor to carry out sea water analysis during detailed engineering and design the system considering worst parameters without any commercial implications for any variations within the range of 10% on TSS and 10% on TDS from the actual values indicated in the sea water analysis report provided along with the tender document. Variations on TSS and TDS if it exceeds beyond 10% the same shall be mutually discussed and finalized during detailed engineering with the owner. SWRO system shall be designed for a	We have considered 38000ppm (as specified in tender) as Sea water TDS for design and guarantee of SWRO system. However maximum 10% variation from 38000ppm TDS will be accommodated over the design as per tender. Customer may kindly note that any further change in TDS or adverse variation in water characteristics may have techno-commercial implication which will be discussed during contract stage. We have considered 4 nos. of water sampling (1 for each season) to arrive at design TDS during contract stage. We	Bidder to follow specification.

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				minimum TDS value of 38000 ppm or the higher value of the samples tested.	also request for joint sampling (Bidder & Customer). Kindly confirm acceptance.	
78.	Vol-III / Attachment-12/ 439-458 of 458			Typical sea water analysis BOD - 8-11 mg/l COD - 41-62 mg/l	BOD & COD seems to be very high for Seawater. Please reconfirm COD and BOD values.	Bidder to follow specification.
79.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 23 of 34			SWRO System Total Capacity - Minimum capacity of the plant shall be 16 MLD. Number of streams - 3 X 50% Nett Capacity Of each stream - 5 MLD each.	These clauses are contradictory. Please clarify the capacity of desalination plant. 1) 10MLD (3x50%, 5MLD each) or 2) 16MLD (3x50%, 8MLD each)	Refer Vol-II, Sec-2, sub-section 2.14 page 23 of 34, wherein "Minimum capacity of the plant shall be 16 MLD. Number of stream shall be 3 x 50% with 8 MLD of each stream
80.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 21,22 of 34			Pressure sand filters + Ultrafiltration system	We recommend Submerged Ultra filtration (UF) system instead of PSF + pressurized UF as Submerged UF system has the following advantages. 1. Submerged UF system offers lesser footprint than PSF+UF (pressurized) combination. 2. Submerged UF system can accommodate higher variation in inlet TSS. 3. These can be operated even when Clarifier system is in upset operation. 4. Operation costs is less compared to PSF + UF (pressurized) combination due to lower pressure requirements and reduced power cost. 5. Due to higher overall recovery, the feed water requirement will be less. Kindly confirm acceptance.	Bidder to follow specification.
81.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 7 of			Suck-back Tank above each SWRO train	We offer common suck-back arrangement	Bidder to follow

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	34			with adequate head & quantity of permeate to ensure gravity flow from the low TDS permeate side to the high TDS brine side during an emergency shut-down (or) power failure to prevent the deterioration of the membranes.	which will be placed outside the Desalination building catering to all the SWRO streams. This enables easy accessibility to the tank. Also we have considered flushing arrangement with emergency power facility for SWRO system Please confirm.	specification.
82.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 7 of 34			A two storied chemical house with chemical storage at the ground floor and dosing equipment on the first floor shall be considered.	We recommend dosing systems meant for RO-DM plant to be placed inside RO-DM building for easy transfer, monitoring & operation. However we confirm that other dosing systems, chemical storage will be provided in the chemical house as per tender.	Bidder to follow specification.
83.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 22 of 34			Ultra filtration system Basket strainers To be provided at the inlet of each skid.	We recommend having basket strainers at common line before UF skids for better availability and interchangeability. Kindly confirm acceptance.	Bidder to follow specification.
84.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 22 of 34			Ultra filtration system SDI at UF outlet < 3 Turbidity Nil	We can guarantee SDI_{15} < 3 at the outlet of UF system. However Turbidity NIL can't be achieved in real time situations. Normally turbidity will be maintained <0.3NTU at UF outlet. Please confirm.	Bidder to follow specification.
85.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 20 of 34			Clarifier Clarifier outlet Suspended solids ppm < 10 ppm	Turbidity at the outlet of clarifier will meet the inlet requirement of DMF system i.e. 10 NTU Please confirm.	Noted.
86.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 22 of 34			Pressure Sand Filter Outlet Quality NTU < 2	Turbidity at the outlet of DMF shall meet the inlet requirement of UF system i.e. 2 NTU (average), 5 NTU (max.) Please confirm.	Bidder to follow specification.

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87.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 22 of 34			Micron Cartridge Filters (MCF)	We recommend high flow cartridge filters of 5 micron nominal with FRP MOC housing, which has the following advantages - 1. Reduction in footprint. 2. Reduction in element replacement time Please confirm.	Bidder to follow specification.
88.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 23 of 34			SWRO System System Recovery 30%	Normally SWRO recovery is of 35% which is easily achievable. Please confirm.	Bidder to follow specification.
89.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 23 of 34			SWRO High Pressure Pumps Pump efficiency >80%	We confirm to provide best efficiency high pressure pumps. However, we request customer to kindly revise the clause with Pump efficiency >78% to obtain more offers and to work out competitive bid.	Bidder to follow specification.
90.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 22 of 34			Ultra filtration system Make Hydronautics / Norit (Pentair)/ Hyflux /Koch/ Dow & SWRO Membrane Make Hydronautics / Dow / Toray	Customer may kindly consider GE make also as approved vendors as they are also leading manufacturers of UF and RO membranes.	The vendor will be approved based on the credentials and this will be reviewed during detailed engineering stage.
91.	General			RO membrane Guaranteed life	The warranty is for 3 years from the date of commissioning on prorate basis and the prorate replacement by Customer. And with terms/conditions as per membrane manufacturer. Kindly confirm acceptance.	The warranty for RO membrane guaranteed life shall be for 3 years from the date of commissioning without any membrane replacement.
92.	General			UF membrane Guaranteed life	The warranty is for 5 years (2 years cliff and 3 years prorate warranty) from the date of commissioning and the prorate replacement by Customer. And with terms/conditions as per membrane manufacturer. Kindly confirm acceptance.	The warranty for UF membrane guaranteed life shall be for 5 years from the date of commissioning without any membrane replacement.

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93.	Vol-II/ Sec 2.0 / 3.2.0 / Pg. 6 of 34			Scope of supply Desalination and water treatment plant: Supply of chemicals	Customer to kindly specify the list of chemicals and quantity to be supplied as a part of Scope of supply along with duration of supply.	Bidder to refer Vol-II, Section-1, GTS, Cl: 3.0.0 and 15.2.0.
94.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 22 of 34			SWRO feed Pumps Pump efficiency >80%	We confirm to provide best efficiency high pressure pumps. However, Customer may kindly revise the clause as Pump efficiency >78% to obtain more offers.	Bidder to follow specification.
95.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 20 of 34			Flash Mixer Agitator MOC - Duplex Stainless Steel.	We recommend Flash Mixer agitator MOC similar to Flocculator agitator MOC as MS-FRP. Kindly confirm.	Bidder to follow specification.
96.	Vol-II/ Sec 2.0 / sub sec 2.24 / Cl. 3.0.0 /Pg. 2 of 7			Miscellaneous pumps / General Service pump shall have flow & head margins of 10% & 15% respectively.	In desalination system, we have considered all pumps with 10% margin on friction head and 5% margin on flow. Kindly confirm acceptance	Bidder to follow specification.
97.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 23 of 34			SWRO High Pressure Pumps VFD required	The SWRO membrane feed pressure variation will be low and can be accommodated by provision of VFD for SWRO feed pump. In addition, flow control valves are provided. Hence, VFD for SWRO HP pump shall not be provided. Kindly confirm acceptance.	Bidder to follow specification.
98.	Vol-II/ Sec 2.0 / 3.2.1 / Pg. 8 of 34			pH Transmitters at Cartridge Filter outlet, each SWRO and each BWRO permeate and at the outlet of each MB.	At the outlet of SWRO and BWRO, normally conductivity analyzers are provided to monitor the conductivity and pH is normally not measured. Hence pH transmitters are not required at outlet of SWRO and BWRO. Please review.	Bidder to follow specification.
99.	General			Process & instrumentation diagram	Please provide detailed P&IDs for desalination and Demineralization systems for better understanding of instrumentation to be considered in our offer.	Tender specification calls for fully automatic operation and for which all the requirements in terms of controls, interlocks and the associated

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						valves/Instruments shall be considered by the bidder.
100.	Vol-II/ Sec 2.0 / 3.2.1 / Pg. 8 of 34			Lime along with carbon dioxide dosing shall be considered at SWRO outlet to achieve the pH and LSI requirements.	Please clarify the arrangement of Lime dosing i.e. lime dosing or limestone filters. Also provide complete details including capacity and redundancy to be considered (W+S) along with P&ID. We presume that LSI treated water is only required for service and potable water requirements. For Demineralization system feed LSI treatment water is not required. Normally the treated water LSI is around ±0.5 and TDS increase will be around 80-100ppm after LSI treatment. Please clarify.	Remineralization system shall consist of limestone filter with CO2 dosing and shall treat the complete SWRO product water to meet the downstream water quality requirement. TDS increase in the product water shall be considered for designing of BWRO system. N + 1 standby shall be considered for filters.
101.	Vol-II/ Sec 2.0 / Annex 2.14.1 / Pg. 23 of 34			SWRO System Product water Quality TDS < 500 ppm	The outlet water TDS after SWRO stream shall be 500 ppm and TDS after LSI treatment shall be around 600 ppm. Kindly confirm acceptance.	Bidder to note that Specification calls for TDS of less than 500 ppm at the outlet of SWRO. Bidder shall design the system accordingly.
102.	General			Order of precedence of tender documents for Desalination and DM plant	We have considered the following order. 1) Datasheet 2) Specification (Vol.II, Sec.II, 2.14) 3) General specification Kindly confirm order of precedence of tender	Refer Vol – I Sec 4 page 4 of 21 clause no: 4.3 wherein " In case of any conflict amongst various sections, drawings, schedules etc., the most stringent requirement shall govern; decision of the Owner shall always be final & binding on the Contractor".

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						Bidder to follow specification.
103.	3.18.0 Bearings Pg.no 234 of 353			For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box.	Please confirm that RTDs shall be provided only for drives rated 200 kW & (HT motors) not for LT Motors.	Confirmed. RTDs shall be provided only for drives rating above 200kW (HT motors) not for LT motors and shall be wired up with terminal box.
104.	3.2.1 Desalination Plant page no 8 of 34			SDI analyzer at each SWRO cartridge filter outlet.	Turbidity analyzer shall be provided at common outlet of cartridge filter. Normally SDI measurement will be for period of 15 mins. Hence manual SDI kit is provided.	Bidder to follow specification.
105.	3.2.1 Desalination Plant page no 8 of 34			Pressure transmitters at suction and discharge of RO high pressure pumps, booster pumps (if applicable), inlet and reject of both SWRO and BWRO, discharge headers of all pumps for auto start of standby pump.	We recommend to provide pressure switch low at individual discharge of the pumps, so that if the pressure is not developed in any of the working pump, pressure switch low signal will be sensed and auto start of the standby pump will be done. Kindly accept. However pressure transmitter at common discharge header of pumps will be provided for monitoring.	Bidder to follow specification.
106.	3.2.3 Control Philosophy page no 9 of 34			The operation of both RO-DM shall be carried out fully automatic (sequentially).	All necessary interlocks will be provided for safe operation of plant. Initiation of RO-DM (Clarifier, PSF, UF, SWRO, BWRO, DM operation/regeneration etc) Plant from DCS to be done manually. However chemical preparation for process, membrane cleaning(UF & RO) will be carried out manually. UF system is completely Automatic. Sequence of operation will be done	Tender specification calls for fully automatic operation and for which all the requirements in terms of controls, interlocks and the associated valves/Instruments shall be considered by the bidder.

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					automatically through RO-DM DCS. Manual override will also be provided. Necessary field instruments will be provided and any mal operation will be Annunciated. If fully automated system is required, please furnish the detailed PID showing the Auto valves/Instruments, interlocks etc. In line with the PID, we will furnish our offer.	
107.	Vol. II, Section 4 1.1.0 Field Instruments PAGE NO 2 OF 16.			For saline applications and other applications which are corrosive in nature, the wetted part material to be selected which shall meet the process applications, preferably diaphragm seal to be used. Haste alloy C wetted part material and SS316L impulse piping / root valve material to be considered for the above applications.	For saline application, we recommend Duplex SS impulse piping / root valve material to be considered. Please confirm.	Bidder to follow specification.
108.	Vol. II, Section 4 3.2.1 Desalination Plant PAGE NO 6 OF 34.			Suitable on line instruments shall be provided for verifying the quality of water at various stages of treatment.	As there are many sub systems (Clarifier, DMF, UF, SWRO, BWRO, LSI), please specify the location, process parameter and type of instrument for better clarity.	Bidder to refer Vol-II, Section4.0, Subsection-4.10, Cl: 3.0.0
109.	Vol. II, Section 4 4.2 Scope of supply & services PAGE NO 5 OF 19.			Desalination/WTP shall be controlled and monitored from the Desalination/WTP local control room, through the DCS remote I/Os.	We understand that dedicated DCS system to be provided for control & monitoring of DMF, UF, SWRO, Re-mineralization system, BWRO, DM & auxiliary chemical systems. Kindly confirm.	Bidder to refer Vol-II, Section4.0, Subsection-4.2, Cl: 1.1.9.
110.	Vol. - II, Section 2.0 2.14 PWT, WW& Chemical Treatment Systems			Re-mineralization system consisting of Lime and CO2 dosing for SWRO product water	We request customer to provide P&ID for Re-mineralization system. Also please explain the level of automation.	Refer pt. No.: 100 above.
111.	3.2.1 Desalination Plant page no 8 of 34			Two out of three logic shall be adopted for	ORP is the only critical Parameter to be	Bidder to provide 2 out

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				the following critical measurements: pH transmitters at cartridge filter outlet, each SWRO and each BWRO permeate • Pressure transmitters at suction and discharge of RO high pressure pumps, booster pumps (if applicable), inlet and reject of both SWRO and BWRO, discharge headers of all pumps for auto start of standby pump. • Conductivity analyzer at RO skid outlet. • ORP analyzer at RO inlet.	measured at the inlet of SWRO. Hence ORP Transmitter shall be given in redundancy. SWRO plant will be tripped upon high ORP. Kindly accept.	of 3 measurements for ORP and the same shall be considered for tripping the HP pump. In addition to this, Bidder shall also consider 2 out of 3 measurements for the following. • pH Transmitters at Cartridge Filter outlet, each SWRO and each BWRO permeate. • Pressure transmitters at suction and discharge of RO HP Pumps, (Booster pumps (if applicable) inlet and reject of both SW and BWRO, discharge headers of all pumps for auto start of standby pump. • Conductivity analyser at RO skid outlet
112.	Vol. II, Section 4 Page : 9 of 11 Section 4-3 Design requirements_R0 `			Electromagnetic flow meter shall be used at the inlet of PSF outlet and RO high pressure pump inlet.	We recommend paddle wheel type Flow transmitter at PSF inlet and outlet which are of proven type. Kindly confirm acceptance.	Bidder to follow specification.

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					However Electromagnetic Flow transmitter will be used for RO high pressure pump inlet.	
113.	Vol. II, Section 4 Page : 9 of 11 Section 4-3 Design requirements_R0 `			Ultrasonic type flow meter shall be used for parshall flume flow, common outlet of SSF, RO module permeate line.	We recommend the following 1) Paddle wheel type Flow transmitter in Individual UF permeate. 2) Magnetic flow transmitter in permeate and brine line of each of SWRO & BWRO skid. Kindly confirm acceptance.	Bidder to follow specification.
114.	Vol. II, Section 4 Page : 7 of 11 Section 4-3 Design requirements_R0			Pressure transmitters at the suction and discharge of main process / pumps / compressors, for all controlled parameters, inlet and outlet of cooling water line of the condenser, flue gas line at inlet / outlet of various pressure parts, pressure conditions of major vessels like separator, de-aerator etc.	Pressure transmitter at common discharge header of pumps shall be provided for monitoring. Please confirm acceptance.	Bidder to follow specification.
115.	Vol. II, Section 4 Page : 6 of 11 Section 4-3 Design requirements_R0			Pressure switches at suction, permissive and trip of pumps and fans/blowers, discharge pressure low for auto-start of standby pumps and pre-trip alarm conditions.	Pressure switches will be provided at common discharge of Air blowers. Kindly confirm acceptance.	Bidder to follow specification.
116.	Vol-II/ Sec 5.0 - Civil 5.2.21 / Pg. 26 of 38			Description of facilities shall be in accordance with the requirements spelt and under Mechanical Specification. Desalination building shall be RCC framed structure with brick cladding and covered with RCC. Pump Houses shall be RCC framed structure with brick cladding and covered with RCC Cast in situ roof slab.	For desalination building, we recommend to use structural steel framed structure with color coated metal sheet roofing for UF, RO Pass 1 & 2 and DM systems. This may be considered as system layout requirement of the plant in order to have long spans (large free space in between columns).	Bidder to follow specification.

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					RCC framed structure with brick cladding and covered with RCC Cast in situ roof slab is considered for pump houses, control room, office area and chemical storage & dosing areas of the plant as per tender specifications. Please confirm acceptance.	
117.	General			MOC piping & fittings	We recommend various piping & fittings as per annexure 1 based on previous sea water plant experiences. Kindly confirm.	Bidder to follow specification.
118.	Vol-II, Section-2 / Sub-sec. 2.3 Condenser System / Page 3 of 12/Cl.4.1.0			Max. Oxygen content of condensate leaving the condenser shall be 0.02 ppm over the entire load range.	Please note there is contradiction in specified clauses. Owner to clarify regarding maximum oxygen content to be considered.	Bidder shall consider Max. Oxygen content of condensate leaving the condenser as 0.02 ppm over the entire load range.
	Vol-II, Section-2 / Sub-sec. 2.3 Condenser System / ANNEX 2.3.1 SPECIFIED DESIGN DATA/Page 11 of 12			Maximum oxygen content of condensate leaving the condenser over the entire range of operation: 0.015 ppm		
119.	Vol-II, Section-2 / Sub-sec. 2.3 Condenser System / Page 4 of 12/Cl.4.1.0			The Condenser shall be designed for heat load corresponding to unit operation for VWO condition, VWO with 1% make up condition, HP heaters out of service condition, turbine operating at house load operation with HP-LP bypass operating at its rated capacity (60% BMCR) and rated steam parameters.	Please note there are various design heat loads specified for condenser design. We have considered VWO 1% MU condition as condenser design point. Please confirm.	Bidder to follow specification.
120.	Vol-II, Section-2 / Sub-sec. 2.3 Condenser System / Page 5 of 12/Cl.4.1.0			Provision in water box of adequate size nozzle and valve for priming of condenser.	Priming of Condenser is not applicable for this project since CW system is closed cycle type.	Bidder clarification noted.
121.	Vol-II, Section-2 / Sub-sec. 2.3 Condenser System / ANNEX 2.3.1 SPECIFIED DESIGN DATA/ Page 11 of 12			Tube side/Water box test pressure : 1.5 times the design pressure	Test Pressure shall 1.3 times of Design Pressure. This is in line of ASME Section VIII, Div.1.	Bidder to follow specification.

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122.	Vol-II, Section-2 / Sub-sec. 2.25 Painting / Page 30 of 31 / Annexure 25.1.2 Painting systems			Primer: Two pack , high build siloxane modified epoxy primer with zinc phosphate pigment. Top coat: Two component High Build high Solid Aliphatic Amine Cured Epoxy coating. - Min VS 85%.	Painting shall be: Primer: Zinc Rich epoxy paint; Intermediate: High Build epoxy suitable for poly eurethene finish paint. Total DFT shall be 200 microns. This is as per bidder's standard practice.	Bidder to follow specification.
123.	Vol-II, Section-2 / Sub-sec. 2.2 Steam Turbine & Aux. System / Page 20 of 27/Cl. 5.4.0			**Unit Purification System** Each steam turbine shall be provided with a permanently connected, continuous oil purification system… … …	Operation of lube oil purification system is dependent on quality of oil and it is required only when quality of oil falls below acceptable limits. Based on site experience, lube oil purification system is operated intermittently normally 8 hours per day. In view of above, the oil purification system is not continuously running system.	Bidder to follow specification.
124.	Vol.- I / Sec – 2 & Vol.- II / Sec – 2 / 2.2 Page 45 of 51 & 3 of 27/ Cl. 73 &3.1.0			The Vendor/Contractor shall supply with the equipment One complete set of special tools and tackles for the erection, assembly of the equipment for each unit. Transport Fixtures along with all special Tools & Tackles.	It is clarified that only One set of special tools & tackles common for two units shall be supplied.	Bidder to follow specification.
125.	Vol-II / Section-1.0 (General Technical Specification)/page 161 of 191		Annexure-1.4 / B	MANDATORY SPARES FOR ELECTRICAL (* One set corresponds to actual quantity of components and devices as installed for the equipment at Site)	Bidder understand that whereever quantity of spares is mentioned as "Set * ", the quantity to be offered corresponds to actual quantity of components and devices as installed in a single equipment at Site. TANGEDCO to confirm.	Bidder to follow specification.
WATER SYSTEM						
126.	II/1.0/-	2.1.0 3 (c & e)	13 of 191	Service Water/ Potable water supply for township: Electrical Feeder provision required for the pumps shall be considered in Stage I. Capacity will be informed during detailed engineering.	For considering Electrical feeders for these pumps in bidder scope, Parameters for Service water & potable water Pumps for township are required. Customer is requested to provide the same.	Details shall be provided during detailed engineering.

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127.	II/ 2.0/2.3	3.3.0 a)	2 of 12	Sponge rubber ball type tube cleaning system designed for continuous & trouble free operation with provision of abrasive coated balls cleaning in case of hard deposits inside tubes.	Purpose of COLTCS is to prevent fouling and scaling. COLTCS may not be able to remove hard deposits formed prior to COLTCS operation even by abrasive coated balls and may require manual cleaning in case of hard deposits formed.	Noted.
128.	II/2.0/ 2.8 II/7.0/-	ANN. 2.8.1 Dwg. No. 00-11151120-M-004 /R0	4 of 9 1 of 3	**STRAINERS** Type Duplex type Self-Cleaning Filters are shown at ACW Header in Flow Diagram for ACW System and DMCW System	Self Cleaning Strainers as shown in Flow diagram are proposed to be provided at the upstream of PHEs in ACW Header. Please Confirm. Self Cleaning Strainers are generally preferred by different Customers being automatic and compact with respect to the Duplex Strainers.	Self cleaning Strainers shall be provided for ACW system as per drawing no: 00-1112140-M-004 /R0. Specification shall be read as "STRAINERS Type: Self cleaning Strainers"
129.	II/2.0/2.13	ANN. 2.13.1	20 of 21	Delivery rate: Suitable to supply cooling water to condenser +10% Margin.	CW Pumps are of very large capacity and any margin on flow rates shall result in operation of these pumps way beyond their best operating point and shall also lead to unnecessary increase in Aux. Power Consumption , Hence no margin on Flow rates is required nor advised . Kindly Confirm.	Bidder to follow specification.
130.	II/2.0/2.14	3.1.1 & 3.1.5	2 & 4 of 34	**Intake Location Lat/Long:** 8··25.548′N 78··5.511′E **Outfall Location Lat/Long:** 8··25.95′N 78··5.157′E	We understand that the Intake and Outfall Locations as per the specifications are final and as per relevant studies conducted by the Customer.	The location of the velocity cap shall be as per the attached drg no 0-1112140-G-001 and to be designed as per MOEF / relevant norms. Bidder to follow specification.
131.	II/2.0/2.14	ANN. 2.14.1	17 of 34	Intake pipe Size: OD 2000 PE 100 SDR 26.	Intake Pipe Size of OD 2000 shall have the velocity of 2.66 m/sec for the Design	Velocity Restriction of 1m/sec does not apply

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	II/2.0/2.20	3.0.0	4 of 31	Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally.	Intake flow of 30000 M3/Hr as mentioned in Ann. 2.14.1 and therefore shall not meet the velocity restriction of 1.0 m/sec under gravity as per the specification. Customer is therefore requested to specify the correct Intake Pipe Size.	to seawater intake lines. Specification calls for two pipes of OD 2000 (vol-II sec 2.14 annex 2.14.1).
132.	II/2.0/2.14	ANN. 2.14.1	18 of 34	SEA WATER INTAKE SYSTEM: Recirculation from discharge Required: Through Control valve	Please note that the recirculation lines are required to be operated generally during commissioning only and therefore Motorized BFV/Gate Valve shall be provided at the recirculation line which shall serve the purpose. Please Confirm.	Bidder to follow specification.
133.	II/2.0/2.14	ANN. 2.14.1	25 of 34	**Boiler floor wash pumps**	Since, the Boiler floors are made of grating, it is not advisable to Wash the Floors with water as dirty water with debris may fall on persons walking in the Boiler area below the floor being washed. For the ground floor, service water shall be provided through the service water tank by gravity. Therefore, there is no requirement to envisage Boiler Floor wash pumps. Please confirm.	Bidder to follow specification.
134.	II/2.0/2.20	7.1.0	21 of 31	**Piping Material Specifications:** 6. DM water distribution system/ **Portable water system** & LP chemical dosing system : SS 316L	Pipe Material for Potable Water System shall be CI(Galvanized) upto 150 Nb Pipe Size. Potable Water pipes greater than 150 Nb shall be CS as per IS 3589 due to limitation of Galvanization for pipes above 150 Nb. Please Confirm.	Bidder to follow specification.
135.	II/2.0/2.20	7.2.0	26 of 31	**Valve Material Specifications:** 12. DM Water / **DMCW/ CCCW Potable water** /LP chemical dosing system: For >65Nb: ASTM A 351 CF3M For <50Nb: ASTM A182 F316L	Valve Material for DMCW/ CCCW/ Potable Water System shall be provided same as mentioned for Service Water System at S. No. 9 of Cl. 7.2.0 Page 25 of 32.	Bidder to follow specification.
136.	II/2.0/2.24	6.0.0	3 of 7	Strainer shall be provided on suction line of each pump. Generally Basket type strainer is preferred .The clear area of strainer shall	Bidder prefer to provide the Conical Strainer at suction line of pumps since Basket Strainers consume lot of space.	Bidder to follow specification.

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				be five times the inlet cross sectional area of the connecting piping. Strainers shall be constructed of 16 gauge perforated stainless steel plates (304grade) and shall be lined with stainless steel (316 grade) screen.	Customer to please accept the same.	
137.	II/2.0/2.20	3.0.0	4 of 31	The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors, valves, flow limiting orifices, etc., or the system heat and/or mass balance diagrams.	For pipeline sizing, the required flow through the pipe shall be considered and not the equipment capacities. This is in line with standard practice being followed by Bidder in all previous projects.	Bidder to follow specification.
138.	II/2.0/2.13	5.1.0 Annex 2.113.1	5 of 21	The basin shall be below or above ground and shall have sufficient holding capacity. The basin shall be 7 min storage capacity (from normal water level to low water level). Basin depth: The basin shall be complete with 7 minutes storage capacity (from normal water level to low water level).	Specification does not indicate what shall be the normal water level. Bidder understands that the Normal Water Level shall be considered in the middle of Min Water Level & Max Water Level. Please confirm.	Bidder to note the following: 1. A minimum of 300 mm free board shall be provided in the basin as per Vol-II sec 2.13 clause 5.1.0 page 5 of 21. This freeboard shall be provided above the Maximum water level (MWL). 2. MWL shall be minimum 200mm above the Normal water level (NWL). 3. The basin shall have 7 minutes storage capacity from NWL to low water level (LWL) as per Vol-II sec 2.13 clause 5.1.0 page 5 of 21.

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						4. The basin invert level shall be minimum 300mm below the LWL. Accordingly bidder shall size the cooling tower basin accordingly.
139.	II/2.0/2.14	Annex 2.14.1	19 of 34	Outfall Pumps: Type Vertical turbine Non-pull out pumps with VFD arrangement	Outfall pumps shall be with constant speed. VFD arrangement for these pumps is not required & hence not envisaged. Please Confirm.	Bidder to follow specification.
POWER CYCLE						
140.	II/2.0/2.2 II/7.0/-	3.1.0 DWG NO. 10-1112140-M-002	2 of 27	Hydraulic/pneumatic power operated quick closing non-return valves (QCNRV) and ordinary non return valves for each extraction including steam lines to BFP turbine drives, and for each cold reheat line one hydraulic/ pneumatic power operated QCNRV shall be provided. Please refer to Flow diagram for steam, feed water & condensate system DWG NO. 10-1112140-M-002 wherein a **QC NRV is indicated before the HPH 7 in the extraction line from CRH.**	QCNRV is not required in the extraction line from CRH to HPH 7 Since the same is already located in the main CRH line after HP turbine. Please Confirm.	Bidder to follow specification.
141.	II/7.0	Tender drawing DWG NO. 10-1112140-M-002		Flow element shown in Main Steam lines and Hot reheat lines.	Flow elements are not envisaged in Main Steam and Hot reheat lines as per bidder's proven standard engineering practice.	Bidder to follow specification.
142.	II/2.0/2.6	Clause 4.3.0	Page 3 of 8	Rated flow of hot well make up pumps shall be sized considering a flow of 10% of VWO steam flow with 1.5% make up. Also	As per the specification requirement, hot well make up pump capacity of 10 % VWO seems to be on higher side. Pump	Bidder to follow specification.

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				Emergency make up control valve to be sized for hot well make up pump rated flow condition. (i.e. 10 % VWO flow with 1.5 % make up)	capacity of 5% VWO is the optimized flow suitable to meet the make-up requirement during emergency in supercritical 660 MW rating. In view of above emergency control valve shall be sized as per the 5% VWO flow for proper control. Please Confirm.	
143.	II/1.0/-	Annex 1.4 (Sl. No. 24)	page 177 of 191	Mandatory spares for the CONTROL VALVE, ACTUATORS and ACCESSORIES has been spelt out. However, no spare list for the APRDS package has been included in the list.	Bidder clarifies that the Mandatory spare for APRDS package is not considered.	Bidder to follow specification and in addition the Bidder shall list the required spares in the spares if the same is not available.
144.	II/2.0/2.5	4.2.0	Page 8 of 22	**Design head** TDH at design capacity shall be derived based on deaerator maximum safety valve set pressure at VWO and equipment and piping pressure drops with 10% margin at VWO condition with 1.0 % make-up, static head etc. While Sizing the Condensate pumps the pressure drop across Condensate polishing unit shall be taken into account in the discharge head of the pump.	To calculate the total dynamic head of the pump, frictional drop shall be calculated as per actual flow from the system as per corresponding HBDs. Please Confirm.	Bidder to follow specification.
145.	II/2.0/2.5	4.1.0	Page 5 of 22	Turbine driven feed pumps to be capable of generating the discharge pressure not less than 3% over steam generator highest safety valve set pressure and flow corresponding to BMCR requirements.	Margin over steam generator highest safety valve set pr. is not required In line with cl. No. PG-61.5 of ASME-BPV Section-I, applicable for once through boilers. Please Confirm.	Bidder to follow specification.
146.	II/2.0/2.3 II/2.0/2.3 II/2.0/2.4	4.1.0 & ANNEX 2.3.1 &	Page 3 of 12 & Page 11 of 12	**4.1.0 :** Max. Oxygen content of condensate leaving the condenser shall be 0.02 ppm over the entire load range.	As oxygen dosing is required for all supercritical plants, oxygen content at deaerator is not required to be complied. Please confirm.	Bidder shall consider Max. Oxygen content of condensate leaving the condenser as 0.02 ppm over the entire load

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		4.3.0	& Page 2 of 11	**ANNEX 2.3.1:** Maximum oxygen content of condensate leaving the condenser over the entire range of operation **4.3.0:** Deaerator shall be designed such that maximum oxygen content at deaerator outlet shall be 0.005 cc/liter measured as per ASME D-888 reference method-A or Indigo Carmine method at all operating condition.		range. Bidder to follow specification for maximum oxygen content at Deaerator outlet.
147.	II/2.0/2.6	3.1.0	1 of 8	Minimum recirculation facility with 2 x 100% recirculation control valves with isolation valves upstream and downstream. The minimum recirculation flow shall correspond to maximum of gland steam condenser minimum recirculation flow and CEP minimum recirculation flow.	A single CEP min. recirculation control valve is sufficient to cater the min flow requirement. The motorized inching type valve shall be provided in the bypass of control valve for better control and plant operation. Please clarify your requirement and confirm?	Bidder to follow specification.
LIFTING EQUIPMENTS						
148.	II/2.0/2.19.0	2.3.0	3 of 8	In special cases, where safe lifting of the relevant component is not certain, specially-made devices shall be provided.	Please elaborate the requirement.	Bidder shall consider the safe lifting of the equipment/ component using lifting tackles.
149.	II/2.0/Sec.2.19.0 & II/2.0/2.19.0	3.0.0 a) & 3.1.0 b)	4 of 8 5 of 8	Cranes & hoist shall be provided in the areas where handling of the equipment / component to be lifted for maintenance weighing above 300 kg. & Hook shall be provided for all possible maintenance location for the weight less 300kg.	Considering the layout constraints, it may not be feasible to provide hoists for all equipment/component above 300 kg in the plant. We have already considered lifting tackles for equipment requiring frequent handling. Further, to meet the requirement of handling of any equipment for which dedicated lifting tackle cannot be provided because of above mentioned reason, chain pulley blocks without	Bidder to follow specification.

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					travelling trolley (in line with specification requirement) will be envisaged which can be installed as and when required above the equipment to be handled. Please Confirm.	
150.	II/2.0/2.19.0	3.1.0 a)	4 of 8	The TG hall crane capacity shall be taken as 10% more than the single heaviest equipment/component to be lifted. And other cranes and hoists capacity shall be selected by considering 20% margin over the weight of the component to be lifted	5% margin for TG Hall Crane over the single heaviest equipment/component to be lifted other than generator stator & 10 % margin for other double girder cranes have been considered for deciding crane capacity. Additional margin shall un-necessary increase the structure cost. Please confirm acceptance.	Bidder to follow specification.
151.	II/2.0/2.19.0	3.1.0 b)	5 of 8	Double girder crane shall be provided for >7.5T SWL	Double girder EOT crane shall be provided for>=15TSWL.However for <15T SWL Single girder underslung /overhead crane shall be provided in line with the practice being followed in industry. Please Confirm.	Bidder to follow specification.
152.	II/2.0/2.19.0	3.1.0 c)	5 of 8	Auxiliary hoist shall be provided, for TG hall EOT crane and CW pump house EOT crane.	All equipment/item to be handled by crane shall be approachable by main hook. In view of above, auxiliary hoist has not been considered in CWPH. Kindly confirm.	Bidder to follow specification.
153.	II/2.0/2.19.0	4.0.0	6 of 8	Drawings, data / documents to be submitted along with bid. 4.1.19 List of recommended O&M spares for 3 years normal operation	Mentioned drawings shall be submitted during detail engineering (except technical schedule & data sheet). List of recommended O&M spares for cranes & hoists shall be furnished during detail engineering. Please Confirm.	Bidder to follow specification.
154.	II/2.0/2.19.1	2.0.0 t)	4 of 9	EOT cranes conforming to Group M5 for Mechanical, Structural and M7 for Electrical of IS:3177 – 1999 shall be designed, manufactured, inspected, shop tested,	Power plant application cranes are intermittent duty type crane not of continuous duty type. Hence M5 mechanism as per IS 3177 shall be	Bidder to follow specification.

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	II/2.0/2.19.2	1.0 a)	1 of 7	erection, site testing and commissioning to well established engineering practices, safety codes and other relevant codes and standards. & EOT cranes conforming to M5 for Mechanical, Structural and M7 for Electrical of IS:3177 – 1999 and Class II of IS 3938 shall be designed, manufactured, inspected, shop tested, erection, site testing and commissioning to well established engineering practices, safety codes and other relevant codes and standards. & However, Work shop single girder over head crane conforming to Group M7 for mechanical, structural and electrical of IS 3177.	envisaged for both mechanical class as well as electrical services. Please Confirm.	
155.	II/2.0/2.19.1 & II/2.0/2.19.2 & II/2.0/2.19.3	30.0 b) & 2.0.0 b) & 2.0.0 E (i)	5 of 9 & 2 of 7 & 2 of 6	Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.	Customer to kindly review this requirement. Please note that after considering 25% over design load and 25% margin over power requirement , the motor capacity shall be approximately 55 % higher than requirement given as per IS 3177. This may lead to crane being loaded beyond its structural and mechanical design. As per IS 3177, the motor rating is calculated at 100% of crane capacity and then the required margin over maximum power requirement (25% in this case) is considered. As per IS 3177,the motor KW rating for is calculated by formula	Bidder to follow specification.

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					(MXVXCvXCdf)/(6.12XEXCamb).In this formula duty factor Cdf for M5 is 1.5.Hence 50% margin already available. **Further 15% margin shall be considered on this calculated value for arriving final motor rating.** The values of SWL also comes out after 5% margin (For TG hall crane) & 10% margin (For other cranes) over single heaviest components to be handled. Hence 125% of design load on hook for hoisting motor is not required. Please Confirm.	
156.	II/2.0/2.19.1 & II/2.0/2.19.2 & II/2.0/2.19.3	3.0(c), Annex. 2.19.1(S.No.17.2 & 17.3 & 2.0.0 b) & 2.0.0 E (ii)	5 of 9,9 of 9, & 2 of 7 & 2 of 6	Motors shall suit the duty class S4, cyclic duration factor 60% and 300 starts per hour	Motor with 150 starts/hr. & 40 % Cdf shall suffice the purpose as generally accepted in all projects. Hence Motors of crane & hoist application shall be rated for S4 duty, 150 starts/ hour & 40% CDF. Please confirm.	Bidder to follow specification.
157.	II/2.0/2.19.1	Annex 2.19.1 (4.1)	7 of 9	Rails sections as per IS: 3443 Grade 50 C 12.	55 C11 material is also acceptable in IS: 3443. Hence 55 C11 material for rail may also be allowed along with 50 C 12. Please Confirm.	Bidder to provide as per IS 3443 latest
158.	II/2.0/2.19.2	1.0.0 c)	2 of 7	Platforms/walkways shall be provided for maintenance of crane components with access ladder to access the platforms from operating floor/maintenance area.	Maintenance platform at suitable height at one end of building shall be provided. Please confirm.	All Single Girder EOT crane shall be provided with walkway along the crane girder level on both sides. Bidder clarification is noted for Under-slung crane only.

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159.	II/2.0/2.19.3	3.0.0	3 of 6	Effort on the hand chain for traveling motion of manual hoist will not be more than 20kgforce.	Efforts shall be as per IS 3832:2005 Please Confirm.	Bidder to follow specification.
160.	II/1.0/-	Mandatory spares for crane	153 of 191	CRANES (FOR EACH CRANE)	Please clarify whether lot of spares shall be provided for each crane or each type & capacity of EOT cranes. For example in TG hall, there are two cranes of similar type & capacity. Hence it is more prudent to provide one lot of spares for each type & capacity of crane.	Bidder to follow specification.
WEIGH BRIDGE						
161.	II / 2.0 / 2.22	3.4.1 S. No. 14.2	20 of 34	Repeatability < ±0.010 % FSO	Repeatability of load cell at rated output is ± 0.05% as per IS 9281. Kindly confirm acceptance.	Bidder to follow the specification
MISC. TANK						
162.	II/ 2.0/ 2.6	4.2.0, Condensate storage tank	3 of 8	The design code of the tank shall be **ASME B&PV Sec VIII, div-1**.	ASME B&PV section VIII, div-1 is applicable for pressure vessels, however, CST under condensate system operates at atmospheric pressure. Hence, design code should be **IS 803/ API 650.** Customer may pls. review and confirm.	Bidder clarification is noted.
163.	II/ 2.0/ 2.14	Annexure 2.14.1, DM water storage tank	28 of 34	**PVC/PP Balls** – Required in three layers	DM water tanks are normally provided with NaOH breather and seal pot to preserve the quality of water. In such case, propylene balls are not required. Use of propylene ball will increase cost of package. Customer is requested to review and confirm requirement of propylene balls.	Bidder to follow specification
FIRE TENDER						
164.	II/ 2.0 / 2.15	Fire tender	Page : 7 of 33	The chassis for carrying out fabrication work of fire water/foam tender shall be of Make TATA1109/TATA 2518 or Ashok	Max Permissible Gross Vehicle Weight of TATA1109 is 11900 Kgs. and TATA 2518 has a gross vehicle wt. of 25000 Kgs.	Bidder shall select fire tender with gross weight of 25000kg. Details of

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				Leyland Taurus/Beaver or Volvo.	TANGEDCO/FI is requested to provide a specific range of vehicles. As per IS: 950 the gross vehicle weight shall not be less than 16000 Kgs (Hence TATA 1109 does not meet IS: 950 requirement). Accordingly we propose TATA 1613/ Ashok Leyland 1616/ equivalent for the water/foam tender. Please Confirm.	the fire tender shall be reviewed during detail engineering.
165.	II/ 2.0 / 2.15	Fire tender	Page : 8 of 33	One (1) number of foam fire tender consist of 3000Lts. capacity water tank, 500 Lts. Capacity foam tank with rear mounted multistage high pressure pump, DCP and CO2 extinguishers including all accessories shall be fabricated as per IS:951/87 and IS:10460.	Foam tender as per IS: 951 is not suitable for power plants due to the large turning radius of the vehicles making the manoeuvring of the vehicle within the power plant difficult. Accordingly the foam tender including all accessories shall be fabricated as per IS: 10460. Please accept.	Bidder to follow IS: 10460 for foam tender.
166.	II/ 2.0 / 2.150	Fire tender	Page : 2 of 33	Two (2 nos.) numbers of fully equipped ambulance (Ventilators, oxygen cylinder, first aid kid, etc.) with all fittings and Fire Jeep.	One no. fire Jeep of Mahindra Thar make/ Equivalent shall be provided. Also the ambulance shall be of Patient Transport type of Force Motor/Hindustan motor/ Maruti Suzuki make. Further the ambulance shall be equipped with Ventilators, oxygen cylinder, first aid kid. Please accept.	Bidder to follow specification.
COMPRESSED AIR SYSTEM						
167.	II/ 2.0/2.16	3.00(B) Compressed Air System	Page : 1 of 9	Three (3) numbers (2W+1S) of Heat of Compression (HOC) Rotary drum type air dryers to match instrument air compressor capacity along with all accessories including control panel, flow meter, online digital dew point meter at the outlet of each dryer, etc.,	Heat of Compression conventional Twin tower type /rotary drum type shall be provided. Please accept.	Bidder to follow specification.
168.	II/ 2.0/2.16	2.16 Compressed Air	Page : 2 of 9	Capacity shall be considered for the maximum compressed air required for BTG operation (simultaneous starting of the two	Compressor capacity shall be considered for the compressed air required for BTG operation (one unit under normal	Bidder to follow specification.

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		System		units.)	operation and one unit starting). This shall result in optimum compressor size and is a common practice followed for selection of compressor sizing. Kindly accept.	
HVAC						
169.	II/ 2.0/2.17	2.1.2	1 of 20	**Water Cooled Package unit shall be provided for the following areas.** • ESP Control room	We proposed that AC System in ESP control room shall be provided through water cooled Precision package unit type air conditioners instead of normal package unit. Please Confirm.	Precision package unit type air conditioners shall be provided for ESP control room.
170.	II/ 2.0/2.17	2.1.3	2 of 20	**Water Cooled Package Type/Split Type Air conditioning System.** • For auxiliary buildings, if AC load is less than 5 TR, multiple split units shall be provided considering one number of standby unit. • For areas having AC load more than 5 TR or equal to 5TR, Water cooled package units shall be provided	For auxiliary buildings under Bidders Scope, • Area for which the total AC load is upto 10 TR, multiple air cooled split units shall be provided considering one number of standby unit. • Area for which the total AC load is more than 10 TR, air cooled ductable split / air cooled package ACs shall be provided. Please Confirm.	Bidder to follow specification.
171.	II/ 2.0/2.17	2.2.1.2	3 of 20	A dedicated plant room shall be provided for UAF unit.	The ESP building ventilation shall be provided through UAF unit and same shall be placed on roof exposed to atmosphere. Hence, no plant room is required for installation of UAF unit. The same is as per the philosophy adopted for all the projects executed/under execution by bidder. Please Confirm.	Bidder to follow specification.

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172.	II/ 2.0/2.17	4.19.0	14 of 20	**Air Distribution System (common for both air conditioning and ventilation Duct work)** • Air quantity regulating flaps	It is being clarified that volume control dampers in supply / return ducts shall be provided for air balancing.	Bidder clarification is noted.
173.	II/ 2.0/2.17	5.0.0	14 of 20	**Control Philosophy**	Kindly note that One common PLC for Air-Conditioning System & Ventilation System shall be provided to control the followings. a) AC system for control building. b) AC system for ESP building. c) AC system for service building. d) Ventilation system (Air washers) for TG building. e) Ventilation system (UAF) for ESP building. Further it may be noted that 1. Control of auxiliaries buildings provided with split AC / package Units shall be independent of common PLC. 2. Control of auxiliaries buildings provided with dry ventilation system shall be independent of common PLC. Please Confirm.	Bidder shall refer Section 4.0 sub section-4.5 for Control philosophy.
174.	II/ 2.0/2.17 / ANNEX- 2.17.1	Sl. No-(G, H, I & J)	19 of 20 & 20 of 20	**Air washer unit:** Redundancy: All working **Unitary Air filtration Unit:** Redundancy: All Working. 2X50% UAF for each ESP building **Air Washer / UAF Fan:** Redundancy: 2 nos of fan for each air	Wet ventilation for TG hall shall be provided through multiple Air washers units (all working) housed in masonry rooms. Each Air washer shall comprises of 2x50% centrifugal fans and 2x100% capacity water recirculation pumps. Wet ventilation for each ESP building shall be provided through one (1) no. Unitary	Bidder to follow specification.

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				washer and UAF. **Pumps for Air washer / UAF** Nos. of units: 3 x 50 % for air washer system and 2 x 100% for UAF system	air filtration unit (UAF) placed open exposed to ambient. Further, each UAF shall comprise of 1x100% capacity centrifugal fan and 2x100% capacity water recirculation pumps. Please Confirm.	
WATER CHEMISTRY						
175.	II / 2.0/2.14	3.2.1	6 of 34	For sea water quality refer Volume II, Section 1, Annex – 1.3. However, contractor to carry out sea water analysis during detailed engineering and design the system considering worst parameters without any commercial implications for any variations within the range of 10% on TSS and 10% on TDS from the actual values indicated in the sea water analysis report provided along with the tender document. Variations on TSS and TDS if it exceeds beyond 10% the same shall be mutually discussed and finalized during detailed engineering with the owner. SWRO system shall be designed for a minimum TDS value of 38000 ppm or the higher value of the samples tested. The seawater sampling procedure during detailed engineering is subject to Owners approval.	Please note that water treatment systems can be designed based on the firm analysis given. We are designing the water treatment plant based on the analysis given by customer in the technical specification. Any change in sea water analysis shall be subject to technical, commercial and delivery implication.	Bidder to follow specification.
176.	II / 2.0/2.7	3.1.4	2 of 13	Two nos resin separation / regeneration vessels, one no mixed resin vessel and one no mixed resin storage vessel (to hold charge of one service vessel) shall be provided along with all internals, fittings and appurtenances for these vessels.	please note that regeneration process is supplier specific, hence the no of vessels and type of vessels required shall be based on supplier's recommendation. Please Confirm.	Bidder to follow Specification.
177.	II / 2.0/2.7	3.1.4	4 of 13	Bulk acid and alkali storage tanks: ..... These tanks shall be made of FRP as per relevant codes	please note that bulk acid and bulk alkali tank and DM Water tank shall be MSRL in construction instead of FRP.	Bidder to follow Specification.

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					FRP tanks of such huge capacity are not feasible. Please Confirm.	
178.	II / 2.0/2.7	3.2.0	4 of 13	Ammonia and Hydrazine dosing system	please note that for super-critical projects hydrazine dosing system is not required and hence not considered. Please Confirm.	Bidder to follow Specification.
179.	II / 2.0/2.7	4.1.0	5 of 13	Silica influent – 30 ppb and effluent – 5 ppb.	please also note that silica in the effluent shall be 5 ppb for temp less than 48deg. For 48 deg and above silica value shall depend on supplier's recommendation. Please Confirm.	Noted.
180.	II / 2.0/2.14	4.2.0	13 of 34	Waste Water Treatment Plant – Boiler Blow down suitably quenched with Service water and transferred to central monitoring basin and utilized for horticulture purpose.	please note that for super-critical projects there shall be no boiler blow down. Hence the same is not considered in our scope. Please Confirm.	Bidder to follow Specification.
181.	II / 2.0/2.7	5.3.0	8 of 13	Vessel Free Board Requirement	please note that vessel free board requirement shall be as per supplier's recommendation. Please Confirm.	Bidder to follow Specification.
182.	II / 5.0/5.1	5.1.2	6 of 17	All statutory clearances/ NOC required for implementation of the project from various departments agencies like PWD, local bodies, highways etc shall be obtained by the contractor.	please note that all statutory clearances/ NOC required for implementation of the project from various departments agencies like PWD, local bodies, highways etc is arranged by the customer, however any documentation support required in obtaining the clearance/ NOC shall be provided by the contractor. Please Confirm.	Bidder to follow Specification.
183.	II / 2.0/2.14	4.2.0 – 8)	14 of 34	Oily wastes from TG Area, Fuel Oil Handling Areas etc. shall be pumped and collected in collection tank and then treated in TPI/API type Oil water separators. The clear water is transferred to the Central Monitoring basin.	There is a discrepancy in the tender specification w.r.t. disposal. Please clarify.	Bidder shall follow Vol-II, Section-5.0, sub-section-5.7 with regard to oily waste water handling and treatment for transformer area.
184.	II / 5.0/5.7	5.7.1.3	6 of 13	The drainage of oily waste water from transformers shall be provided with dual system. The oily water during normal		

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				operation shall be passed through oil water separator system and then connected to drainage system. The oily water during emergency operation shall be led through another system of pipes connecting to central blind sump. The blind sump shall have sufficient capacity to store transformer oil and fire fighting water for half hour duration. Very hot (over 60°C) water shall be first cooled down to less than 60°C in collecting basin by mixing with cold water before connecting to storm drainage system.		
185.	II /1.0/-	Annex 1.4- CPU	133 of 191	Mandatory spares for CPU – Valves – 20% of each type and size Pumps & blowers along with drive motors – 1 no of each type and size Ejector and dosing pumps-1 no of each type and size Resin trap – 1 no of each type and size.	As per mandatory spare part list for CPU complete pump, blower, motor, valve, ejector, dosing pumps, resin trap are asked for as mandatory spares. Please note that complete equipment is not required as mandatory spare whereas sub parts of the equipment's for e.g. for centrifugal pumps bearing, fasteners etc can be supplied as mandatory spares. Please review the requirement and confirm. Also except the mandatory spares indicated in the referred clause no other mandatory spares shall be considered for Condensate Polishing Plant system. No mandatory spare have been indicated for oxygen dosing system hence the same shall not be considered.	Bidder to follow specification.
186.	II /1.0/-	Annex 1.4- HP/LP Chemical Dosing	133 of 191	Mandatory spares for HP/LP Chemical Dosing System Dosing pump and drive – 1 no of each type and size Agitator-1 no of each type and size	As per mandatory spare part list for HP/LP Chemical Dosing System complete pump and agitator are asked for as a mandatory spares. Please note that complete equipment is	Bidder to follow specification.

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		System			not required as mandatory spare whereas sub parts of the equipment's for eg for dosing pumps plunger, cross head etc can be supplied as mandatory spares. Also except the mandatory spares indicated in the referred clause no other mandatory spares have been considered for Chemical dosing system. No mandatory spare have been indicated for oxygen dosing system hence the same are not considered.	
187.	II/2.0/2.14	4.2.0– 10)	14 of 34	Sewage from the entire plant area shall be transferred by gravity flow and treated in common sewage treatment plant. Sewage from power plant shall be collected in common sewage collection sump. The collected sewage will be treated in Aeration tank followed by clarifications and the overflow from clarifier will be stored in a clarified water tank. The clarified effluent will be filtered in activated carbon filter and pressure sand filters and reused for horticulture applications. Sodium hypo chlorite should be dosed in the treated water for disinfection purpose.	Instead of a conventional sewage treatment plant consisting of Aeration tank followed by clarifications, filtration consisting of activated carbon filter and pressure sand filters, we are proposing Bio toilet based Sewage Treatment Plant. Brief write up on the same is attached. The same has already been proposed for 2 X 660 MW ENNORE SEZ STPP. Please confirm the acceptance.	Bidder to follow specification.
FO SYSTEM AND DIESEL BUNK						
188.	II/2.0/2.9	4.7.0	5 of 19	Capacity of HSD unloading pumps is given as 100 cum/hr whereas the same is mentioned as 50 cum/hr in tender PID for FO unloading & storage system, 00-115112-M-005.	The said requirements are contradictory, customer to please review and confirm the HSD pumps capacity.	Specification shall be read as "configuration of HSD pump is given as Two (2) nos. – (1W+1S) each with a capacity of 100 cum/hr"
189.	II/7.0/-	Drwg no. 00-		Oil water mixture transfer pumps along with separate oil water collection tank	Please note that the oil water separator (OWS) envisaged here is a gravity type	Bidder to follow specification. Type of oil

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		1115112-M-005, Sh 3 of 3		(RCC) are shown in the PID.	separator. A single chamber (RCC) with recovery oil transfer pumps and waste water transfer pumps shall be sufficient for gravity type separator. In view of above, separate water collection tank along with oil water mixture transfer pumps is not required. Customer to please confirm.	water separator is API conventional baffle type.
190.	II//2.0/2.22	3.5.0	22 of 34	1 No. diesel bunk with tank of capacity 12 KL and metering filling facility to be provided near stores and all the approval and license to be arranged by the contractor.	We understand that the Diesel bunk with metered filling facility is actually a diesel filling pump station. **The Equipment required for this are:** o Horizontal fabricated steel tank (To be Buried Underground) for diesel storage. o Metered filling pump for dispensing Diesel. o Associated Piping, Valves & Instrumentation. o Small Electrical Panel for operation of metered filling pumps. The above Equipments required for diesel bunk are provided by Oil Companies like IOCL, BPCL, HPCL, and Reliance. Normally these companies provide filling station along with E&C. Civil Works is excluded from their scope. Further, they provide assistance in getting the CCOE / other statutory approvals before construction and also in obtaining license for operating this facility. Space required as per the guidelines is minimum 20M x20M for Urban area and 35M x 35M for Rural area.	This shall be reviewed during detailed engineering. All the approval and license to be arranged by the EPC contractor. Scope of civil works and other works shall be in EPC contractor's scope as per specification.

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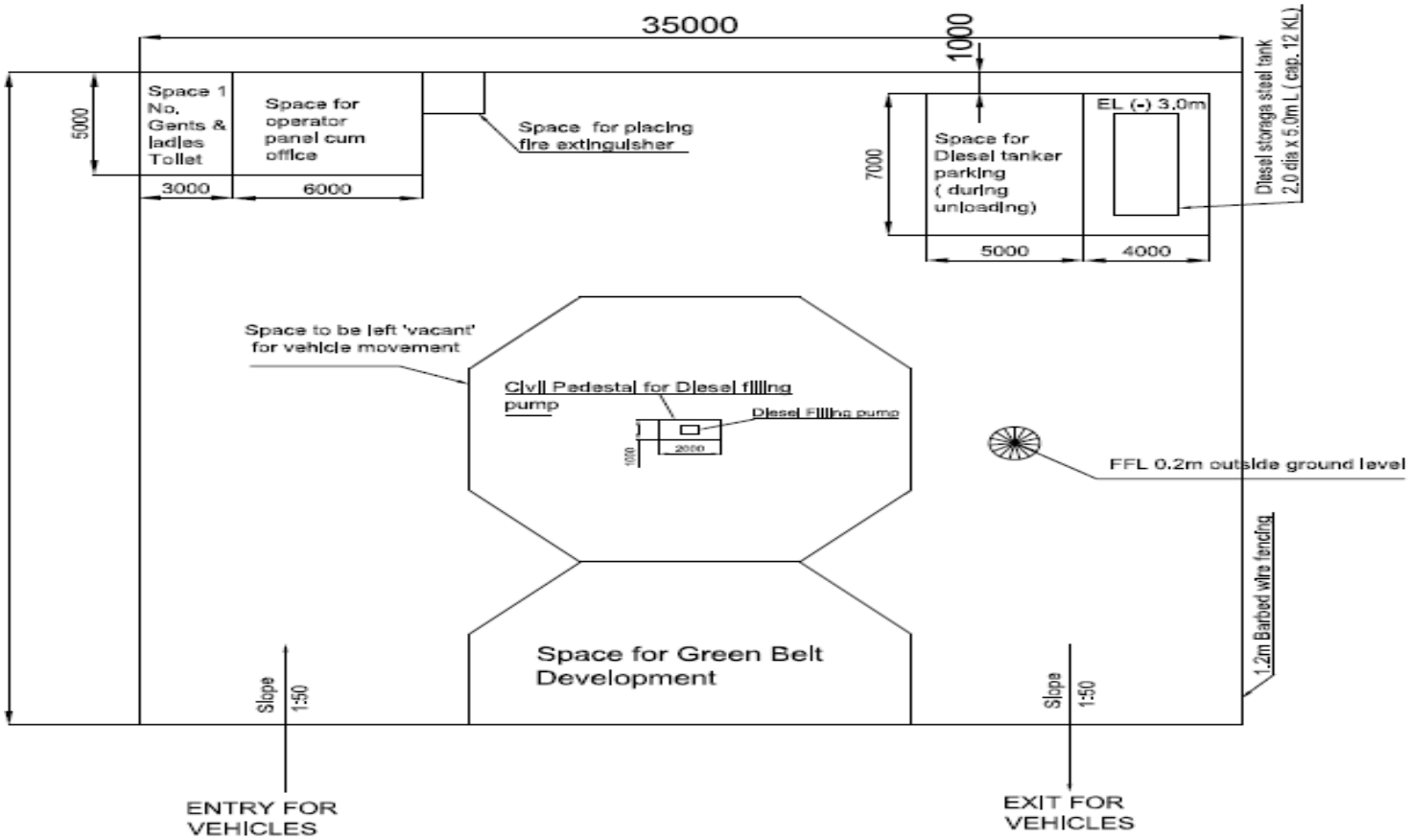
					A sketch is attached for customer ready reference. Customer to please confirm above.	



DIESEL FILLING STATION (DIESEL BUNK)

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191.	II /2.0/ 2.12	3.0.0 (14)	2 of 13	Insulation of human accessible parts/hopper/air lock vessel/pipe to maintain outside surface temperature at 60 deg. C	We have envisaged intermittent water spray through nozzle in pyrite hopper to lower the temperature/ inhibit rise in temp. Further it is desired that extra heat should dissipate quickly and equipment surface insulation shall inhibit the same. Hence, insulation has not been considered. Kindly note that similar practice is followed by bidder for earlier projects also.	Noted , however this will reviewed during detailed engineering.
192.	II /2.0/ 2.12	4.0.0	2 of 13	All the bends in the pneumatic handling system shall be provided with wear back of Ni-Hard	We have considered ACI bends for pneumatic conveying system having hardness up to 400BHN, in line with specification requirement. Thus no separate wear back of Ni-Hard has been considered nor envisaged for the application requirement. Please Confirm.	Bidder to follow specification.
193.	II /2.0/ 2.12	4.0.0	3 of 13	The water required for cooling of Dome valves and for spraying in pyrite hoppers shall be drawn from Service water distribution system	Type of inlet valve to the conveying vessel shall be supplier design specific. Hence, cooling water requirement shall be applicable only if dome valve is provided by supplier at vessel inlet. For other type of valves, cooling water requirement may not be applicable. Please Confirm.	Noted , however this will reviewed during detailed engineering.
194.	II /2.0/ 2.12	6.0.0	3 of 13	Pyrite hopper shall be provided with one cylinder operated knife gate valve and one manual operated knife gate valve on upstream which shall be normally kept in open position.	Please note as per recommendation of mill manufacturer, mill is not to be operated under any conditions with mill reject outlet spout valve in closed condition. Thus providing manually operated valve at mill reject spout will become a potential hazard in operation of mill. In view of this, we have considered only pneumatically operated valve only at upstream of pyrite hopper. This is in line with practice followed in all the executed/under-execution jobs. Please	Bidder to follow specification.

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					review requirement and accept above submission.	
195.	II /2.0/ 2.12	6.0.0	3 of 13	The bypass arrangement in pyrite hopper shall be provided for removing the raw coal to avoid mixing with rejects.	Requirement in referred clause is not clear. However kindly note that oversize and undersize bypass chutes with isolation knife gate valves have been envisaged and shall be provided. Please Confirm.	Bidder to follow specification.
196.	II /2.0/ 2.12	6.0.0	4 of 13	Transport vessel shall be provided with inlet valves, outlet valves and air inlet valves	Please note that outlet valves to transport vessel are not applicable in the system envisaged/design offered by various suppliers. Hence, the same shall not be considered. Please confirm acceptance.	This shall reviewed during detailed engineering.
197.	II /2.0/ 2.12	6.0.0	4 of 13	The vessel shall be designed considering the temperature of mill reject as 200deg C. Design pressure of the vessel shall be 1.5 times the compressor discharge pressure.	Please note that we have envisaged quenching through water spray in pyrite hopper. Thus the temperature of rejects in vessel shall be substantially low. Further, since the compressor discharge pressure shall never be encountered by vessel due to pipe line losses, we are envisaging vessel design pressure at 1.0-1.5kg/cm^2 .Please Confirm.	Bidder to follow specification.
198.	II /2.0/ 2.12	6.0.0	4 of 13	3mm thick SS304 liner in conical as well as vertical portion of Silo.	Please note that the main purpose of providing liner in bunker is to bear impact load of coal falling from tripper and ensure smooth flow. Both of these purposes are served by providing liner on conical portion of the bunker only. Liner on vertical portion of the hopper shall not serve any significant purpose. In view of this, please confirm that liner on only conical portion of the bunker is acceptable.	Bidder to follow specification.

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199.	II /2.0/ 2.12	6.0.0	4 of 13	Motor operated undercut gate of double pivoted sector type, access ladder inside the bunker, pressure relief door	Kindly note that sector gate below reject silo being OEM item from suppliers, sector gate shall be cylinder operated. Further kindly note that pressure relieve valve (as per suppliers design) shall be provided. Separate man hole on top of silo shall be provided. Kindly confirm acceptance. Kindly note that the reject bunker profile and material properties are not suitable/conducive for provisions of access ladder inside the bunker. Further, due to abrasion, use of access ladder at later date may prove to be detrimental.	Bidder to follow specification.
200.	II /2.0/ 2.12	6.0.0	4 of 13	Clear head room of 5.5m shall be maintained below the operating floor.	Please note that 4.5m clear height is sufficient to accommodate truck for mill reject disposal. Increase on operation floor elevation will unnecessarily increase the height of bunker thus causing chances of interference with fuel oil piping above bunker. In view of this, we have envisaged clear head room of 4.5m below operating floor. Please Confirm.	Bidder to follow specification.
201.	II /2.0/ 2.12	6.0.0	4 of 13	Mill reject compressor shall be located with AHS compressor.	We have envisaged mill reject compressors in main plant compressor house as the same is located closer to mill bay area as per the plot plan, thus reducing the piping length. Please Confirm.	Bidder clarification is noted.
202.	II /2.0/ 2.12	6.0.0	5 of 13	The finished receiver complete with all welded attachments shall be hydraulically tested at 150% of the design pressure. The test pressure shall be maintained for at least 30 minutes. All joints shall be gently hammered during the test.	Testing of air receiver shall be in line with IS 7938. Please confirm acceptance.	Bidder to follow specification.

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203.	II /2.0/ 2.12 & Annexure 2.12.1	6.0.0 & 7.1.0	5 of 13 & 11 of 13	Valves isolating mill pyrite hopper and rejects conveying vessel shall be of knife gate / dome type, (one number pneumatically operated and one number manually operated) & Type of mill reject handling valves: Slide type/dome/swing type	Type of valve for mill reject handling shall be supplier specific. Please Confirm.	Bidder to follow specification.
204.	II /2.0/ 2.12	6.0.0	5 of 13	The valves shall be tested hydraulically to a pressure of minimum of 1.1 times (for seat) and 2.0 times (for body) the maximum pressure encountered. Air tests shall be conducted to detect seat leakage.	Knife gate valves shall be tested as per MSS-SP81. However, other mill reject conveying valves shall be as per manufacturer's standard practice. Please confirm acceptance.	Bidder to follow specification.
205.	II /2.0/ 2.12	6.0.0	5 of 13	Mechanical lever for manual operation of the valve shall be provided additionally on solenoid operated or pilot air operated valve for compressed air line.	Mechanical lever for manual operation is not available in market for control valves. Hence, option of manual operation of control valves shall be subject to availability in market. Please Confirm.	Bidder to follow specification.
206.	II /2.0/ 2.12	6.0.0	5 of 13	The main valves shall be tested hydraulically to a pressure of minimum 1.1 times (for seat) and 2.0 times (for body) the maximum pressure encountered. Control valves and pneumatic cylinders shall be tested to a pressure of minimum 1.5 times the maximum pressure encountered.	Pneumatic cylinder of the valve shall be tested as per IS 14167. For testing of valves, please refer our clarification against S. no. 15 above.	Bidder to follow specification.
207.	II /2.0/ 2.12	6.0.0	6 of 13	MOC for cooling water piping shall be SS	Normally MS ERW (H) pipes as per IS: 1239 are used for the application. SS pipes are not envisaged for the application. Kindly review requirement and confirm acceptance as above.	Bidder to follow specification.
208.	II /2.0/ 2.12	8.0.0	7 of 13	Drawings, data / documents to be submitted along with the bid	We are submitting technical schedules and list of mandatory spares considered with the bid. All other details shall be in line with specification requirements	Bidder to follow specification.

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					except clarifications/deviations considered. Rest of the documents shall be submitted during detail engineering.	
209.	II / 2.0 / Annexure 2.12.1	2.2.0	9 of 13	Buffer Capacity of pyrite hopper: minimum 1.5m3 or effective volume of 3 cycles, whichever is higher	Please note that buffer capacity of 1.5m3 is too high for pyrite hopper and for conforming to this requirement, pyrite hopper, conveying vessel, bypass & emergency chutes along with other accessories will have to be placed in pit thus causing maintenance difficulty for customer at later date. In view of this, we shall provide pyrite hopper with minimum buffer capacity as effective volume of 3 cycles. This is in line with practice followed for all other executed/under-execution jobs. Please confirm acceptance.	Bidder to follow specification.
210.	II /2.0/ Annexure 2.12.1	2.3.0	9 of 13	6mm thick SS316 liner for pyrite hopper	Kindly note that as velocity of reject in the pyrite hopper is nominal liner for the pyrite hopper is not envisaged in line with earlier executed projects. Kindly review requirement and confirm acceptance.	Bidder to follow specification.
211.	II /2.0/ Annexure 2.12.1	6.2.1 c)	11 of 13	Material of construction for conveying air pipe flanges: ASTM A 105 (A283 GR-C for 200NB and above)	Since there is no demarcation of flanged connection between pipe and fittings/valves, we are providing socket welding for sizes up to 50NB and flanged connections for more than 50NB size pipes. Please confirm acceptance.	Bidder to follow specification. Refer 6.2.1 clause no: e
212.	II /2.0/ Annexure 2.12.1	7.0.0	11 of 13	Details of mill reject handling valves	Plate/disc with 10mm thick SS plate with 300-350BHN hardness is not a standard product available in market. Similarly, seat with 250BHN hardness doesn't fall in standard manufacturing range of suppliers. In view of this, we propose material of MR handing valves as under:	Bidder to follow specification.

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					Knife Gate Valves: a) Body-CI to IS 210 Gr FG 260 b) Gate-SS (ASTM A240 type 304 with abrasion resistant material of hardness 350-400BHN Dome / swing valve a) Body-CI to IS 210 Gr FG 260 b) Dome-Alloy CI with hardness as 225BHN c) Shaft: SS 304 d) Disc- SS 304/Alloy CI Please Confirm.	
213.	II /2.0/ Annexure 2.12.1	8.4.0	12 of 13	Continuous/ RF type bunker level measurement and indicator	We have envisaged Hi level probe for mill reject bunker to give annunciation in DCS, as indicated in tender flow diagram for MRS. Continuous level measurement through level transmitter is not required as system conveying shall be stopped once Hi level is sensed by level probe. Hence continuous level monitoring has not been considered. Please Confirm.	Bidder to follow specification.
214.	II /2.0/ Annexure 2.12.1	10.2.0	13 of 13	Ni-hard deflector (500-550BHN Hardness) for terminal box	Ni-hard material is brittle in nature owing to its high hardness. We shall provide SAIL HARD/TISCRAL lining on the terminal box plate with 180-200BHN hardness which will take care of the abrasion/impact due to mill rejects.	Bidder to follow specification.
215.	II /2.0/ Annexure 2.12.1	Note	13 of 13	All equipment shall be suitable for sea water application.	None of the equipment in MRS shall be used for sea water application. Hence, the said clause is not applicable.	Noted.

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216.	II / I /-	General		MS for MRS	Mandatory spares, as applicable, for the system considered by MRS supplier shall be supplied in line with list provided.	Bidder to follow specification. Refer Vol-II, Section-1, Pg 152 of 191.
THERMAL INSULATION AND PIPING LAYOUT						
217.	II/2.0/ 2.20	9.2.3	31 OF 31	Piping general arrangement dwg	Composite piping layout will be furnished.	Bidder to follow specification.
218.	II/2.0/ 2.21	CL 3.1.0	1 of 4	Mineral (Rock) Wool material of density 150kg/m3 shall be provided for piping and Fittings.	150 kg/m3 normally used for temperature above 400 deg C, for temp 400deg C & below 100kg/m3 density mattresses is used. Pl clarify.	Bidder to follow specification.
219.	II/2.0/ 2.5	Cl 5.1.0	15 of 22	Turbine exhaust shall be separately piped to the condenser of main TG unit in the downward direction.	In case of TDBFP at lower elevation the turbine exhaust will be upward.Pl confirm.	Bidder to follow specification.
CIVIL						
220.	II/1.0/-	2.4.0 Civil	20 of 191	Drains from Owner's non-plant buildings (those which are not in EPC contractor scope)	Please define owner's non-plant buildings from which storm water surface run-off is to be inter-connected with main storm water network by EPC contractor.	Storm water drainage system is to be designed for the complete plant area, irrespective of, is there is a building or not. Hence, this clause means, EPC contractor need to take over the storm water discharge from non-plant buildings

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						to be constructed by owner, if any.
221.	II/5.0/5.2	5.2.3.4 Roads and Drains	6 of 38	Patrol road along boundary wall shall be single lane road.	Patrol road along boundary wall shall be single lane road without shoulder. Please confirm.	Clause 5.2.3.4 says "Patrol road along boundary wall shall be single lane road." " Single lane roads shall be of 4.0 m wide with 1.0 m wide shoulders on both sides of the road."
222.	II/5.0/5.2	5.2.26.3 Workshop and Permanent Store	30 of 38	**Workshop and Permanent Store…….** The workshop and store shall be of structural steel frame work…	Workshop and permanent store shall be of RCC framed structure with structural steel roof truss and brick cladding. Please confirm.	Confirmed.
223.	II/5.0/5.2	5.2.27.1 Condensate Storage Tank Foundations	34 of 38	Foundations for the condensate tank and associated pumps shall be of RCC construction.	Foundations for the condensate tank and DM tank shall be of RCC ring wall. Please confirm.	Confirmed
224.	II/5.0/5.5	5.5.2.2 Foundations and Underground Structures	2 of 37	Maximum settlement for, (as per Table 1 of IS: 1904) a) Isolated footings : 25 mm b) Rafts : 40 mm	Maximum settlement for, a) Isolated footings: 25 mm-For buildings/structures in BTG area and 40mm for other BOP/Non-plant building/structures. b) Rafts : 75 mm for all buildings/structures in BTG/BOP area Please confirm.	Bidder to follow specification

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225.	II/5.0/5.5	5.5.2.3 Liquid Retaining Structures	4 of 37	Pressure relief valves shall be of gun metal.	Pressure relief valves in liquid retaining structures shall be of PVC as per standard practice. Please confirm.	Bidder to follow specification
226.	II/5.0/5.5	5.5.2.4 Machine Foundations	5 of 37	Steam turbine generators, Boilers Feed Pumps and crushers may be supported on vibration isolation system	Steam turbine generators, Boilers Feed Pumps and crushers may be supported on vibration isolation system/block foundation. Please confirm.	Bidder to follow specification
227.	II/5.0/5.11	5.11.7 BACKFILLING	5 of 8	Density requirements as per standard Proctor Test shall be in accordance with relevant parts of IS:2720 and all tests shall be made by/on under the supervision of Purchaser at contractor's own expenses, at optimum moisture content:- a) Backfilling of foundations and under grade slabs - 98% b) Under roadways and parking areas - 95% c) Embankment - 95%	Backfilling in foundations shall be 90% standard Proctor density against the specified 98% as the clear space between foundation and excavated face is limited due to which heavy compaction equipment cannot be deployed and accordingly 98% compaction is difficult to achieve. Please confirm.	Bidder to follow specification
228.	II/5.0/5.2	5.2.3.4 Road and drains	6 of 38	The drainage system shall be designed for rainfall intensity resulting from a 1 in 50 year frequency rainfall event.	Please furnish the design rainfall intensity in mm/hr for storm water design.	Design rainfall intensity shall be taken as 100 mm / hour.
229.	II/5.0/5.3	5.3.11.2 Roof drainage	8 of 11	Rainwater collected from roofs shall be let into a rainwater harvesting pit. Rainwater collected from major buildings may be let into raw water reservoir.	There is no raw water reservoir envisaged in the plot plan. We understand that rainwater collected from major buildings may be let into rain water harvesting recharge pit. Please confirm.	Confirmed

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230.	General	-	-	-	Please provide the following drawings in AUTO CAD format. 1. Plot Plan 2. Contour Map 3. ESLD	Provided
231.	II/1.0/-	5.3.0	28 of 191	Area drainage study as required is in Contractor's scope of work.	Area drainage study provided by customer vide Sl. No. 10 of attachments in Vol III shall be followed. No separate area drainage study is required. Please confirm.	Confirmed
232.					We invite your kind attention to the Bid Specification Vol-II, section 2 Annexure 2.1.1 Page 54 of 66 (Specified Design Data - Steam Generator & its Auxiliaries) which stipulates the various pressure part materials with their temperature range. With respect to the above details, we propose the following changes which is as per the latest codes and is also being followed by other utilities as on date	**Pressure Parts Materials** Above 605 deg C : Austenitic stainless steel, Super 304H, TP347H or equivalent shall be provided. Bidder shall meet the process parameters as per specification.
233.					**Pressure Parts Materials** a) Up to and including 400°C : Carbon steel to ASME SA 106 Gr. B/C or SA 210 Gr.C or approved equivalent b) Upto & including 550 deg C : Alloy steel to ASME SA-335: P-11/P-12/ P 22/ P-23;ASME SA213 : T-11/T12/ T22/T23/ or approved equivalent. c) Upto & including ~~605~~ 610 deg C: Alloy steel to ASME SA-335/213:P-91/T-91, **P-92**/T -92, or approved equivalent	

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234.	II/1.0/-	6.1.3 Roads, Fencing and Compound Wall	30 of 191	Approach roads to the plant site shall be provided to access from existing road network. (SH-176).	Please provide the length and contour details of proposed approach road stretch.	Length and contour details can be arrived from Topo survey drawings.
235.	II/5.0/5.2	5.2.3.8 Storm Water Diversion Channels	8 of 38	A peripheral channel along the western boundary of the project site to drain off the runoff from watersheds on the western side of the project site.	Please confirm the location and scope of proposed diversion channel in view of future extension projects.	The peripheral channel along the western boundary of the project site to drain off the runoff from watersheds on the western side of the project site mentioned in the specification **need not be considered**
	Chimney					
236.	II/5.0/5.10.1	5.10.1.3.1	8 of 32	Air outlets.....intake and exhaust of air for ventilation and pressurizing system as per the requirements of supplier.	Please note that ventilation shall be natural ventilation. Pressurised ventilation is generally provided in brick liners. In steel liner chimneys, with steel internal platforms, pressurized ventilation is neither required, nor feasible. Please confirm.	Noted
237.	II/5.0/5.10.1	5.10.1.3.1	11-12 of 32	The minimum.....vertical reinforcing.....they shall not be spaced at more than 250mm centres.	Maximum spacing for vertical reinforcement in shell shall be considered as 600 mm as per IS 4998 (PART I) cl 9.2.1.3. Considering 250 mm spacing as per specification can lead to problems while concreting. Please confirm.	Bidder to follow specification
238.	General	-	-	-	Please provide the following details:- 1. High flood level (HFL)of the site	Already available in General Tech. Spec./Vol-II / Sec-1/ Clause 5.2.0

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					2. Location of disposal area for disposing surplus earth.	Within the plant area
239.	II/5.0/5.10.1	5.10.1.3.1	7 of 32	In anticipation.....aerodynamic interference shall be considered for the design of chimney from fig1 of IS 4998 Part-1..... A provision of 10% increase in the wind forces (due to dynamic interference effect) as calculated based on relevant codes, shall be considered in the initial designs.	Fig 1 of IS 4998 is erroneous and not followed else-where. Hence, Initial 10% increase in the wind forces (due to dynamic interference effect) shall be considered in the initial designs, verified by value coming from wind tunnel test. Please confirm.	Bidder to follow specification
240.	II/2.0/ 2.21	CL 5.0.0	8 OF 31	50% extra space for the routing of future pipes for stage –II shall be provided in the pedestals and pipe rack. While designing the pipe rack / pedestal, extra 50 % load shall be taken in order to meet the future pipes. Number of the future pipes will be finalized during detailed engineering.	Pipe rack is being considered for two units of stage I .By providing 50% space it is not possible to accommodate the pipes of 4 future units i.e. stage II.But necessary space provision for interconnection of Aux steam .We presume dedicated pipe rack for future units is being planned separately .Please review and confirm.	The plot plan provided by the owner along with this tender specification is indicative only. It is the intent of the owner to provide extensions in future for four more units in adjacent land. The bidder shall develop a plot plan for 2 x 660MW considering the future requirements of TANGEDCO and submit the same along with Bid.
241.	Vol-II, Sec-3 Clause no.- 6.1.0 (4), Pg-117 of 353			Short circuit duration - 3 sec	IPBD short time current duration shall be considered as 1 sec instead of 3 sec. Pl confirm.	Bidder to follow specification.
242.	4.13.1	Vol. II / Section 3.3 / Spec. No. SE/C/UP/ EE/ E/OT No.01/		The Gas Segregation	TANGEDCO shall appreciate that the maximum availability of the feeders and bus bars are of utmost important for the	Bidder suggestion of improving gas compartment portioning

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		2015-16 & DWG No. 10-1115112-E-202 Rev.0			HV s/s especially for the generating stations. The partioning concept of the gas compartments of the GIS substation plays the vital role for maintaining the service continuity during repair & maintenance of GIS components. IEC 62271-203 provides the detail recommendation in this regard in the Annexure F. Enclosed is a PGCIL gas scheme which aptly implements this recommendations. Two major highlights are 1. Bay wise gas segregation of the bus bar (this also helps in removing bus sectionalizers understood to be used for future extensions) and 2. CB in the separate gas compartment. Same is also described in clause no. 12.2.0 in this speciation but is not reflecting in the Gas SLD. Inline with this, request to kindly make the necessary changes in the gas scheme.	concept is noted. However detailed aspects of gas segregation will be firmed up during detail engineering stage.

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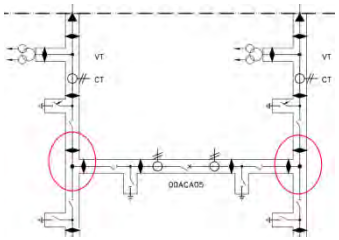
243.		General		Additional earth switch at 'T' point	In GIS schemes, the 'T' point are not accessible for earthing during maintenance unlike AIS schemes. Hence, same is recommended to be incorporated. Enclosed PGCIL SLD can be referred for arrangement. 	Bidder shall provide necessary earthing switches for all "T" points. However these aspects will be firmed up during detailed engineering stage.
244.	6.5.0	Vol. II / Section 3.3 / Spec. No. SE/C/UP/EE/E/OT No.01/2015-16		Optical indicator for isolator	Easily visible open & close indications shall be provided on the drives. Also for verification of physical isolation of Isolator contacts, inspection windows of sufficient size are provided. Hence, requirement of optical indicators are not envisaged.	Bidder to follow specification
245.	7.3.0	Vol. II / Section 3.3 / Spec. No. SE/C/UP/EE/E/OT No.01/2015-16		The earth switch shall also comply with the requirements of IEC-601129, in respect of induced current switching duty as defined for Class-B Earth switches.	The induced current switching duty shall be applicable to the exit Earth switch i.e. FAES which shall be of Class-B as required by cl. 8.5.0. Maintenance Earth switch shall not subject to induced switching duty of Class-B type.	Bidder to follow specification
246.	8.3.0	Vol. II / Section 3.3 / Spec. No. SE/C/UP/EE/E/OT No.01/2015-16		FAES shall be constructionally interlocked with their associated circuit breaker such that the grounding switches cannot be closed if the circuit breakers are closed. The constructional interlocks shall be built in construction of isolator and shall be in	Fast acting Earth switch is electrically interlocked only with associated disconnector along with pedlock facility for maintenance purpose. No built in constructional interlock provided.	Bidder to follow specification

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				addition to the electrical interlocks.		
247.	9.1.0	Vol. II / Section 3.3 / Spec. No. SE/C/UP/EE/E/OT No.01/2015-16		The instrument transformers shall be of metal enclosed, inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation.	The current transformers should be outside of the SF6 compartment to avoid any degradation of the SF6 insulation due to any problem in CTs, and, easy access and maintainability of the current transformers.	Bidder to follow specification
248.	11.1.0	Vol. II / Section 3.3 / Spec. No. SE/C/UP/EE/E/OT No.01/2015-16		Separate control cubicle including gas monitoring kiosk shall be provided for each bay which shall be installed near the swtichgear for local control & monitoring of respective switchgear bay. Local control cubicle for GIS shall be equipped with suitable hardware & software for remote control operation and conform to the bay level controller unit.	1. Kindly elaborate requirement of gas monitoring kiosk. Does this mean a 'online gas monitoring system' with local HMI and provision for SCADA interface for remote monitoring? 2. The offered LCC shall be convention all type as per the standard design and it shall contain no software. If it is referring to BCU then it should be a part of remote CRP Panels.	Bidder to follow specification
249.	12.4.0	Vol. II / Section 3.3 / Spec. No. SE/C/UP/EE/E/OT No.01/2015-16		The enclosure shall be manufactured and tested according to the pressure vessel code.	IEC does not have a pressure vessel code & ANSI is more appropriate for Mechanical equipments. For GIS, the applicable standard is CENELEC standard. Request to confirm.	Applicable IEEE / CENELEC standard shall be followed for pressure vessel code.
250.	18.5.0			d) Line differential relays shall be provided for shorter line lengths. e) Line differential protection shall be considered for lines having OPGW network.	As per SLD for Metering and Protection, Drg. No. 10-1115112-E-203, R0, all lines are provided with distance protection. Hence we understand that all outgoing lines are not shorter line and Line differential protection is not required. Kindly confirm.	The type of protection for lines either differential or distance shall be finalized during DDE.
251.	18.5.0			f) Phasor Measurement Unit (PMU) shall be provided for feeders as per the requirement of grid authority.	PMU called in the specification of Line protection is available as built-in function of distance protection relay. Kindly confirm acceptance.	Bidder to follow specification

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252.	18.5.0			g) For line feeders, synchronizing socket shall be provided in the **relay panel**, for manual synchronizing through synchronizing trolley.	Keeping control (BCU, synch sockets, TNC switch etc) and protection relays on same panel will lead to bulky wiring inside the cubicle. Neatness and traceability during O&M will be difficult. We propose to provide control and protection on separate cubicle. Kindly confirm.	Bidder to follow specification. However the proposed modification for a separate control and protection cubicle shall be reviewed and approved at the time of DDE by owner.
253.	**19.0.0**			**DISTURBANCE RECORDER (DR) -** The disturbance recorder shall comprise of distributed individual acquisition units, one for each feeder and an evaluation unit common for the whole GIS Switchyard.	Disturbance Recorder called is for each feeder (outgoing lines). Distance Protection Relays are having built-in DR meeting the TANGEDCO specification requirement in totality. Kindly confirm acceptance to built-in DR facility in distance relays for each feeder (outgoing lines).	Bidder to follow specification
254.	**19.0.0**			• Software along with interface port for transferring the data automatically from local evaluation unit to a remote station and receiving the same at remote station through OPGW / VSAT / leased line.	Distance relay once hooked up on SAS LAN, disturbance records can be retrieved from remote station over same communication infrastructure. Kindly confirm acceptance to built-in DR facility in distance relays for each feeder (outgoing lines).	Bidder to follow specification
255.	20.14.0			The SAS shall contain the following main functional parts: e) Dual redundant communication bus at station level and at BCU level f) Dual redundant communication between intelligent electronic devices (IEDs) and Ethernet switches. l) Communication link for protection relays	As per SAS drawing, Drg. No. 10-1115112-E-217,R0 dual redundant link is called for BCU and Single link is called for relay interconnection. Kindly re-confirm requirement as per SAS drawing.	Drawing is indicative. Communication links for protection relays shall be redundant
256.	20.14.0			The SAS shall contain the following main functional parts:	Referring SAS drawing, Drg. No. 10-1115112-E-217,R0 and Elect Monitoring	Drawing is indicative. Bidder to follow

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				j) Dual redundant bi-directional communication link & gateway for power plant DCS k) Dual redundant bi-directional communication link & gateway for power plant electrical monitoring system (EMS)	and Energy Management System drawing, Drg. No. 10-1115112-E-218,R0, no interconnection is envisaged between the two systems. Of course both the systems are reporting to Plant DCS and remote station. Hence data will be available from the two systems at Plant DCS and remote station. Kindly confirm acceptance to interconnection as per above drawings.	specification.
257.	20.17.0			The data exchange among bay level IEDs, and between bay level and station level take place via the dual fiber optic inter-bay bus according to IEC 61850-8-1 standard. **One Ethernet switch shall be provided for each bay.** The connection from each IED to the switch shall be by a dual fiber optic link. The Ethernet switches shall be connected in a dual redundant fault tolerant ring.	1/ To minimize MTBF and MTBR and maximize availability of the system as desired in the specification, we may go for more than one number of Ethernet switches per bay. Kindly confirm. 2/ Connection from each IED to Ethernet Switches can be over Copper/FO port as available from the IED manufacturer as both IED and Ethernet Switch will be within the cubicle/board. Also refer Clause 4.8.9 of Section 3.11 where Ethernet Switches are called with two FO and 14/16 Copper ports. Kindly confirm connection from each IED to Ethernet Switches can be over Copper/FO port.	Bidder to follow specification
258.	20.25.0			BCU shall be located in relay panels of respective bays. A separate control switch (TNC) spring return type with pistol grip handle for each breaker shall be provided in the SAS panels housing the BCU to facilitate manual operation.	Keeping control (BCU, synch sockets, TNC switch etc) and protection relays on same panel will lead to bulky wiring inside the cubicle. Neatness and traceability during O&M will be difficult. We propose to provide control and protection on separate cubicle. Kindly confirm.	However the proposed modification for a separate control and protection cubicle shall be reviewed and approved at the time of DDE by owner.
259.	20.28.0			Large video screen shall be 84".	Maximum 80" LVS is available from all leading manufacturer.	Bidder to follow specification

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					Kindly accept.	
260.	21.1.0			Tariff meters shall meet the requirements of the respective State Electricity Regulatory Commission.	Kindly arrange to furnish requirements of the respective State (Tamil Nadu) Electricity Regulatory Commission to review the same and offer suitably. Any non-standard requirement if come up during execution may have techno-commercial implication.	Bidder to follow specification Regulatory documents can be down loaded from respective website.
261.	21.17.0			The meters shall have following facilities: a) Communication port: RS 485, RS 232 & front optical port & Ethernet port.	As per SAS drawing, Drg. No. 10-1115112-E-217, R0, all tariff meters are looped on rear RS485 communication port over MODBUS protocol. Hence we propose to provide Front RS232/optical port for communication to MRI and rear RS485 port for remote communication over MODBUS. In view of above Ethernet port on Tariff meters are not required. Kindly confirm.	Bidder to follow specification
262.	**Section 3.11**					
263.	2.0.0			The scope of work shall include supply, installation, testing and commissioning of the following: a) Relay panel for generator transformer of Unit-1 b) Relay panel for Unit transformers of Unit-1 d) Relay panel for station transformer-1 e) Relay panel for generator of Unit-1	Protection System is designed as Unit Protection (Generator, GT, UAT and ST Protection as whole) and hence separate relays panels for each equipment is not recommended. Kindly accept suite of panels for protection of Generator, GT, UAT and ST incorporating all protections envisaged as per specification.	Bidder to follow specification
264.	2.0.0			l) Relay testing kit	Section 3.32 Electrical Lab equipment (Sl No. 12 of Clause 2.2.0) is already having three phase Universal relay test set and hence same is not required to be supplied along with this package. Kindly confirm.	Bidder to follow specification

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265.	4.4.3			The earth fault detection principle shall be of low frequency injection method. It shall not be harmonic distribution type.	Stator and Rotor Earth fault protection is principally based on frequency (other than normal frequency) injection principle so as to sense fault during machine shutdown as well. Hence frequency (other than normal frequency) injection meets the requirement. Kindly accept.	Bidder to follow specification
266.	4.4.4			• Voltage Restrained Over current Protection (51VG) • Back-up Impedance Protection (21G) (two stage)	As per CBIP recommendation CBIP-274 and standard practice followed for Generator Protection, 51VG is deployed for small rated machines and back-up impedance protection (21G) for higher rating machines. Kindly furnish acceptance to back-up impedance protection (21G) for the project.	Bidder to follow specification
267.	4.5.0			Internal Arc withstand Rating	Please consider Internal Arc withstand rating of 40 kA 1 sec for 11 kV switchgear instead of 50 kA 0.5 sec.	Bidder to follow specification
268.	5.1.8				Please note that switchgear up to 3150 A normal current rating shall be natural air cooled only. Above 3150 A rating, forced cooled switchgear shall be considered	Bidder to follow specification
269.	II	Sec.:3.10	165	5.2.5 The arrangement of the feeders shall ensure that operating handle of the switch/breaker shall be above 350mm but below 1800mm from finished floor level.	The working height shall be limited within 200mm to 2000 mm.	Bidder to follow specification.

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270.	II	Sec.:3.10	160 4.2.1	Ambient temp. prevelling inside the switchgear while carring ratted current ,when the outside air ambient temp. is 50 deg. C shall be considered as design ambient temp. for sizing the equipment/device/bus rating. Continuous current rating shall be such that the tem. Does not exceed 90 deg. C. For silver plated joints the temp. shall not exceed 105 deg. C.	Temp. Rise test will be as per IEC 61439-1(for LV panel) and IEC 61439-2(for Bus duct).	Bidder to follow specification.
271.	II/3.0/ 3.7	4.10.0	121 of 353	The connections & GCB shall be rated to carry the full unrestricted fault current for 3 seconds	Only GCB and disconnector shall be rated to carry fault current for a duration of 3 sec. Earth switch shall be rated for 1 Second. Please confirm	Bidder to follow specification.
272.	II/3.0/ 3.7	4.4.0	121 of 353	Continuous current rating of GCB shall be selected considering the generated power evacuation at Valve wide open condition. A 10% margin shall be considered for both continuous current and interrupting current and rounded off to next higher rating.	Continuous current rating of GCB shall be selected considering the generated power evacuation at Valve wide open condition at 95% operating voltage. This is the maximum current GCB shall be required to handle. Further margin of 10% on this rating shall not serve any useful purpose hence it is not considered. Please Confirm.	As per specification, 10% margin shall be considered for both continuous current, **which is MCR rating** and interrupting current rating and rounded off to next higher rating.
273.	II/3.0/ 3.7	5.5.0	123 of 353	GCB enclosure shall be non-magnetic aluminum alloy, minimum flux, and isolated phase type with degree of protection IP-55.	Please note that since GCB shall be indoor installed type hence GCB enclosure IP protection shall be IP 54. Please Confirm.	Bidder to follow specification.
274.	II/3.0/ 3.7	5.15.0 a)	125 of 353	Electrically operated short-circuiting switch shall be provided.	Please note that Short circuit switch shall be manually operated. Please Confirm.	Bidder to follow specification.

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275.	II/3.0/ 3.7	5.17.0 & 5.18.0	126 of 353	Current transformer & Voltage transformer	All current transformers meant for generator protection and metering shall be installed in IP Bus duct. All Voltage transformers for generator protection and metering shall be installed in LAVT and SPVT cubicles. Please confirm	Bidder to follow specification.
276.	II/3.0/ 3.7	5.19	127 of 353	The electrical motor operated spring charge mechanism shall be provided for the GCB, Complete with all control equipment. .	Operating mechanism of GCB shall be motor operated spring charged / hydro-mechanical spring charged as per GCB manufacturer practice. Please confirm	Bidder to follow specification.
277.	II/3.0/ 3.7	5.20 h)	128 of 353	A system of hard wired safety interlocks shall be provided by means of auxiliary contacts on all necessary remote equipment so as to prevent • Closing of disconnectors unless all relevant earthing switches are open • Closing of earthing switches unless all relevant disconnectors are open and all relevant HV and LV circuit-breakers withdrawn into the test position.	Please note that all the safety interlocks pertaining to GCB circuit, shall be built in the GCB itself as per OEM practice.	Bidder to follow specification.
278.	II/3.0/ 3.7	7.1.0	129 of 353	All the equipment shall be of type tested quality.	Type test report of GCB may be more than 5 years old also as submitted by GCB OEM manufacturer. Please accept.	Bidder to follow specification.
279.	II/3.0/ 3.11	4.4.4	188 of 353	Over Excitation Protection (61G) (two stages)	Please note that over fluxing protection (99G) shall be provided instead of Over Excitation Protection (61G). Please Confirm.	Bidder to follow specification.
280.	II/3.0/ 3.11	4.4.4	188 of 353	Neutral point displacement protection	Please clarify the purpose of this protection as Stator Earth Fault 95% & 100% Protection (64G1, 64G2) is already envisaged.	Bidder to follow specification.

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281.	II/3.0/ 3.32	2.2.0	349 of 353	Make & Model of Equipments	Please note the Lab equipments make shall be as specified in the tender specifications or of equivalent reputed make. Please Confirm.	Bidder to follow specification.
282.	II/3.0/ 3.32	-	-	-	Please furnish technical specification for lab equipment items esp. items at Sl. No. 6,7,9,10 ,14-21,24,25,27,32,36,38,41-49 of the list.	Lab equipment shall of specific make and model as stated in specification.
283.	II/3.0/ 3.21	4.2.0	266 of 353	For H2 plant, Fuel unloading pump house, Tank farm area & FOPH shall be provided with explosion proof system.	Please note that outdoor PA system equipment in these areas shall be provided with flame proof type.	Bidder to follow specification.
284.	II/3.0/ 3.29	4.1.0	325 of 353	A clear head room clearance of 1800 mm shall be provided in the cable spreader room.	Clear head room clearance of 1800mm (minimum) shall be provided in walkways of cable spreader room.	Clearance of 1800 mm shall be provided in walkways and to its access way and also wherever personnel access in addition to the above is required.
285.	II/3.0/ 3.1	4.14.0	10 of 353	Voltage level for AC motors Up to 0.2 kW : 230 V, 1 phase, 50 Hz Above 0.2 kW up to 200 kW voltage : 415 V, 3 phase, 50 Hz Above 200 kW & up to 2000 kW : 6.6 kV, 3 phase, 50 Hz Above 2000 kW : 11 kV, 3 phase, 50 Hz	Voltage level for AC motors Up to 0.2 kW : 230 V, 1 phase, 50 Hz Above 0.2 kW up to 200 kW voltage : 415 V, 3 phase, 50 Hz Above 200 kW & up to 1500 kW : 6.6 kV, 3 phase, 50 Hz Above 1500 kW : 11 kV, 3 phase, 50 Hz Please Confirm.	Bidder to follow specification.
286.	II/3.0/ 3.4	3.19.0(a)	74 of 353	a) Generator transformer shall be used to connect to EHV network to evacuate power. The transformer shall be adequately sized for the stringent operating condition. It shall be rated to evacuate full power of the generator with valve wide open condition at 95% operating voltage, when unit/station	There is mismatch between the two specification clauses. The Generator transformer rating shall be 3 x 275 MVA. Please confirm.	Generator Transformer Rating shall be 3X275MVA (Single phase) as per specification Vol-II, Section-3, DTS-Electrical, page 91 0f

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		6.1.0	91 of 353	auxiliaries are not powered directly by generating source. Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator. b) Rating Maximum : 3x 275 MVA		353. The last sentence of referred clause "Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator." is deleted.
287.	II/3.0/ 3.23	4.1.1	283 of 353	Tubular day light guidance system	Please note that this is a typical requirement generally not applicable for thermal power plant. Please review the requirement of this system. Further this item is not yet established.	Bidder to follow specification.
288.	II/3.0/ 3.23	6.4.0	293 of 353	In all office rooms & Control rooms conduit shall be concealed type. In, admin building, canteen, dispensary, concealed conduit wiring shall be adopted.	Please note that in false ceiling areas conduits shall not be concealed type for ease in maintenance.	Noted.
289.	II/3.0/ 3.1	2.1.0. & 4.9.0	5 of 353 & 9 of 353	25) 33 kV switchgear To feed external coal handling system 2 Nos. each 25 MVA rated feeders shall be provided at 33 kV switchgear located, at Sea water intake electrical room near plant boundary.	Two nos. 11/34.5kV transformers fed from 11kV Station Swgr shall be provided and shall be located near the plant boundary (near sea water p/h). Please Confirm.	Bidder to follow specification. Bidder to refer drg No. 10-1115112-E-201
290.	II/3.0/ 3.4	6.1.0 6.4.0	91,94 of 353	Technical parameters of Generator transformers : Vector group YNd1 Technical parameters of Unit transformers : Vector group Dyn11	Vector group shall be Ynd11 for Generator transformer since it results in better layout design. Due to above, vector group for UT shall be Dyn1. Please Confirm.	Bidder to follow specification.
291.	II/3.0/ 3.4	6.7.0	97 of 353	Technical Parameters of Oil filled External CHP Transform	ONAN/ONAF rating shall be 60%/100% in line with other transformers. Please Confirm.	ONAN/ONAF rating of Oil filled External CHP transformers shall be 80%/100%

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292.	II/3.0/ 3.1	4.21.0	11 of 353	Main plant electrical system shall be controlled and monitored from plant DCS. Electrical system of auxiliary plants (such as CHP, AHP, WTP, Desal plant, water intake system, Fuel oil system, Fire water system, etc.) shall also be controlled and monitored from respective control system. Further the entire plant electrical system shall be monitored from SCADA based electrical monitoring system EMS).	We understand that control of electrical systems shall be from DDCMIS / PLC of the respective areas. Only monitoring of electrical systems shall be from EMS. No control of HV / LV switchgear is envisaged from EMS. Please confirm.	Bidder to follow specification.
293.	II/3.0/ 3.1	5.10.0	13 of 53	Cable spreader room shall be provided for all the electrical room and control rooms and control equipment rooms for the various buildings and areas….	Cable spreader room shall be provided for Main plant turbine building ; Central control building ;·Switchyard control building; ESP control building; Ash handling plant ;·Coal handling plant etc and other HT switchgear rooms. This is in line with existing TANGEDCO projects Please confirm.	Bidder to follow specification.
294.	II/3.0/ 3.1	5.30.0	15 of 53	All electrical buildings shall have two floor construction with the following rooms	This clause is not applicable for switchgear located in main plant turbine building and for electrical buildings which do not have cable spreader. Please confirm.	Bidder to follow specification.
295.	II/3.0/ 3.8	6.04.0 (a) and (b)	148 of 353	Station to Unit Transfer: During plant start, Unit switchgear will be energized through tie feeder. After stabilizing generation, incomer breaker will be closed by the operator through manual planned changeover and the tie breaker will be tripped through BTS. Unit to Station Transfer under following conditions: ··Manual planned transfer during normal operation of the unit (in case Unit transformer is to be taken out from	There is no tie between unit board and station board. Hence station to unit transfer and unit to station transfer is not envisaged. Please confirm.	Bidder to follow specification. Station transfer achieved at 11kV Standby switchgear. Bidder to refer drg No. 10-1115112-E-201

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				service). ‥Protective transfer shall be initiated automatically on operation of Master trip relay of the Unit. ‥Auto transfer during under voltage, bus under frequency or high df / dt by continuously monitoring the system parameters.		
296.	II/3.0/ 3.9	4.2.0	155 of 353	The short time current rating of the NGR shall be such that it can allow about 300 A current for 5 minutes without exceeding the temperature rise of 300oC over 50oC ambient.	The short time current rating of the NGR shall be such that it can allow about 300 A current for 10 seconds without exceeding the temperature rise of 300oC over 50oC ambient. Please confirm	Bidder to follow specification.
297.	II/3.0/ 3.10	8.0..0 4.0 (e,f,g) 2 (a)	181 and 182 of 353	Short time current for 1 sec. for 2500 kVA Transformer kA(rms) 65 Rated short circuit breaking current for 2500 kVA transformer kA(rms) 65 g) Rated short circuit making current for 2500 kVA transformer kA(peak) 137 Short circuit withstand current rating for switchgear fed from 2500 kVA transformer	The percentage impedance of 2500 KVA transformer shall be selected so that short time current rating for I second / rated short circuit breaking current / short circuit withstand current rating is limited to 50 KA for 1 second. Accordingly the rated short circuit making capacity shall be limited to 105 KA peak. Please confirm	Bidder to follow specification.
298.	II/3.0/ 3.11	2.0.0	184 of 353	The scope of work shall include supply, installation, testing and commissioning of the following:	Composite Generator relay panel shall be provided for Generator, Generator transformer and unit transformers (one for unit#1 and one for unit#2). All the protection functions mentioned in the specification shall be provided.	Bidder to follow specification.

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					Separate protection panel shall be provided for standby maintenance transformer Separate protection panels shall be provided for station transformers 1 and 2. This is in line with existing TANGEDCO projects Please confirm.	
299.	II/3.0/ 3.13	4.2.0	207 of 353	The Insulation monitoring system shall on-line monitor the insulation between the DC bus and the earth, as well as the grounding resistance …..	Insulation monitoring system is not envisaged. Please confirm	Bidder to follow specification.
300.	II/3.0/ 3.18	4.31.10	248 of 353	DG sets rated 1000 KVA and above shall be connected through non segregated phase bus	DG sets rated 1000 KVA and above shall be connected through non segregated phase bus/ cable based on layout considerations. Please Confirm.	Bidder to follow specification.
301.	II/3.0/ 3.21	4.15.0	268 of 353	Master control stations are proposed at following locations….. AHP Control room ·CHP Control room.	Master control station common for CHP and AHP shall be provided. Please confirm	Bidder to follow specification.
302.	II/3.0/ 3.27		310 of 353	Fire Coating of cables	Fire coating of cables is not mentioned in the specification and hence not envisaged. Please confirm.	Bidder to follow specification.
303.	II/3.0/ 3.28	4.1.3	314 of 353	Maximum earth fault Current : 65/50 kA	Main Plant earthing system shall be designed considering fault level of 50 KA for 1 second. Please Confirm.	Bidder to follow specification.
304.	II/3.0/ 3.23	5.1.5 5.1.6	287 of 353	For high bay areas, light emitting plasma (LEP) light fittings shall be provided. For outdoor areas involving road lighting and flood lighting, light emitting plasma (LEP) light	For high bay areas LED lights are envisaged. For outdoor area involving street lights LED lights are envisaged. Please confirm	LED lights are acceptable. Instead of LEP for all areas.

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		5.1.20		fittings shall be provided. Turbine Hall operating floor : LED high bay	Light emitting Plasma is a new technology and there are no reputed manufacturers of Light Emitting Plasma in India.	
305.	II/3.0/ 3.4	6.7.0	97 of 353	Vector Group of oil filled external CHP Transformer	The vector group of external CHP transformer is not matching with main single line diagram for Auxiliary power distribution.	Vector Group of oil filled external CHP Transformer shall be YNd11.
306.	II/3.0/ 3.4	3.23.0 (f)	76 of 353	Each ST shall be sized to feed the following loads and shall have a design margin of 10%: ‥Loads connected to station switchgear ‥Power requirement for external coal handling as specified ‥Additional load imposed on the largest rated outgoing feeder due to bus supply Change over at downstream switchgear.	We understand that station transformer 10 BCT11 shall be sized to cater to loads being fed from 11 KV station switchgear #1 (10 BCC) + Power requirement for external coal handling as specified +‥Additional load imposed on the largest rated outgoing feeder due to bus supply changeover at downstream switchgear. Similarly station transformer 10 BCT12 shall be sized to cater to loads being fed from 11 KV station switchgear #2 (10 BCD) + Power requirement for external coal handling as specified +‥Additional load imposed on the largest rated outgoing feeder due to bus supply changeover at downstream switchgear. Total External CHP load shall be considered as 22MVA. Please confirm	Bidder to follow specification.
307.	Vol I/Sec 1 / Cl 1.0 / Page 6 of 44 Vol II/Sec 4.2 / Cl 1.1.29 / Page 9 of 19 Vol II/Sec 4.2 / Cl 2.17.0/ Page 16 of 19 Vol II/Sec 4.2 / Cl 4.0.0/ Page 17 of 19			ERP based billing and project monitoring is to be adopted. User Interface bidirectional Connectivity with other system like ERP & PADO. Enterprise resource planning	We understand that ERP is not there in the scope of this Project but the same is appearing at so many places. Kindly confirm ERP system is not part of this project.	ERP system is not part of the EPC scope

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	Vol II/Sec 4.3 / Cl 2.2.1.1/ Page 4 of 11 Vol II/Sec 4.5 / Cl 1.4.0 (j) / Page 6 of 11 Vol II/Sec 4.6 / Cl 1.4.0 (j) / Page 32 of 34 Vol II/Sec 4.10 / Cl 3.0.0 (j) / Page 6 of 29 Vol II/Sec 4.16 / Cl 3.2.0 (j) / Page 2 of 6 Vol II/Sec 4.16 / Cl 3.6.0 (j) / Page 2 of 6 Vol II/Sec 4.16 / Cl 4.4.0 / Page 3 of 6 Vol II/Sec 4.16 / Cl 4.6.0 / Page 4 of 6			ERP : Enterprise Resource Planning Room for Station in charge attending in shifts shall be provided in main control room and this room shall contain the operator stations, printers, ERP station etc., The Bidder shall provide MOD BUS/OPC/IEC Protocol as decided during detailed engineering to interface with…..ESP, TSI, ERP, MIS Server, ….. …BOP DCS, SOE & for all microprocessor based system like TSI, VMS, HMS, Flame monitoring & detector system, Boiler tube leak detection system, Plant performance & Optimization system, ERP, MIS… etc. Signals required to find the functioning time of RO-DM plant are to be classified and to be connected with DCS for cost evaluation in MIS / ERP Refer MIS configuration drawing (Dwg No. 30-1115112-I-355) for the requirements and the interfaces with PADO, Plant Wide LAN and ERP servers… The MIS system server shall be connected with ERP server through L3 layer switch. The network devices, cabling etc. in order to cater the data flow from/to the MIS, ERP, Station LAN servers… Refer ERP Network Infrastructure diagram (Dwg No. 30-1112140-I-354) for the requirements and the interface of Plant wide office LAN with the ERP servers and MIS servers		
308.	Vol II/Sec 4.2 / Cl 1.1.37 / Page 10 of 19			For automatic refresh features for viewing Web based Plant information extending option forAdditional 25 viewers shall be	We presume the quantity to be 25 viewers. Please confirm.	Automatic refresh features for viewing Web based Plant

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	Vol II/Sec 4.2 / Cl 2.15.0 / Page 16 of 19			provided. For automatic refresh features for viewing Web based Plant information extending option for additional 50 viewers shall be provided.		information extending option for 25 viewers shall be provided.677 Bidder shall also provide extending option for additional 50 viewers in the WAN in line with technical specification cl 2.15.0.
309.	Vol II/Sec 4.2 / Cl 4.0.0/ Page 18 of 19 Vol II/Sec 4.5 / Cl 1.4.0 (j) / Page 6 of 11			OCAMMMS: Online Computer Aided Microprocessor Based Machinery Maintenance Management System The Bidder shall provide MOD BUS/OPC/IEC Protocol as decided during detailed engineering to interface with…..ESP, TSI, ERP, MIS Server, …..Vibration monitoring & Analysis system, OCAMMS, AAQMS	Requirement of OCAMMMS is not clear in the spec. and the same is mentioned at abbreviation expansion and at interfacing provision requirements only. Kindly confirm whether this package is part of this project. No specific make like OCAMMMS (being a brand name) is proposed due to statutory regulations however features common for all the vendors required for the analysis of vibration shall be suitably proposed. Please confirm.	Vibration monitoring and Analysis system is included in bidder's scope. Bidder to refer Sec 4-12, Cl 1.2.0 and the features as specified in the specification shall be followed completely.
310.	Vol II/Sec 4.3 / Cl 1.1.21/ Page 3 of 11			Bidder shall furnish a composite list of bought-out items along with proposed sub-vendors for each of the same.	Vendor list shall be submitted to the Customer for the approval during post contract stage.	Bidder to follow the specification
311.	Vol II/Sec 4.3 / Cl 1.1.21/ Page 3 of 11			Software packages such as Life evaluation software, Asset management system, Equipment capability curves to be included.	Software packages in the name of life evaluation, Asset management system, Equipment capability curves does not exist. Kindly delete the same.	The functional requirement of the software packages as covered in Sec 4-6, Cl 4.0.0 of the specification shall be followed completely
312.	Vol II/Sec 4.16 / Cl 3.12.0/ Page 2 of 6 Vol II/Sec 4.16 / Cl 3.2.0/ Page 1 of 6			MIS software with multiple user's license,… MIS users of 50 nos shall be distributed and provided in Administrator building, Service	Please confirm that Multiple user's license means license for 50Nos. of users as given clause no. 3.2.0 of section 4.16.	Confirmed. However bidder to refer clause no. 3.2.0 for the other

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				building and other buildings. However, the system shall be expandable in future to accommodate additional 20 no users through additional client workstations and user licenses.		details provided and follow the specification completely
313.	Vol II/Sec 4.2 / Cl 1.1.6 (s) / Page 3 of 19 Vol II/Sec 4.16 / Cl 4.4.0/ Page 3 of 6 Vol II/Sec 4.16 / Cl 4.7.0/ Page 4 of 6			Plant wide office LAN comprising of 450 users at various location of plant and installation of 300 PCs with 21" LED display units,.. System shall be suitable for simultaneous use by multiple users of 300 numbers which is commonly used for MIS and Office LAN. Out of 300 numbers, 150 nos. of users shall be provided with PC including 21" LED monitor and all required accessories…. Redundant Server, Personal computers (PC) of 100 numbers, Operating licenses for 200 nos. users,…	Conflicting No. of users of office LAN & MIS are given in various clauses of the spec. Kindly confirm No. of users and PCs to be provided. Also we understand that ERP package (with 200 Licenses) is not part of this project and we don't foresee requirement of such a large quantity of PCs/Nodes. Hence TANGEDCO is requested to decrease the LAN requirements/No. of users suitably. Typical quantity ranges from 50-100 users.	Bidder to refer Sec 4-16,Cl 4.4.0 and the requirement specified is as follows 1. No. of licensed users : 300 2. MIS station : 50 3. LAN station : 150 The number of PCs to be provided by the bidder shall be 200. ERP is not part of the EPC's scope. However the bidder to follow the specification requirement of Plant wide office LAN completely. Plant wide office LAN comprising of 450 users at varies location of plant is to be provided.
314.	Vol II/Sec 4.2 / Cl 1.1.6 (x)/ Page 3 of 19			Marshalling & Interposing relay cabinets (Bidder to note that, all the field cables should be terminated…	TANGEDCO is requested to consider Cable termination at marshalling cabinet or any other equivalent methodology being followed by the manufacturer for several projects in the past may also be permitted to be adopted in this project. Accordingly the spec. may include "marshalling	Bidder to follow the specification

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					cabinet philosophy or any other equivalent methodology/ philosophy recommended by the C&I manufacturer**".**	
315.	II/4.0/4.12	1.1.0 (L)	1 of 16	Vibration switch (alarm, trip) and oil level switch to be provided for the cooling towers.	As NDCT is envisaged, the instrumentation mentioned will not be applicable. Kindly confirm.	Noted
316.	II/4.0/4.2	1.1.6	4 of 19	Radar type instrument for coal bunker level measurement. Three (3) nos. of Radar level transmitters shall be provided for each bunker	Quantities of level measuring instruments are contradictory in both the clauses. We propose 2 no. of LT per bunker. Kindly confirm.	Sec 4.3, Cl 5.4.0, two (2) nos. of level transmitters for each coal bunker with not less than IP 67 protection shall be provided. The type of the level transmitters shall be 3 D scanner with which the profile of coal surface is scanner and the average level of coal available in the bunker is made available in the DCS.
317.	II/4.0/4.3	5.4.0	10 of 11	Continuous level measurement for unit coal bunker and other bunkers of Coal handling system shall be provided with two (2) numbers of radar type level transmitters for each bunkers with IP 65 protection for each bunker level measurement.		
318.	II/4.0/4.2 II/4.0/4.10	1.1.11 / 1.1.0	5 of 19 / 1 of 29	Instrument and service air compressors and driers shall be controlled and monitored from the Central control room & local control room, through the DCS Remote I/Os, Redundant processor, power supply, communication module, redundant communication link all hardware, software and other interfaces envisaged to control and monitor it. Remote operation is envisaged from the Central control room.	The cl. 1.1.12/1.1.0 and cl. 1.4.0(d) are contradictory. We propose that the individual compressor shall be Proprietary microprocessor based control system and only remote start / stop operation from DCS shall be provided through hardwired signals as per cl. no. 1.4.0(d). Please Confirm.	Confirmed and in addition to the hardwiring to unit DCS redundant soft link connectivity from compressor control system to unit DCS shall be provided as per specification.

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319.	II/4.0/4.5	1.4.0(d)(6)	3 of 11	Compressed Air System Proprietary microprocessor based control system / DCS Controls. Compressors Start/Stop operation from DCS shall be provided through hardwired signals		
320.	II/3.0/3.17	3.8.0	238 of 353	All actuators shall be of integral type. Actuators shall be provided with integral starters.	Both the clause are contradictory. We propose integral starter type actuators. Kindly confirm.	Bidder to refer Sec 3.0, Electrical section and follow the same for electrical actuators.
321.	II/4.0/4.5	2.1.0	8 of 11	All bi-directional drives are provided with non-integral starters.		
322.	II/4.0/4.5	2.1.0	8 of 11	For each contact/signal, independent wires shall be used for the cabling, ie. One terminal of each contacts/signals shall not be shorted to create a common terminal.	In case of independent wires for each signal/contact the size of plug in connection shall be huge (long term reliability of huge plugs shall remain a concern). Also the TB's in DCS panel will increase resulting in increase in number of panels. Further the size and number of cables shall increase. This shall increase the system complexity which is not desirable for smooth operation and maintenance during plant life. We propose to use common terminals along with plug in connectors to provide technical advantages as brought out above and as per proven practice followed. Kindly confirm.	The proposal to use Plug in connectors is not acceptable. Bidder to follow the specification wherein independent wires shall be used for each signal/contact

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323.	II/4.0/4.2	1.1.12	5 of 19	AC and ventilation system shall be controlled and monitored from the AC and ventilation system local control room, through the DCS remote I/Os,	Control and monitoring system for various BOP systems shall be as per table indicated in section 4.5 under cl. 1.4.0 (d) page 3 of 11. AC and ventilation system shall be controlled from PLC with soft link connectivity to plant DCS CCR. Please Confirm.	Bidder shall provide PLC based control system for AC and ventilation system. The PLC offered in this project shall be same make & model.
324.	II/4.0/4.5	1.4.0.d(11)	4 of 11	Controlled from PLC with soft link connectivity to plant DCS CCR.		
325.	II/4.0/4.2	1.1.18	7 of 19	Hydrogen generation system shall be controlled and monitored from the Hydrogen generation system local control room, through the DCS remote I/Os,	Control and monitoring system for various BOP systems shall be as per table indicated in section 4.5 under cl. 1.4.0 (d) page 3 of 11. Hydrogen generation system shall be controlled from PLC with soft link connectivity to plant DCS. Please Confirm.	Bidder shall provide PLC based control system for Hydrogen generation plant. The PLC offered in this project shall be same make & model.
326.	II/4.0/4.5	1.4.0.d(13)	4 of 11	Controlled from PLC with soft link connectivity to plant DCS		
327.	II/4.0/4.2	1.1.20	7 of 19	Electro chlorination system shall be controlled and monitored from the Electro chlorination system local control room, through the DCS remote I/Os,	Control and monitoring system for various BOP systems shall be as per table indicated in section 4.5 under cl. 1.4.0 (d) page 3 of 11. Electro chlorination system shall be controlled from PLC with soft link connectivity to plant DCS. Please Confirm.	Bidder shall provide PLC based control system for Electro chlorination system. The PLC offered in this project shall be same make & model.
328.	II/4.0/4.5	1.4.0.d(14)	4 of 11	Controlled from PLC with soft link connectivity to plant DCS CCR.		
329.	II/4.0/4.2	2.17.0	16 of 19	Enterprise resource planning	Kindly clarify the scope of supply. In case it is in bidder's scope please provide the detailed requirement.	ERP is not part of EPC's scope
330.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/3.14.0			Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the transformer shall be able to operate at full load for atleast ten (10) minutes without the calculated winding hot spot temperature exceeding 140°C.	Kindly note that during total failure of cooling fans and oil pumps of one radiator bank, the transformer shall be able to operate at full load for at least twenty (20) minutes without the calculated winding hot spot temperature exceeding	Bidder to follow specification.

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				Further, cooling shall be so designed that during total failure of cooling fans and oil pumps of one radiator bank, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 115°C.	140°C. This is in line with CBIP standard. Kindly confirm.	
331.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/4.2.0 d)			Core d) The core shall be boltless type.....	Kindly note that the main limbs, main bottom yoke, Auxiliary limbs and Auxiliary yokes of the Transformer core shall be without any bolts. However, in order to give adequate mechanical strength to the core assembly, bolts shall be provided only on the top yoke. This is as per Bidder's standard technological practices adopted internationally in the industry & same is acceptable to all major utilities within India (like, NTPC Ltd, SEBs, PGCIL, etc) as well as in the overseas markets. Hence core shall be bolted on top yoke only. Kindly confirm	Manufacturer's practice will be reviewed during detail engineering.
332.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/4.10.0 a), b)			a) Bushing for voltage rated 72.5 kV and above shall be of the oil filled condenser type. 36 kV bushing shall be solid porcelain or oil communicating type. b) **Oil filled condenser bushing with silicon RTV** coating shall be provided with the following fittings. • Oil level gauge. • Oil filling plug and drain valve if not hermetically sealed. • Tap for capacitance and tan delta test.(	Kindly it may be noted that oil filled condenser bushing shall be oil impregnated condenser body within a porcelain insulator envelope on the upper air end and lower oil end of the bushing without silicon RTV coating. However mentioned fittings shall be provided. This is as per bidder's standard technological practices adopted internationally in the industry & same is acceptable to all major utilities within India (like, NTPC Ltd, SEBs, PGCIL, etc) as well as in the overseas markets.	Bidder to follow specification.

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				tan delta monitoring)	Kindly confirm.	
333.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/4.22.0			**Online Dissolved Gas Analyzer**	Please note that there are many proven suppliers in the market who are supplying the On line DGA system based on different technology. Hence, It is requested to amend this clause and delete the makes and technology.	Bidder to follow specification.
334.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/4.23.0			**On line partial discharge (PD) measurement**	Please note that there are many proven suppliers in the market who are supplying the **On line partial discharge (PD) measurement** system based on different technology i.e. Acoustic /UHF etc. Hence, It is requested to amend this clause and delete the UHF only technology. Further, Systems available are meant for PD testing of the transformer only and Bushings are not separately monitored in that system. Kindly confirm.	Bidder to follow specification.
335.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/5.3.0 (c)			(c) Short circuit withstand test.	We would request TANGEDCO to kindly review their requirement of the short circuit test on GT because of following reasons: I) Short circuit test is a special test. Facility for conducting short circuit test on such a large rating transformer is not available in India. Transformer will be sent for short circuit testing to a foreign laboratory which will require total period of 6 to 8 month which may affect the project schedule because of unfortunate occurrence of any event beyond the contractor's control. II) Bidder has excellent record of short	Bidder to follow specification.

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					circuit testing for various rating of Power transformers. For the 400 KV Class transformer our 260 MVA, 21/400/√3 kV,1-phase Generator transformer is successfully short circuit tested in KEMA high Power laboratory Netherland. Our design and facilities is well proven for Short circuit testing. In view of above, We propose to furnish calculation for thermal withstand capability for short circuit for transformer during detail engineering. We, therefore, request TANGEDCO to exclude this the conductance of this test. Kindly accept.	
336.	Vol II, Section 3 Electrical_R0/Section 3.4 Power Transformer & Bus Reactor/6.1.0 (13-a)			One minute Power frequency withstand voltage HV – 630 kV LV – 70 kV	Kindly it may be noted that the mentioned clause deals with Separate Source Voltage Withstand test For which voltage levels shall be: HV – 38 kV LV – 50 kV Kindly confirm. However, transformer HV wdg. Shall be suitable for 630 kV.	Separate source Power frequency test voltage shall be as per CBIP manual for the applicable voltage rating of generator.
337.	Vol. I / Section – 3.0/ 32.3.1/ ECC – 17 of 26			the Contractor shall be provided with 33kV HT power supply at one location inside the plant site near boundary for erection works	Kindly provide 11 KV power supply at one point inside the plant boundary.	Bidder to follow specification.
338.	Vol. I / Section – 3.0/ 32.3.1/ ECC – 17 of 26			All initial deposit, installation and connection charges shall be borne by the contractor.	It is understood that the power at 33 kV level shall be terminated at a pole located inside the plant boundary. Further, distribution charges as well as actual consumption charges shall be to the account of the contractor. Hence initial deposit, installation and connection charges are not applicable to the contractor. Pl. clarify.	All initial deposit, installation and connection charges, as applicable shall be borne by the contractor.
339.	Vol. II / Section – 1.0/ 4.0.0/ GTS – 26 of 191			The power at 33 kV level shall be terminated at pole. The contractor shall	33 KV from one point provided by TANGEDCO will be stepped down to 11	Bidder to follow specification.

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				receive the same and establish33 kV Construction Power Substation and distribute 33 kV supply to various distribution substations in the plant and further step down to 415 V supply to provide construction power for various locations.	KV and ring main will be formed for the construction power requirement of the project. This 11 KV will be further stepped down to 415 V for construction power works of bidder. No distribution of 33 KV is envisaged in bidder's scope. Please confirm.	
340.	Vol. II / Section – 2.0/ 5.2.4.4/5.2 – 9 of 38			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	By temporary covering, it will be ensured that fabrication works will not get affected even during inclement weather. Hence part of covered fabrication yard is not required.	Bidder to follow specification.
341.	Vol. II / Section – 5.0/ 3.1.1/2.14– 2 of 34			Intake quantity is 25,600 m3/hr. The intake system shall be designed for 30,000 m3/hr considering margin. The system is sized considering the future requirement.	Pl. clarify whether the intake flow quantity is 25,600m3/hr or 30,000 m3/hr.	Refer Vol –II sec 2.14 Annex 2.14.1 page 17 of 34 wherein "Flow to be considered for design of sea water intake system -30000m3/h".
342.	Vol. II / Section – 5.0/ 3.1.5/2.14– 4 of 34			Outfall quantity is 19,500 m3/hr. The outfall system shall be designed for 22,500 m3/hr considering margin. The system is sized considering the future requirement	Pl. clarify whether the outfall flow quantity is 19,500m3/hr or 22,500 m3/hr.	Refer Vol –II sec 2.14 Annex 2.14.1 page 18 of 34 wherein "Flow to be considered for design of sea water outfall system -22500m3/h".

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Mechanical-Ash Handling plant							
343.	Section-2/Sub section 2.11/Volume II	1.3.0	2 of 13 & 3 of 13	**BA ash slurry** - BA seal water pump with its accessories - BA seal water sump with its accessories **FA ash slurry** - FA seal water pump with its accessories - FA seal water sump with its accessories	Instead of separate seal water pumps and seal water sump for BA & FA ash slurry, we propose that seal water for all applications can be supplied from AHS seal water tank using the common seal water pumps for two units. We request Owner to confirm.	Supplying seal water from the common AHS seal water tank using the seal water pumps for all applications instead of separate seal water pumps and sumps for BA and FA slurry system, shall reduce the overall cost of the system	Bidder to follow specification.
344.	Section-2/Sub section 2.11/Volume II & Section-7/Volume II	2.5.0 & dwg no. 00-1115112-M-018	5 of 13	The water from the clariflocculator shall be led in to a clear water sump by gravity through open channel located above ground. The clear water sump shall be located above ground	Flow diagram for recovery water system (dwg no. 00-1115112-M-018) does not indicate a clear water sump and clear water pumps as mentioned in cl no. 2.5.0-c) of Sub section 2.11-Volume II. We understand that there shall be a clear water sump and clear water pumps as mentioned in cl. no. 2.5.0-c) of Sub section 2.11-Volume II. We request Owner to confirm.	Discrepancy between Flow diagram for Recovery water system & Cl. No. 2.5.0 of sub-section 2.11 of volume II.	Clear water pump and its sump shall be provided as per section 2.11/ clause 2.5.0
345.	Section-2/Sub section 2.11/Volume II & Section-7/Volume II	1.3.0 & dwg no. 00-1115112-M-010	3 of 13	**FA ash slurry** - FA drain sump pumps complete with drive motors, couplings & other accessories - FA drain sump	We understand that the Fly ash water pump house sump and pumps as indicated in Flow diagram of Ash disposal system (dwg no. 00-1115112-M-010) is same as 'FA drain sump pumps' & 'FA drain sump' as indicated in cl. No. 1.3.0 of Sub section	No separate sumps and pumps named 'Fly ash drain sump' & 'Fly ash drain pumps' is indicated in Flow diagram Ash disposal system (dwg no. 00-1115112-M-010)	FA drain sump pumps and FA water sump pump are same.

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					2.11/Volume II. Owner to confirm.		
346.	Section-2/Sub section 2.11.10/Annex 2.11.10.1/Volume II & Section-7/Volume II	1.0.0 & dwg no. 00-1115112-M-009	2 of 4	Type of Silo Construction- RCC fly ash silos (flat bottom)	Flow diagram Fly ash handling system (dwg no. 00-1115112-M-009) indicates conical bottom ash silo. Owner to confirm that Fly ash silo shall be flat bottom as indicated in section-2/Sub section 2.11.10/Annex 2.11.10.1	Discrepancy between Flow diagram Fly ash handling system & Cl. No. 1.0.0 of Sub section 2.11.10/Annex 2.11.10.1	Bidder to follow as per Flow diagram Fly ash handling system (dwg no. 00-1115112-M-009)
347.	Vol-II, Sec-2, 2.11.0Dwg. No. 00-1115112-M-008	1.1.0	1 of 13		Scraper chain conveyor system is continuously operating system and jet pump is installed below the scraper chain conveyor. Hence, jet pump shall be operated continuously to evacuate bottom ash. We propose bottom ash to be evacuated through jet pumps directly from water impounded type bottom ash hopper once in a shift of eight (8) hours. With this arrangement, common ash slurry disposal system for fly ash and bottom ash slurry can be adopted. Please confirm of acceptance of this system as an alternative.	This would be a viable techno-commercial solution which is in operation in other sea water based power plant like 5x800 MW Mundra of TATA Power, TPCIL krishnapatnam, Dahanu TPP etc.Suggest that bidder be allowed to decide as evaluation by owner is being done on price & performance parameters.	Bidder to follow specification.

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348.	Dwg. No. 00-1115112-M-009				As per the specification, fly ash slurry shall be prepared after Fly Ash Silo. We propose fly ash slurry preparation at fly ash extraction tower by applying wetting unit and air separator tank. From FAE tower, fly ash slurry will be sent to ash slurry sump. Please confirm.	Savings in power and installation cost.	Bidder to follow specification.
349.	Vol-II, Sec-2, 2.12	3.1.0	7 of 13	Operating time	Fly ash evacuation in slurry mode will be done eight (8) hours in a shift for each unit. We request Owner to confirm our understanding.	Clarification.	Refer Vol II sec 2.0 Sub section 2.11.0 clause 3.0.0 wherein "fly ash generation for each unit is mentioned in terms of %. Operating time of Fly ash silo to ash slurry pump and ash slurry sump to ash pond (4W+4S)- 8h in a shift i.e. continuous basis. FA jet pump and FA slurry pump shall be designed accordingly.
350.	Vol-II, Sec-2, 2.12			Ash slurry disposal pipe garlanding length	We request Owner to confirm the garlanding length of ash slurry disposal pipes.	Clarification.	Ash pond garlanding is required as per flow diagram 00-1115112-M-010 and plot plan 00-

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							1115112-M-001.
351.	Vol-II, Sec-2, 2.11	1.1.0Dwg no. 00-1115112-M-008	1 of 13	Bottom ash overflow transfer pumps complete with drive motors, couplings & other accessories to pump BA overflow water to clariflocculator.BA Overflow discharge to BA slurry sump & clariflocculator	Please clarify the discharge of BA overflow pump.	Discrepancy noted in different parts of specification.	Bidder to follow Vol-II, Sec-2, 2.11 clause 1.1.0 page 1 of 13.
352.	Vol-II, Sec-2, 2.11	2.2.0	4 of 13	Fly Ash Handling System Ash Source: ESP ash, APH hoppers, duct hoppers (if applicable) and **Stack hopper.**	Stack ash will be evacuated manually instead of pneumatic evacuation.	Since rate of ash generation in stack hopper will be much lower comparatively to other FA hoppers.	Bidder to follow specification.
353.	Vol-II, Sec-2, 2.11	2.5.0	5 of 13	Ash Water Recovery System	Please furnish the percentage of recovery water from ash dyke for ash water recovery system design. Also request to confirm recovery water design condition while only BA Slurry Pumping System in operation .	Detailed specification is not furnished in the Tender Specification.	70% recovery shall be considered. Recovery water design condition shall be as per specification.
354.	Vol-II, Sec-2, 2.11	2.5.0	5 of 13	From the clear water tank, it shall be pumped to AHS sea water tank/sea water outfall.	Please furnish the clear water transfer pump and piping sizing & material of construction details.	Detailed specification is not furnished in the Tender Specification.	Refer Vol-II, Sec-2, 2.11.6. Details already furnished.

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355.	Vol-II, Sec-2, 2.11	2.11.7	1 of 5	Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.	Please clarify the followings:a. Maximum BA & FA slurry pumping distance for pump head calculation.b. Final Static height to be considered in ash pond with respect to plant grade level for pump head selection.	Detailed specification is not furnished in the NIT.	Refer Vol II sec 1.0 page 21 of 191 clause 2.5.0 wherein " For ash pond, the required area of the land will be about 120 acres considering the bundheight of 25m for both fly and bottom ash above finished ground level".
356.	Vol-II, Sec-2, 2.11	2.11.7	1 of 5	Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.	Please clarify the followings: a. Maximum BA & FA slurry pumping distance for pump head calculation. b. Final Static height to be considered in ash pond with respect to plant grade level for pump head selection.	Detailed specification is not furnished in the Tender Specification.	Refer Vol II sec 1.0 page 21 of 191 clause 2.5.0 wherein " For ash pond, the required area of the land will be about 120 acres considering the bund height of 25m for both fly and bottom ash above finished ground level".
357.	Vol. - II, Section 2.0	ANNEX 2.11.7.1	Page 4 of 5	Slurry Pump Efficiency MIN. 70%	Please confirm whether there is any specific requirement from Fichtner regarding eff of slurry pump to be considered for GPC calculation.	For GPC calculation bidder will consider actual pump eff (at rated point) as declared by pump manufacturer.	Slurry Pump Efficiency shall be MIN. 70% as per specification.
358.	Vol. - II, Section 2.0	1.0.0	Page 1 of 4	One (1) outlet connection with blind flanges for installation of jumbo transmitter at a later date.	Please provide spec for this.	Detailed specification is not furnished in the Tender Specification.	Details shall be furnished during detailed engineering.

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359.	Vol. - II, Section 2.0	1.0.0	Page 1 of 4	Ceramic fluidizing pads to fluidise fly ash in fly ash silo.	Cloth type fluidiser shall be provided.	Its as per equipment supplier standard engineering practice.	Bidder to follow specification.
360.	Vol. - II, Section 2.0	ANNEX 2.11.10.1		Shed Over Silo Provided: Yes.	We understand only individual shed for equipment is required. Side cladding/ ventilation etc not considered. Please confirm.	Clarification.	Noted.
361.	Vol. - II, Section 2.0	ANNEX 2.11.12.1	Page 3 of 6	Type Two stage, Water cooled, Oil free compressor with drive motor and accessories like inter cooler, after-cooler, Oil cooler, Moisture separators, intake filters, Suction silencers, Vibration isolators, etc.,	Please indicate limit of oil content as acceptable at discharge of oil filter at compressor discharge.	Detailed specification is not furnished in the Tender specification.	ISO 8573 Class -1 shall be followed.
362.	General	-	-	Design & material of construction of BA Hopper feed gate, Jet Pump, Clinker Grinder, ash inlet & outlet valve, feeder ejector, vacuum breaker, wetting head, air washer, collector tank, flushing apparatus paddle mixer etc.	All these equipment being proprietary in nature, will be provided as per bidder's standard design & Material of Construction which is proven & working in many domestic & international plants successfully over the years.	Its as per equipment supplier standard engineering practice.	Bidder to follow specification.
363.	Flow Diagram: FA Handling system	Detail-X	-	Flow diagram ESP fluidising arrangement in ESP hoppers	Requirement of fluidisation in ESP hopper / number of fluidising pad in ESP hopper shall be checked during detail engg and will be provided if required.	Clarification	Bidder to follow specification.

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364.	Flow Diagram: FA Handling system	-	-	Bulker unloading below FA Silo	Flow diagram show bulker unloading at two points. Please confirm whether simultaneous unloading through two bulkers are required. If required whether back to back arrangement is acceptable.	Column orientation and Silo dia will get affected by this.	Simultaneous unloading in two bulkers (side by side) shall be considered.
365.	Vol. II, Section 2 2.2 Steam Turbine & Aux. System	4.0.0	Page : 5 of 27	Steam turbine proposed for this project is proven design with respect to HPT inlet pressure and temperature, IPT inlet temperature, HP, IP,LP blade profile and number of stages in HP, IP,LP turbines and the offered steam turbine with above design for the similar capacity should already be in successful operation.	Bidder understands that though offered Steam turbine shall be of proven design, Blade profile and number of stages may be modified by Bidder for design optimization of steam turbine. Owner is requested to confirm.	Number of stages & blade profile depends upon the selection of steam pressures, Condenser back pressures which in turn depends on the environment conditions such as cooling water temperature, selection of CW temperature rise & corresponding condenser back pressure. Hence it is not always possible to exactly replicate the number of stages or blade profile.	Bidder shall furnish detailed write up along with the bid.
366.	Volume II Section 1 GTS ANNEX - 1.4 MANDATORY SPARES	Mandatory Spares	155/191	Please confirm Mandatory Spares required for Pulveriser/Coal Mills. Also specify the definition of sets.	Clarification		Bidder to refer specification, Volume II Section 1 GTS, ANNEX - 1.4, pg 155 of 191 for the spare list for mills. Bidder to note that "set" is comprising

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							of complete assembly as per description specified in the specification.
367.	Volume II Section 1 GTS ANNEX - 1.4 MANDATORY SPARES	Mandatory Spares	154/191	Please change the Quantity for Pressure part spare as below: Sl. No. 1 (Various spec tube of water wall system/superheater /reheater/economizer etc.,) - 100 ~~160~~ M	Clarification		Bidder to follow specification.
368.	Volume II Section 1 GTS ANNEX - 1.4 MANDATORY SPARES	Mandatory Spares	155/191	Dampers - Quantity not specified	Clarification		Bidder to refer specification, Volume II Section 1 GTS, ANNEX - 1.4, pg 155 of 191 under Spares parts list for Boiler Pt. No. 16.
369.	Volume II Section 1 GTS ANNEX - 1.4 MANDATORY SPARES	CPU 1) Service & regeneration vessels(for each type & size)	133 /191	Bidder understands that item no 2 to 9 are to be provided for each type /size of service & regeneration vessel. Further any service vessel & regeneration vessel is not to be provided as mandatory spares. Please confirm bidder's understanding.	Clarification		Bidder to follow specification. Service and regeneration vessel shall not be provided as mandatory spares.
370.	Volume II Section 1 GTS ANNEX - 1.4 MANDATORY SPARES	Cooling water pumps 1) CWP	134/191	Bidder understands that item no. 2 to 4 are to be provided as mandatory spares for CWP. Please confirm.	Clarification		Confirmed

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371.	Volume II Section 1 GTS ANNEX - 1.4 MANDATORY SPARES	GENERAL	-	Bidder understands that the items which falls under multiple category, spares pertaining to those items shall be consider for only one category which ever specified higher number of spares.	Clarification		Bidder to follow specification.
	Sea Water Intake & Outfall reject System						
372.	Section-2/Subsection-2.14/Volume-II	3.1.3	Page 3 of 34	Marker Buoys- Pegging system	Normally the pegging system is not required for the water intake facility. However If the pigging system necessarily require, then please provide the detail specification for the pigging facility	As such we are providing the 5 mm screen & Hypo dosing at the intake velocity cap, there are less chances of debris to come in pipeline. Hence there is no requirement of pigging system for intake HDPE pipe.	Bidder to follow specification. Refer Vol-II, Sub sec 2.14, cl3.1.3. Basic concepts and requirements of Peg launchers, Peg receivers, Peg launching platform, Peg pumps are specified. Pegs shall also be included . Engineering is to be done by the bidder other scope as per specification
373.	Section-2/Subsection-2.14/Volume-II	3.1.5	Page 4 of 34 Page 17 of 34	Sea Water Intake Pump house ANNEX -2.14.1,SPECIFIED DESIGN DATA(Sea water Intake system (Sluice gate MOC for intake system)	As per the given clause on page no 4 & P&ID ref 10-1115112-M-012 the sluice gates are of FRP but as per the clause mentioned on page no 17. says it is of Duplex SS please confirm the final MOC	Discrepancies w.r.t the tender specification	The sluice gates shall be of duplex stainless steel.
374.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	Page 19 of 34	Trash Rack with auto raking mechanism &Travelling Screen for intake system	Please indicate the screen size(bar/opening) & provide the detailed specification for Trash rack & Travelling	Tender specification does not specify the design criteria	Travelling water screen opening size shall be 10 mm x 10 mm and the

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					screen		speed of travel shall be < 2.0 m/min. 2 x 100 % screen wash pumps shall be provided. Coarse screens mesh opening shall be 50 mm x 50 mm. Automatic mobile trash cleaning mechanism shall be envisaged. The debris from TWS and Trash rack shall be collected in a tank and screened. The debris is removed manually and clear water is recycled back to the system by gravity.
375.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	Page 19 of 34	Coarse screens / Fine screens (For outfall system)	Please indicate at which location the screens are required & also provide the type of screening system required. As per the system design; outfall system does not require any screening. Hence we do not envisage the requirement of such screens in outfall system. Please confirm	Tender specification does not specify the design criteria	Bidder to follow the specification. Details are furnished in the specification. Screens are required for the outfall pumps. Refer Vol-II, Sub sec 2.14, Annexure 2.14.1- Specified Data sheet (Page 18 & 19 of 34). The

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							screens are specified for the Pump chamber.
376.	Vol-II /Sec-7	Drawing	1--1115112-M-012	Flow diagram Sea water Intake System	Provide the design criteria for desilting basin to decide the sediment removal mechanism		Refer Vol-II, Sub sec 2.14, Annexure 2.14.1- Specified Data sheet (Page 17 of 34). Clear water shall meet the requirement of the Pumping system. Portable Sand slurry pumps are envisaged to pump/dispose the settled suspended solids settled in the desilting basin through the slurry pipe.
377.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	Page 17 of 34	Intake pipe size (OD 2000)	We understand the OD 2000NB is tentative and can be changed during detail engineering		Pipe size is firm and shall be as per the specification.
	Section-2/Subsection-2.14/Volume-II	3.1.5	page 5 of 34	Sea water Outfall system			
378.	Section-2/Subsection-2.14/Volume-II	3.1.6	page 5 of 34	Sea water Intake & Outfall piping	From the given information we understand that the inside pipe (off Shore piping) shall be covered with rip-rip (By stone) & the outside piping (On shore piping) is covered with 250 mm concrete encasement. Please confirm		Bidder to follow the specification.
	Section-2/Subsection-2.20/Volume-II	4.0.0	page7 of 31	DESIGN AND CONSTRUCTION OF PIPEWORK AND ACCESSORIES-Seawater Intake, Outfall & ACW piping			Onshore piping from the Sea water Intake and outfall Pump discharge is GRP and the underground GRP pipes shall have

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							250 mm thick concrete protection.
379.	Section-2/Subsection-2.14/Volume-II	3.1.2	page 3 of 34	Floating Fencing	Bidder request to owner to provide the specification for floating fencing		Refer Cl 3.1.2, page 3 of 34 for the requirements of the floating fence.
380.	Section-2/Subsection-2.14/Volume-II	3.1.4	page 4 of 34	All pumps shall have margin of 10% on capacity & head over theactual requirement	10% margin on flow will be considered for selection of pump capacity. Further, 10% margin on friction drop of piping and valves will be considered while selecting head of pumps.Please confirm.	Please clarify Bidder understanding	Noted.
381.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	page 22 of 34	Specified Design data (Ultrafiltration System)- Avg design flux 60 LMH	We suggest the avg design flux for UF shall be of 60-75 LMH Please accept & confirm	For sea water application the avg design flux of UF will be in between 60-75 LMH for UF. The mentioned range is the standard & proven range used by manufacturer	Bidder to follow specification
382.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	Page 23 of 34	Specified Design data (SWRO System)- avg design flux <14 LMH	We suggest the avg design flux for SWRO will be range from 15-18 LMH. please confirm	For sea water application the avg design flux for SWRO will be in between 15-18 LMH. The mentioned range is the standard & proven range used by manufacturer	Bidder to follow specification
383.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	Page 26 of 34	Specified Design data (BWRO System)- Avg Design Flux< 25 LMH	We suggest the avg design flux for BWRO will be range from 25-30 LMH. Please confirm	For sea water application the avg design flux for BWRO will be in between 25-	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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						30 LMH. The mentioned range is the standard & proven range used by manufacturer	
384.	Section-2/Subsection-2.14/Volume-II Section-5/Volume-II	Annex 2.14.1	Page 24 of 34 Drg : M-013 & M-017	Remineralization system consisting of Lime and CO_2 dosing for SWRO product water	We do not envisage the lime /CO2 dosing system in fire water cum SWRO product tank . We consider the pH correction only in Service water tank & Potable water tank as required. Please confirm	The SWRO product water tank pH correction will be done by using either lime or CO2 based on the outlet from SWRO permeate quality. The lower pH is favorable for BWRO system , if the SWRO permeate has low pH value then we will only do pH correction in the potable water tank with CO_2 instead of SWRO permeate cum fire tank. Please confirm	Bidder to follow specification
385.	Section-2/Subsection-2.14/Volume-II	Annex 2.14.1	Page17 of 34	Sea water Intake system-Intake pipe size	We suggests to take 1600 NB HDPE pipe for intake which will also cater the system service requirement. Please confirm	As per bidder understanding no Indian manufacturer has manufacturing range of 200 NB HDPE line. 1600 NB is sufficient considering the 2 m/sec velocity design criteria	Bidder to follow specification
386.	Section-2/Subsection-2.4/Volume-II	3.2.1	7 of 34	Transient analysis & stress analysis shall be conducted for piping from the SWRO feed Pump to RO high pressure pumps and HP pumps to SWRO and the reject lines.	Transient analysis for the piping from the SWRO feed Pump to RO high pressure pumps and HP pumps to SWRO and the reject lines is not	The equipments/assemblies in the RO System are standard and skid mounted. These are factory tested and	Bidder to follow specification

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					considered. Owner to provide specific requirement if any.	designed to take care of transient. Hence transient analysis is not envisaged for the system	
387.	Section-2/Subsection-2.4/Volume-II	3.2.2	8 of 34	The DM Plant shall follow the scheme of Brackish Water RO with Strong Acid Cation Exchangers(SAC), Strong Base Anion Exchangers (SBA), Mixed Bed. BWRO shall be sized for 3 x 50%, SAC -2 x 50%, SBA – 2x 50% and Mixed Beds shall be sized for 3 x 50%. Bidder to consider an additional provision to bypass both SAC and SBA and feed directly to MB units from BWRO outlet.	SAC and SBA are not considered as the TDS of the DM feed water is < 20 ppm. We propose feed of the DM feed pumps directly to the Mixed bed. Owner to confirm.	The DM Plant feed water i.e. BWRO water TDS is < 20 ppm. MB can directly take this load to meet the required quality water.	Bidder to follow specification
388.	Section-2/Subsection-2.4/Volume-II	Annex-2.14.1	26 of 34	BWRO System-Outlet TDS < 20 ppm			
389.	Section-2/Subsection-2.14/Volume-II	Annex-2.14.1	23 of 34	SWRO System: Minimum Capacity of SWRO Plant shall be 16 MLD. Number of streams = 3X50% Net capacity of each stream = 5 MLD	From the clause we understand the SWRO design is for 2W +1S (3X50%) i.e;10 MLD working SWRO+ 5 MLD standby SWRO. Please Clarify & confirm	The plant capacity mentioned in various places is 16 MLD which is confusing against 10 MLD as mentioned in the Drawing No. 12 for desalination plant capacity.	Refer Vol II sec 2 sub section 2.14 page 23 of 34, wherein "Minimum capacity of the plant shall be 16 MLD. Number of stream shall be 3 x 50%. With each stream of 8 MLD.
390.	Section-2/Subsection-2.4/Volume-II	3.2.2	9 of 34	DM water storage tanks each sized to store 1500 MT of DM water production of **one**	We understand that total two (2) nos. of tanks have to be provided for the DM	"One Stream" is not clear.	Noted

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				stream.	water storage. Each Tank effective capacity is 1500 MT. Owner to confirm.		
391.	Section-2/Subsection-2.4/Volume-II	3.2.9	10 of 34	Bidder to consider 2 x 100% bulk tanks each of capacity to hold 30 days requirement or one tanker capacity of 20 Tonne whichever is higher.	We suggest to consider total 2 nos. of storage tanks each sized for 15 days requirement or 20 Tons of tanker whichever is higher (For two tanks), instead of 30 days storage each. Please confirm.	Bulk storage tanks are sized for total 30 days storage or 20 tons tanker capacity as per standard practice.	Bidder to follow specification.
392.	Section-2/Subsection-2.4/Volume-II	Annex-2.14.1	21 of 34	Bulk Storage Tank - Nos-2			
393.	Section-2/Subsection-2.4/Volume-II	4.2.0 (Sr. No-3)	13 of 34	Boiler Blow down suitably quenched with Service water and transferred to central monitoring basin and utilized for horticulture purpose.	The boiler units proposed for the plant are supercritical and accordingly we have not considered continuous boiler blow down in the water balance. Owner to confirm.	Supercritical units shall not have boiler blow downs as they are drumless boilers.	Bidder to follow specification.
394.	Section-2/Subsection-2.11.0/Volume-II	2.5.0 (C)	5 of 13	a) Ash pond decanted water shall be re-circulated back from ash pond to plant for treatment and reuse in ash handling system. C) Water from collection sump shall be pumped to clariflocculator by using recovery water pumps. Parshall flume flow measuring instrument shall be provided for measuring the inflow to the clarifier. The clarifier shall be located partially above ground. The dosing system (100% standby) shall pump, measured quantity of	clause (a) & (c) are contradictory statements . We have designed the system based on clause (a) by re use of clarified water for ash slurry preparation. Please confirm.	Clause (a) & (c) has mismatch.	There is no mismatch in the specification. Bidder to follow specification.

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				coagulant solution into flash mixer of clariflocculator. The water from the clariflocculator shall be led in to a clear water sump by gravity through open channel located above ground. The clear sump shall be located partially below ground. The acceptable limit of suspended solids of the recovered clear water shall be less than100 ppm. From the clear water tank, it shall be pumped to AHS sea water tank/sea water outfall.			
395.	Volume II/ Section - 7	Dwg: 00-1115112-M-018		Flow Diagram for Recovery water system	Clariflocculator Effluent is not shown in the flow diagram. Bidder requests owner to provide the same,	Tender specification does not specify the system	Refer volume II section 2, sub section 2.11.0, ash handling system, clause 2.5.0, s. no. C for clariflocculator outlet application/ reuse details.
396.	Section-2/Subsection-2.14/Volume-II	3.3.1	12 of 34	Hypo chlorite required for potable water disinfection shall be procured separately and hypo chlorite generated from electro chlorination system shall not be used for potable water disinfection.	Owner is requested to clarify the discrepancy between cl. No. 3.3.1 and ANNEX – 2.14.1 regarding Hypo chlorite required for potable water disinfection system. Owner to clarify that whether Hypo chlorite required for potable water disinfection shall be procured separately OR	Discrepancy	Bidder to note that hypo chlorite required for potable water disinfection shall be procured from the market. Hypo chlorite generated from electro chlorination plant shall not be used for potable water disinfection.
397.	Section-2/Subsection-2.14/Volume-II	ANNEX – 2.14.1	30 of 34	Hypo Storage Tanks: Two (2) Nos. Common for Cooling water system, Pretreatment plant, Potable water system,			

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				STP and other if any.	shall be used from common hypostorage tanks.		
398.	Section-2/Subsection-2.14/Volume-II Section-2/Subsection-2.14/Volume-II	ANNEX – 2.14.1 ANNEX – 2.14.1	29 of 34 29 of 34	Electro Chlorination for 2 x 660 MW: No. of streams: 2 Capacity of each stream: To meet requirement for 2 x 660 MW units Electrolysers: Quantity: As per system requirement Capacity: As per system requirement	We suggest the Electro chlorination system shall be 1W +1S .Please confirm	One (1) complete unit shall be provided as stand by .	Noted
399.	Vol. II, Section 1.0	6.2.2.1	33 of 191	If the fuel with high Sulphur content is used, then FGD plant will have to be installed as per the norms. The space for FGD plant shall also include requirement of Waste Water Treatment required for FGD plant effluent. **The mechanical, electrical and control & instrumentation design for the plant shall consider provision for the future installation of FGD.**	Bidder has considered only space provision in line with bid specifications, for future FGD plant. No other provisions related to mechanical, electrical and control & instrumentation can be considered by Bidder as no guidelines / specification have been provided..	Clarification.	Bidder to comply with specification requirements Limestone based FGD shall be considered. The mechanical, electrical and control & instrumentation design for the plant shall consider provision for the future installation of FGD. Bidder consideration shall be reviewed during detailed engineering.

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400.	Vol. II, Section 1.0	16.0.0	102 of 191	**APPROVED SUB-VENDOR / MAKES** The makes of all the equipment/ instruments under this specification shall be subject to Owner's approval in the event of order. Contractor shall furnish a list of makes/ subvendors/ sub-contractors along with his bid. Owner reserves the right to accept/ reject any make or sub-vendor or add new makes/ sub-vendors for the project, after award of contract. Approval, rejection or addition of makes shall not have any cost implication to the Owner after award of contract.	As the proposed project schedule is extremely tight, Owner is requested to accept the Bidder's proposed vendor list in to, which would be submitted with the bid. Bidder has a robust framework of due diligence procedure for selection of vendors.	The suggestion is proposed due to extremely tight project schedule.	Bidder to follow specification.
401.	Vol-II, Sec-1,	1.2.0 (32)	7 of 191	Solar PV Plants on Roof Tops. The Solar Photo Voltaic (PV) installation on Rooftop of various buildings in the SG Package of Thermal Power Plant shall be carried out preferably on shadow free area in such a way that the generation is maximized on each building Rooftop suitable for installation of Solar PV power plants. The final solar plant capacity shall be as per detailed approved engineering design of each of the buildings	Bidder understands that impact of solar power generation will not be considered in calculation of Auxiliary Power Consumption. Owner is requested to confirm.	Clarification is sought to bring all Bidders at par.	Noted.

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402.	Vol-II, Sec-1,	1.2.0 (26)	7 of 191	Electro chlorination and gas chlorination system	As per mechanical section-2 specification, only electro chlorination needs to be considered. No gas chlorination is envisaged for the project. Please clarify.	Clarification is sought to bring all Bidders at par.	Gas chlorination system shall be ignored.
403.	Vol-II, Sec-1,	6.2.4	36 of 191	Where Stage II equipment are to be located in Stage I buildings, necessary space, power supply and other provisions shall be incorporated in the building for easy construction, installation and maintenance of such Stage II equipment	Owner is requested to identify the areas where the referred provisions for Stage-II need to be considered. Presently no other provisions are being considered by Bidder in stage-I. Owner is requested to clarify.	Clarification is sought to bring all Bidders at par.	Bidder to follow specification.
404.	Vol-II, Sec-1,	6.2.4	36 of 191	Where Stage II equipment are to be located in Stage I buildings, necessary space, power supply and other provisions shall be incorporated in the building for easy construction, installation and maintenance of such Stage II equipment	Bidder shall consider only space provision for Stage-II requirements based on Owner's clarification on above point. No other provisions will be considered by Bidder in stage-I. Owner is requested to clarify.	Clarification is sought to bring all Bidders at par.	Bidder to follow specification.
405.	Vol-II, Sec-2,2.24	3.0.0	2 of 7	Miscellaneous pumps / General Service pump shall have flow & head margins of 10% & 15% respectively	While selecting pump capacity of general service pumps, Bidder will consider margin on flow as 10 % and margin on friction drop of piping & valves will be considered as 10% which would be more than adequate for the purpose. Otherwise auxiliary power consumption will increase as equipment will not be operating at duty point.	Clarification is sought to bring all Bidders at par.	Noted.

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406.	General			Owner is requested to furnish auto CAD drawing of plot plan & site topography submitted			Already uploaded in the TANGEDCO website
MAIN PLANT SYSTEM & PG TESTS							
407.	Vol. I, Section – 4.0, SCC	23.2	19 of 21	**/ LOADING CRITERIA & PENALTY:** Total Auxiliary power consumption for the plant * (1320 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85: Rs.4,70,72,094 for every 0.01 % increase **(considering 5.5% Aux. Power Consumption as base)**	Owner is requested to clarify if the evaluation loading will be done considering base as 5.5% Aux Power Consumption OR considering base as lowest power consumption quoted by one of the Bidder.	Clarity is required to establish base for loading on Aux Power Consumption.	Bidder shall follow the specification. Loading for evaluation of shortfall in performance shall be considering 5.5% Aux. power consumption as base.

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408.	Vol. I, Section – 4.0, SCC	23.2	19 of 21	**EVALUATION / LOADING CRITERIA & PENALTY:** ..... 2: Total Auxiliary power consumption for the plant * (1320 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85: Rs.4,70,72,094 for every 0.01 % increase **(considering 5.5 % Auxiliary Power Consumption as base)**	Bidder understands that 0.01% corresponds to 1320 MW i.e. (1320 x 0.01% = 132 kW). Hence auxiliary power loading will be @: (4,70,72,094 / 132 = 3,56,607 INR / kW) for any Bidder who quotes Auxiliary Power in excess of 5.5%. Please confirm Bidder's understanding.	Clarification is sought to bring all Bidders at par.	Bidder understanding is correct
409.	Vol. I, Section – 4.0, SCC Vol. II, Section 1.0 GTS	23.2 11.11.3.2	20 of 21 72 of 191	**EVALUATION / LOADING CRITERIA & PENALTY:** **.....** 5. Steam generator efficiency with following conditions: i) **100% TMCR** Major Requirements/ Method of Steam Generator Efficiency Tests ii Test Loads: **105% TMCR (VWO unit Load)** 100% TMCR (660 MW unit Load)	Bidder understands that Steam Generator efficiency test will be done at 100% TMCR only. Owner is requested to confirm.	Clarification sought since redundancy in tests observed in specification.	Bidder to follow specification

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410.	Vol. II, Section 1.0 GTS	11.11.2.1	68 of 191	The guaranteed performance parameters furnished by the Bidder in his offer, shall be **without any tolerance values** whatsoever. All margins required for instrument inaccuracies and **other uncertainties** shall be deemed to have been included in the guaranteed figures.	Tolerances & measurement uncertainties allowed by test codes may please be allowed by Owner.	Standard & international test code permit tolerances & measurement uncertainties.	Bidder to follow specification.
411.	Vol. II, Section 1.0 GTS	11.11.3.4	74 of 191	2) STEAM GENERATOR AND AUXILIARIES ..... g) Electrostatic precipitators (ESP)	Bidder understands that ESP Auxiliary power consumption will be the power consumption of corona power (Excluding power consumption by hopper heaters, insulator heaters, rapping system, ventilation fans etc.) of all fields of all passes of ESPs while firing design coal. Owner is requested to confirm.	Clarification to bring all Bidders at par.	Complete ESP power consumption shall be included for Auxiliary power consumption.
412.	Vol. II, Section 1.0 GTS	11.11.3.4	74 of 191	AUXILIARIES TO BE CONSIDERED FOR CALCULATING AUX POWER CONSUMPTION: Coal Handling System – Maximum of the mentioned flow path in the specification	Bidder understands that while guaranteeing CHP Aux Power, the power consumption of auxiliaries like Dust Suppression, Dust Extraction System are not to be considered. Owner is requested to confirm.	Clarification to bring all Bidders at par.	Auxiliary power consumption of complete CHP shall be considered except drain pump, Coal sampling unit, Elevator, flap gate and handling facility.

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413.	Vol. II, Section 1.0 GTS	11.11.3.4	74 of 191	AUXILIARIES TO BE CONSIDERED FOR CALCULATING AUX POWER CONSUMPTION: 4) BALANCE OF PLANT-COMMON SYSTEMS: Desalination plant (SWRO, BWRO, DM Plant)	There are certain drives which do not run continuously in the Water Treatment Plant such as backwash pumps etc. Owner is requested to confirm whether addition of rated power consumption of all the drives, which will be operating intermittently, is to be considered for Aux Power Calculation?	Since the tender mentions that all continuously running auxiliaries shall be considered for Aux Power Guarantee, it may be interpreted that intermittently running auxiliaries need not be considered if they are not specifically mentioned in tender list.	Bidder to note that tender specifies factor for complete Desalination plant (SWRO, BWRO, DM Plant). Same shall be followed.
414.	Vol. II, Section 1.0	11.11.3.4 (4)	74 of 191	AUXILIARIES TO BE CONSIDERED FOR CALCULATING AUX POWER CONSUMPTION: Ash handling system i. Bottom Ash Evacuation System: 1.0 ii. Fly Ash Evacuation System: 0.7 iii. Bottom ash disposal System: 1.0 iv. Fly Ash disposal System: 1.0 v. Recovery water system: 1.0	Certain equipment in the ash handling system will not be working continuously during operation of the system. Please clarify whether those equipment (like Sludge pumps, sump pumps, conditioner pump, chemical dosing pumps) need to be considered for guaranteed auxiliary power consumption.	Since the tender mentions that all continuously running auxiliaries shall be considered for Aux Power Guarantee, it may be interpreted that intermittently running auxiliaries need not be considered if they are not specifically mentioned in tender list.	Bidder to note that tender specifies factor for complete Ash handling system. Same shall be followed.

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415.	Vol. II, Section 1.0	11.11.3.4 (4)	74 of 191	AUXILIARIES TO BE CONSIDERED FOR CALCULATING AUX POWER CONSUMPTION: ..... Ash handling system ii. Fly Ash Evacuation System 0.7 iv. Fly Ash disposal System 1.0	Bidder understands that Fly Ash Evacuation System refers to ash handling from ESP & APH hoppers to Buffer hopper. Please confirm.	Clarification to bring all Bidders at par.	Fly Ash Evacuation System refers to ash handling from ESP & APH hoppers to Buffer hopper and further to silo.
416.	Vol. II, Section 1.0	11.11.3.4 (4)	74 of 191	AUXILIARIES TO BE CONSIDERED FOR CALCULATING AUX POWER CONSUMPTION: ..... Ash handling system ii. Fly Ash Evacuation System 0.7 iv. Fly Ash disposal System 1.0	Bidder understands that Fly Ash disposal system refers to ash handling from outlet flange of buffer hoppers to Dry fly ash silo & further unloading through open truck. Please confirm.	Clarification to bring all Bidders at par.	Noted. In addition disposal from fly ash silo to ash pond shall also be covered in Fly Ash disposal System.
417.	Vol. II, Section 1.0 GTS	11.11.3.4	75 of 191	AUXILIARIES TO BE CONSIDERED FOR CALCULATING AUX POWER CONSUMPTION: ..... 4) BALANCE OF PLANT-COMMON SYSTEMS: ..... Effluent treatment plant	There are certain drives which do not run continuously in the Effluent treatment plant such as backwash pumps etc. Owner is requested to confirm whether addition of rated power consumption of all the drives, which will be operating intermittently, is to be considered for Aux Power Calculation?	Since the tender mentions that all continuously running auxiliaries shall be considered for Aux Power Guarantee, it may be interpreted that intermittently running auxiliaries need not be considered if they are not specifically mentioned in tender list.	Bidder to note that tender specifies factor for complete Effluent treatment plant. Same shall be followed.

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418.	Vol. II, Section 1.0 GTS	11.11.5.3	83 of 191	**Guarantees Under Category-III:** ..... **6. Turbine-generator set capability:** The steam turbine generator shall be capable of delivering at generator terminals the output as indicated in the heat balances under the following conditions: **Continuous TG output of 100% TMCR under rated steam conditions at 89 mm Hg (a) worst condenser pressure** with 1% make up. While conducting this test, the condenser pressure measurement shall be done at 300 mm above the top row of condenser tubes.	Bidder understands that worst condenser pressure shall be considered as condenser pressure at maximum cooling water temperature (i.e. 36 Deg.C.) instead of 89 mmHg. Owner is requested to confirm.	Worst condenser pressure corresponds to maximum cooling water temperature.	Bidder to follow specification.

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419.	Vol. II, Section 6	SCHEDULE 1. C.	7 of 302	SCHEDULE – 1 FUNCTIONAL GUARANTEES ..... C. GUARANTEES UNDER CATEGORY III - PERFORMANCE GUARANTEES UNDER COMPULSORY CORRECTION	Certain details sought in the list of guarantees under category-III guarantees shall be submitted in detail engineering stage..	The list is exhaustive & certain details can only be finalized after completion of detail engineering / or finalization of equipment supplier.	In performance guarantee under Cat-III, various parameters like Capacity, flow rate, temperature, head, applicable test codes, noise level, vibration, etc. would be finalized during detailed engg and will be subjected to review and approval by TANGEDCO to validate the compliance to specification requirements. Bidder compliance to such review, comments and approval during detailed engineering shall not have any implication to TANGEDCO.

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420.	Volume II/ Section - I	11.11.3.4	75 of 191	Fire fighting system 0.4 Duty Factor	Bidder will consider Jockey pumps in fire fighting system for Aux Power Consumption. Hydrant pumps & downstream equipment in fire protection & detection system will not be considered for Aux. power consumption in Fire fighting system as the same is not in continuous operation.	Clarification is sought to bring all Bidders at par.	Bidder to follow specification.
421.	Section 2-2 ST and Aux System / Vol-II	4.1.0	8 of 27	The HP/LP Bypass System shall be designed to handle 60% of BMCR flow and sized for 65% BMCR flow at rated steam conditions. LP bypass system shall be designed to condition the incoming steam from **reheater to parameters matching the LP turbine exhaust steam**	Bidder would like to clarify that the LP Bypass exhaust steam condition shall be limited within the acceptable limit per HEI. Please confirm acceptance.	HEI recommendations may please be allowed to be followed.	Bidder shall follow specification.
422.	Section 2-2 ST and Aux System / Vol-II	4.1.0	8 of 27	Each bypass station shall be **designed for the respective maximum steam pressure, i.e. the safety valve set pressure in the respective section** and sized for maximum steam capacity generated taking into account the condensate injection for attemperation.	As per bidders standard engineering practice, HP bypass valve design parameters will be same as main steam piping design parameters and LP bypass valve design parameters will be same as cold reheat piping design parameters. Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification. Bidder to note that the Main steam and CRH piping will be designed for respective max. steam pressure, i.e. the safety valve set pressure in the respective section.

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423.	Section 2-2 ST and Aux System / Vol-II	3.0.0	4 of 31	Wet Steam / Exhaust steam: 30 m/s	BFPT exhaust pipe/duct connecting to condenser velocity shall be considered max.137 m/s as the same is inline with NEMA Standards. Please confirm the acceptance.	Layout constraints demand higher velocity to be considered & the same is also acceptable as per NEMA standards.	Bidder to follow specification.
424.	Section 2-2 ST and Aux System / Vol-II	3.0.0	4 of 31	Feedwater Suction lines: 1.0 m/s	Shall be allowed up to 2-3 m/s. Please confirm the acceptance.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder shall follow specification
425.	Section 2-2 ST and Aux System / Vol-II	3.0.0	4 of 31	The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors, valves, flow limiting orifices, etc., or the system heat and/or mass balance diagrams.	Line sizing considering rated capacities of equipment leads to oversizing of the lines. Bidder proposes the following: "The design flows considered in line sizing shall not be less than the corresponding values in system heat and/or mass balance diagrams with sufficient margin as per Bidder's proven practice" Please confirm the acceptance.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder shall follow specification

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426.	Section 2-3 Condenser System / Vol-II Section 2-4 FW Heating System / Vol-II Section 2-4 FW Heating System / Vol-II	3.1.0 (h) 5.2.0 Annex 2.4.1	2 of 12 6 of 11 10 of 11	Design for installation of LP heater(s) in condenser neck. **The drain cooler to be installed outside the condenser neck.** LP heaters shall have provision of integral desuperheating, condensing and drain cooling zones except for condenser neck **LP heater which has a separate drain cooler.** Condenser Neck LP heater: Straight or U tube design with separate drain cooler	a) Bidder may please be allowed to select integral / separate drain cooler. b) If LP Heater drain pumps are provided, then there shall not be any drain cooler as no drain cooling zone in these heaters. Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder clarification is noted for selection of integral / separate drain coolers for LP heaters in condenser neck. Bidder to follow specification for other technical requirement.
427.	Section 2-3 Condenser System / Vol-Iiz Section 2-3 Condenser System / Vol-II	4.1.0 Annex 2.3.1	3 of 12 11 of 12	Condenser to be designed for minimum air leakage and under normal operating conditions, the air leakage in condenser not to exceed more than 50% of design value taken for sizing of vacuum pumps. The same shall be demonstrated at site under actual operating condition failing which Bidder shall carryout necessary modifications. Max. Oxygen content of condensate leaving the condenser shall be 0.02 ppm over the entire load range. Maximum oxygen content of condensate leaving the condenser over the entire range of operation : 0.015 ppm	There is discrepancy found in the two clauses. As per HEI for surface condenser, corresponding to 50% leakage, the oxygen content shall be 0.03 cc per liter (42 ppb). Maximum oxygen content of condensate shall be as per HEI recommendation considering ratio of actual load to design capacity as 50%. Please confirm.	HEI recommendations may please be allowed to be followed.	Noted.

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428.	Section 2-3 Condenser System / Vol-II	4.1.0	4 of 12	The Condenser shall be designed for heat load corresponding to unit operation for VWO condition, VWO with 1% make up condition, HP heaters out of service condition, turbine operating at house load operation with HP-LP bypass operating at its rated capacity (60% BMCR) and rated steam parameters.....	As the Heat Rate guarantee and output guarantee (under evaluation) is on 100% TMCR, 0% MU, Bidder has considered the Condenser design point as heat load corresponding to unit operation for 100% TMCR, 0%MU and design condenser pressure (optimized condenser pressure).	The tender specification outlines operating conditions of Condenser however a specific design point is required for sizing the equipment.	Bidder to follow specification.
429.	Section 2-3 Condenser System / Vol-II	4.1.0	4 of 12	DM Make-up water shall be added to condenser from an condensate surge tank of adequate capacity through a normal make up control valve sized for 1.5% of VWO flow with 1.5% Make Up and emergency make up control valve sized for sized for 10% of VWO flow with 1.5% Make Up All necessary piping, valves, tank etc shall be engineered and supplied by the Contractor.	As per Bidder standard practice, Normal makeup control valve shall be sized for 1% of VWO flow and emergency make up control valve shall be sized for 5% of VWO flow. Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.

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430.	Section 2-3 Condenser System / Vol-II	4.2.0	6 of 12	Capacity of each pump in free dry air at standard condition with condenser operating at design pressure of 1 inch (25.4 mm) of Hg (abs) and sub cooled to 4.17 degC below temperature corresponding to absolute suction pressure shall not be less than 30 SCFM (51 m3 per hour) under standard conditions i.e. 760 mm Hg(abs) and 21.1 deg C.	Capacity of each vacuum pump shall be decided as per HEI.	HEI recommendations may please be allowed to be followed.	Bidder to follow specification.
431.	Section 2-3 Condenser System / Vol-II	4.2.0	6 of 12	Noise levels should not exceed limitations as specified in section of general technical requirements and vibration levels shall be as per VDI-2056 /	Vibration levels shall be as per ISO-10816-7 may please be allowed to be considered.	Relevant ISO standard recommendations may please be allowed to be followed.	Bidder to follow specification.
432.	Section 2-3 Condenser System / Vol-II Section 2-3 Condenser System / Vol-II	Annex 2.3.1 Annex 2.3.1 4.2.0	11 of 12 11 of 12 8 of 22	Maximum cooling water inlet temperature: 33°C CONDENSER AIR EVACUATION SYSTEM: Maximum temperature of condenser cooling water: 33°C ....maximum CW inlet temperature of 36°C at 47.5 Hz	There is a discrepancy in two clauses: Bidder understands that the indicated 33°C temperature is the Design Cooling Water Temperature which will be used for designing condenser and condenser air evacuation system. However, maximum Cooling Water Temperature shall be 36°C (as indicated in cl.no. 4.2.0 of Vol-II, Sec 2-5 pg no. 8 of 22). Please confirm.	Clarification.	There is no discrepancy in the specification. Bidder to follow specification.

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433.	Section 2-3 Condenser System / Vol-II	Annex 2.3.1	11 of 12	Maximum temperature rise of cooling water in condenser during abnormal condition: Less than 10°C	Request customer to modify the statement as "Maximum temperature rise of cooling water in condenser during abnormal condition **except during HPLP bypass operation**: Less than 10°C"	During HP/LP bypass, the temperature rise may exceed 10 Deg.C.	Bidder to follow specification.
434.	Section 2-3 Condenser System / Vol-II	Annex 2.3.1 Annex 2.3.1	11 of 12 11 of 12	Maximum cooling water velocity in condenser tubes with 10% blocked tubes = 2.2 m/s Tube plugging margin = 5%	For designing condenser 5% tube plugging margin shall be considered and accordingly maximum cooling water velocity in condenser tube with 5% blocked tube shall be 2.2 m/s. Please confirm.	Clarification sought to bring all Bidders at par.	Bidder to follow specification.
435.	Section 2-4 FW Heating System / Vol-II	4.3.0	3 of 11	The deaerator shall be of floating pressure type with **pegging pressure of 3.5 ata during warm and hot startup, HP-LP bypass operation, major load rejection, turbine trip** and low loads when extraction steam pressure is less than 3.5 ata...	Deaerator pressure as optimized by bidder shall be allowed during HP/LP bypass, start-up, Turbine trip condition. Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.

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436.	Section 2-4 FW Heating System / Vol-II	4.3.0	3 of 11	Feed water storage tank capacity shall be minimum 6 minutes storage of 100% BMCR flow between normal operating level and low-low level with a filling factor of 0.66	Following sizing criteria are considered: (1). Level between HHWL & NWL shall be 200mm min. (2). Holdup volume between NWL & LLWL shall correspond to 6 min of BMCR flow. (3). BFP normal operation trip point is LLWL (corresponds to 15% of gross volume). (4). BFP transient check will be performed with Deaerator level at LWL & accordingly LWL will be set. 5) The Deaerator fill factor shall be 0.75. Same may be please accepted.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.
437.	Section 2-4 FW Heating System / Vol-II	4.4.0	3 of 11	..... The low pressure heater shall have an alternate path to the surface condenser via the flash tank.	AS per Bidder's practice, low pressure heaters alternate/emergency drain shall be directly routed to condenser and no LP Flash Tanks are required. Please confirm the acceptance.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.
438.	Section 2-4 FW Heating System / Vol-II	4.4.0	3 of 11	Provide sentinel relief valve on tube side.....	Tube side relief valves shall be provided as per HEI. Please confirm.	HEI recommendations may please be allowed to be followed.	Bidder to follow specification.

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439.	Section 2-4 FW Heating System / Vol-II	4.4.0	3 of 11	..... Relief valves on shell side shall be sized to pass flow from two ruptured tubes (four open ends) or 10% of design water flow at 10% accumulation whichever is higher and set to open at heater design pressure.	Bidder wishes to clarify that for arriving feed water heater shell side relief valve capacity as per HEI requirement. As per HEI standards for closed feed water heaters, Cl. No. 6.1.2, "It is suggested that this relief valve be sized to pass the larger of the following flows at 10 percent accumulation: (a) Minimum of 10 percent of the maximum overload feed water flow specified through the heater based on water at Tv b) Flow based on the clean rupture of one heater tube resulting in two (2) open ends discharging as orifices. Flow shall be determined for orifices of a diameter equal to the nominal inside diameter of the tubes using an orifice coefficient of 0.9, a pressure differential across the orifice equal to the difference between the tube and shell design pressures, and water at Tv." Please confirm that the relief valve on shell side can be sized as per HEI.	HEI recommendations may please be allowed to be followed.	Bidder to follow specification.

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440.	Section 2-5 PCP and Accessories / Vol-II	3.1.0	2 of 22	**Boiler Feed water pumps** ..... One complete minimum-flow system with ON/OFF type automatic recirculation valve.....	Alternatively option of providing Modulating type minimum recirculation valve also be envisaged. ON-OFF or modulating type minimum recirculation valve with valve body designed for 40% of design flow shall be provided	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.
441.	Section 2-5 PCP and Accessories / Vol-II Vol-II Section 2-1 SG and Aux	3.1.0 4.13.0	2 of 22 12 of 66	Scope of this specification shall include but will not be limited to the following (for each pump unless indicated otherwise):. Inter stage bleed connection from boiler feed pump to supply water to reheat steam desuperheater and **kicker stage tap-off from boiler feed pump to supply water to superheater attemperation.** Spray water for superheater attemperation shall be tapped off from a suitable source upstream of HP heaters (from BFP discharge or Kicker stage outlet). The bidder can also tap off the spray water from a suitable location downstream side of HP heaters, provided, bidder has experience of such tapping, details of which shall be provided to Owner.	There is discrepancy found in the two clauses. Bidder will consider source of spray water for superheater attemperation as per Cl. 4.13.0 of page no. 12 of 66, 52 of Vol-II Section 2-1 SG and Aux of tender specification.	Clarification.	Bidder to follow Vol-II Section 2-1 clause no: 4.13.0 page 12 of 66.

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442.	Section 2-5 PCP and Accessories / Vol-II	3.1.0	2 of 22	Scope of this specification shall include but will not be limited to the following (for each pump unless indicated otherwise):. . **Portable type oil purifier unit.**	One common centrifuge type oil conditioning system for TDBFP and MDBFP per unit as per tender requirement shall be provided. Please confirm. In total, two nos. oil purifiers shall be provided for the project.	Clarification sought to bring all Bidders at par.	Bidder to follow specification.
443.	Section 2-5 PCP and Accessories / Vol-II	3.1.0	3 of 22	Feed regulating station for feed water flow control during unit startup and normal condition, consisting of the following for each unit: a) One pneumatically operated (0 to 30% BMCR capacity range) feed control valve. b) **Two numbers of motor operated gate valves with motor operated integral bypass valve, one each on upstream and downstream of pneumatically operated feed control valve.** c) One motor operated gate valve with motor operated integral bypass valve in parallel to the pneumatically operated feed control valve to bypass the feed control in the unit operation range of 30-100% BMCR.	Motor operated gate valves on both upstream and downstream of feed control valve is not required. Instead, One (1) motor operated isolation valve at the upstream side of feed control valve and One (1) manual operated isolation valve with LO facility at the downstream side of the feed control valve shall be provided.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.

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444.	Section 2-5 PCP and Accessories / Vol-II	3.1.0	3 of 22	n) Gland sealing steam supply piping from auxiliary steam header or CRH line during starting conditions and boiler feed pump dive turbine shall be self sealing during normal condition.	BFPT gland sealing source during normal operation shall be as per standard practice of Drive Turbine OEM . Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.
445.	Section 2-5 PCP and Accessories / Vol-II	4.1.0	5 of 22	Turbine driven feed pumps to be capable of generating the discharge pressure not less than 3% over steam generator highest safety valve set pressure and flow corresponding to BMCR requirements.	Attached is Interpretation to PG-61.5, Feed Water Supply for a Steam Generator With No Fixed Water Level. This was published in ASME website in July 2014. Per interpretation 1-13-15, Bidder would like to consider the emergency point for BFP capability as **flow corresponding to BMCR condition and head corresponding to maximum expected pressure at economizer inlet** (design pressure).	Standard code recommendations may please be allowed to be followed.	Bidder to follow specification.

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446.	Section 2-5 PCP and Accessories / Vol-II	4.1.0	5 of 22	**Boiler Feed Water Pumps** ..... The characteristic curves of all the pumps shall be identical and shall be of continuously rising type with decrease in flow. The shut off head of the pump shall be between 120% and 130% of TDH at rated condition or **1.25 times of boiler design pressure whichever is higher.**	Bidder proposed to modify the clause as below: The characteristic curves of all the pumps shall be identical and shall be of continuously rising type with decrease in flow. **The shut off head of the pump shall be between 120% and 130% of TDH at rated condition.**	Shut off head is characteristics of pump. It will be decided by OEM based on pump design.	Bidder to follow specification.
447.	Section 2-5 PCP and Accessories / Vol-II	4.1.0	5 of 22	Boiler Feed Water Pumps ..... The maximum continuous motor rating corresponding to maximum cooling water temperature at cooler inlet shall not be less than larger of the following conditions: a. Sufficient to drive the pump through the entire range of run-out flow to shut-off conditions operating at frequency variations from 47.5 Hz to 51.5 Hz **b. 110% of pump design point rating. The maximum load demand of driven equipment at its entire range of operation at frequency variations from 47.5 Hz to 51.5 Hz.**	a) The maximum continuous motor rating corresponding to maximum cooling water temperature at cooler inlet shall not be less than larger of the following conditions: a. Sufficient to drive the pump through the entire range of run-out flow to shut-off conditions operating at frequency variations from 47.5 Hz to 51.5 Hz **b. 110% of pump design point rating.** b) This criteria is also applicable for Condensate Extraction Pump and LP Heater Drain Pump. Please confirm.	OEM design.	Bidder to follow specification.

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448.	Section 2-5 PCP and Accessories / Vol-II	4.1.0	6 of 22	The boiler feed pumps shall be capable of coasting down safely to standstill after it is tripped in the event of a sudden interruption of suction flow. **The Bidder shall demonstrate this capability by a suitable dry-running** test at his works.....	Dry running is not envisaged as this is not recommended by BFP suppliers. Please confirm the acceptance		Bidder to follow specification.
449.	Section 2-5 PCP and Accessories / Vol-II	5.1.0	10 of 22	Booster Pump **Side suction and discharge connections** shall be of flanged type with weld neck raised face as per ANSI B16.5.	Booster Pump **Top suction and Top discharge** connections shall be of flanged type with weld neck raised face as per ANSI B16.5 may please be allowed. Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Noted.
450.	Section 2-5 PCP and Accessories / Vol-II	4.2.0	8 of 22	**Condensate Extraction Pumps** **.....** **Design head** TDH at design capacity shall be derived based on deaerator maximum safety valve set pressure at VWO and equipment and piping pressure drops with 10% margin at VWO condition with 1.0 % make- up, static head etc.....	TDH at design capacity shall be derived based on maximum Deaerator pressure of all operating conditions with piping pressure drops with 10% margin, equipment pressure drop and static head.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.
451.	Section 2-5 PCP and Accessories / Vol-II	5.1.0	15. of 22	**Turbine Exhaust pipe** Turbine exhaust shall be separately piped to the condenser of main TG unit in the **downward direction.**	If BFPT is placed at ground floor, upward exhaust shall also be accepted.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.

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452.	Section 2-5 PCP and Accessories / Vol-II	5.1.0	15. of 22	**Protection against water induction** Turbine shall be designed for protection against water induction. **All drains shall consist of motorised drain valves** with isolating valves and drain piping for connection to drain flash tank	All drains shall consist of pneumatic drain valves to meet the ASME TDP-1 requirements.	ASME recommendations may please be allowed to be followed.	Noted. For Turbine protection against water induction: ASME-TDP-1 Latest shall be followed.
453.	Section 2-5 PCP and Accessories / Vol-II	Annex 2.5.1	22 of 22	BFP Suction Strainer Type : - Conical Strainer	Requirement and type of strainer at main BFP suction shall be as per pump manufacturer standard practice. Please confirm	OEM design recommendations may please be allowed to be followed based on proven practice..	Bidder to follow specification.
454.	Section 2-6 Condensate system / Vol-II Section 7 / Vol-II	3.1.0 DWG NO. Dwg No. 10-1115112-M-002	1 of 8 Sht 1 of 1	**Minimum recirculation facility with 2 x 100% recirculation control valves** with isolation valves upstream and downstream. The minimum recirculation flow shall correspond to maximum of gland steam condenser minimum recirculation flow and CEP minimum recirculation flow. <u>Flow Diagram for Steam, Feed water and condensate system:</u> 1x100% Minimum recirculation control valve is shown	As per Bidders standard engineering practice, only 1x100% capacity minimum recirculation valve sufficient and accordingly only 1x100% control valve is considered. The same is inline with the tender flow diagram also. Please confirm.	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow Section 2-6 Condensate system / Vol-II 3.1.0 page 1 of 8.

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455.	Section 2-6 Condensate system / Vol-II	3.3.0	2 of 8	**2 x 100% steam generator initial fill pumps** (i.e. each pump shall have capacity of filling the steam generator in 2 hour maximum) for each unit along with complete piping, fitting, valves, instrumentation and supports.	2X100% (1W+1S) steam generator initial fill pumps shall be provided for both units along with complete piping, fitting, valves, instrumentation and supports.	Clarification is sought to bring all Bidders at par.	Bidder to follow specification.
456.	Section 2-6 Condensate system / Vol-II	5.2.0	4 of 8	**Cycle make-up pump and Steam generator initial fill pump Pumps shall be identical in construction** and similar parts of the pumps shall be interchangeable.	Since the capacity (flow and head) of cycle make up pump and steam generator initial fill pumps are different, this clause is not applicable.	Clarification.	Noted.
457.	Section 7 / Vol-II	DWG NO. Dwg No. 10-1115112-M-002	Sht 1 of 1	Flow Diagram for Steam, Feed water and condensate system: Flow Element on Main Steam and Hot Reheat Line	Flow Element on Main Steam and Hot Reheat Line is not considered as per Bidder standard practice	Since this is an EPC project, Bidder's standard proven practice may please be allowed to be followed.	Bidder to follow specification.
458.	Section 7 / Vol-II Vol-II Section 2-1 SG and Aux	DWG NO. Dwg No. 10-1115112-M-002 4.5.0	Sht 1 of 1 9 of 66	Flow Diagram for Steam, Feed water and condensate system: Four nos. of HP Bypass valves are shown in the flow diagram Bidder can offer either 1x100% or 2x50% bypass valves to suit the layout.	There is discrepancy found in the documents. Bidder will consider Cl. 4.5.0 of page no. 9 of 66 of Vol-II Section 2-1 SG and Aux of tender specification for number of HP Bypass valves.	Clarification sought to bring all Bidders at par.	Bidder shall consider Cl. 4.5.0 of page no. 9 of 66 of Vol-II Section 2-1 SG and Aux.
459.	Vol. II, Section 1.0	7.1.0 General	38 of 191	The life span to be considered for the design of equipment and component selection shall be at least 40 years. The civil structures shall be designed for a design life of 50 years.	In general practice, Boiler life is considered to be 25 - 30 yrs.	General industry practice	Bidder to follow specification
460.	Vol. II, Section 1.0	11.11.3.2 Steam Generator	72 of 191	e) Excess air at economizer outlet (at 100% TMCR load) 20% (min.)	Bidder and the technology partner have lot of reference installations with	Bidder standard design	Bidder shall follow specification.

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		Efficiency			15 % excess air for large capacity supercritical boilers. Hence the boiler shall be designed with 15% of excess air and same shall be demonstrated by the bidder.		
461.	Vol. II, Section 2	4.4.0 Limiting Parameters for Steam Generator Design	9 of 66	i) Excess air at economiser outlet at TMCR load: 20% (minimum).			
462.	Vol. II, Section 1	ANNEX - 1.1 COAL ANALYSIS	123 of 191	• Design Coal : 70% Imported & 30% Domestic Coal on weighted average • Worst Coal : 50% Imported & 50% Domestic Coal on weighted average 3. HGI Domestic Coal : 45 to 55 Average 52 50 Imported Coal : 51	From the imported and Indian Coal Analysis furnished, Bidder has considered the following HGI. For Design Coal : 52 For Worst Coal : 52 TANGEDCO to confirm the same.	Clarification	Bidder shall consider HGI for mill sizing as per vol-II Sec 1.0 Annex 2.1.1 page no: 55 of 66. However for other equipments, HGI of 45 shall be considered as per vol-II Sec 1.0 Annex-1.1 page 123 of 191.
463.	Vol. II, Section 2	ANNEX 2.1.1 COAL MILLS	55 of 66	Design Hard grove grindability index of coal(HGI)-- 38			
464.	Vol. II, Section 1	ANNEX - 1.1 COAL ANALYSIS	123 of 191	1. HIGHER HEATING VALUE - As Fired basis given Kcal/kg Domestic Coal : 3000 (GCV as received basis)	As per Dulong's Formula, the GCV is 2484 Kcal/kg. TANGEDCO to clarify the same.	Clarification	Bidder to follow specification.
465.	Vol. II, Section 2	3.1.0 Water/ Steam System	2 of 66	b) One motorized and One manual isolation valves at suction of start-up recirculation pumps and Motorized isolation, electrohydraulic operated control valves and Non return valves at discharge of the start-up recirculation pumps.	Bidder proposes to supply one motorized operated isolation valve at the recirculation pump and one motorized operated isolation cum non return valve at discharge of the start-up recirculation pump.	Bidder standard practice	Bidder to follow specification.

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466.	Vol. II, Section 2	3.1.0 Water/ Steam System	2 of 66	d) Pump minimum flow control valve and recirculation flow control valve.	Bidder proposes to supply one pneumatic operated minimum flow line block valve and recirculation flow control valve.	Bidder standard practice	Bidder to follow specification.
467.	Vol. II, Section 2	3.1.0 Water/ Steam System	2 of 66	e) Mixing box at pump suction, a non-return valve upstream of the Mixing box on the recirculation line from separator, along with necessary piping and valves.	As per bidder standard, no mixing box is required at the pump suction and hence the same is not envisaged.	Bidder standard design	Bidder shall provide the details along with bid
468.	Vol. II, Section 2	3.1.0 Water/ Steam System	2 of 66	f) Piping with necessary level control valves from separator/ drain collection vessel to startup flash tank. A start-up and emergency drain control valve upstream of flash tank with a motorized isolation valve upstream of drain control valve. g) 2 x 50% drain pumps with necessary isolation valve, control valve, minimum flow facility and piping up to condenser . The pumps are designed for the worst operating scenario including the start up without Boiler start-up recirculation pump in operation and entire flow diverted to condenser.	As per bidder standard when BCP is not in operation, drain water from WSDT shall be sent to condenser directly through WDC valve during swelling at start-up operation. Hence separate flash tank and drain pumps is not envisaged. However one number boiler flash tank shall be provided to collect the drain during start-up and shut-down.	Bidder standard design	
469.	Vol. II, Section 2	3.1.0Water/ Steam System	3 of 66	Electromatic valves on SH and RH outlet), complete with solenoid valve assembly, pressure sensing device, impulse piping, accessories,	As per ASME guidelines AND Bidder standard, Electromatic relief valve is not required in the RH outlet and hence the same	Clarification	Bidder to follow specification.

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				necessary instrumentation etc., and a remote operated motorized isolation valve on the upstream side of each Electromatic valve.	is not provided.		
470.	Vol. II, Section 2	5.7.0 Safety valves / Pressure relief devices	22 of 66	• Electromatic relief valve of suitable capacity at reheater outlet shall be provided, if recommended by the manufacturer.			
471.	Vol. II, Section 2	3.1.0 Water/ Steam System	3 of 66	c) Two (2) Nos. electrically operated isolating valve downstream of each control valve	Bidder proposes to supply one(1) no. of manually operated isolating valve downstream of each control valve.	Bidder standard practice	Bidder to follow specification.
472.	Vol. II, Section 2	3.1.0 Water/ Steam System	3 of 66	d) Quick acting block valve (pneumatically operated) at upstream of superheater spray control station on the common super heater attemperatation line.	Bidder proposes to supply Motor operated isolation valve upstream of superheater spray control station on the common super heater attemperatation line.	Bidder standard design	Bidder to follow specification.
473.	Vol. II, Section 2	3.1.0 Water/ Steam System	3 of 66	All startup vents shall be provided with two valves in series – one motorized isolating and other motorized regulating type. All start-up vents, first lowest and second lowest set pressure safety valves electromatic relief valves at superheater & reheater outlets, first lowest and second lowest set pressure safety valves on the water separators	For supercritical units, boiler will be started with HP bypass valve in operation. Hence, start up vent valve is not necessary and not envisaged. However the drain& vent valves, which are required as per OEM standard for boiler start-up, are provided with motorized valves.	Bidder standard design	Bidder to follow specification.

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				shall be provided with silencers.			
474.	Vol. II, Section 2	3.1.0 Water/ Steam System	3 of 66	Steam Generator integral piping consists of valves and fittings, feed check valves, motorized main steam stop valve with integral motorized bypass valve with actuators including hand wheel, motorised drain/vent valves, safety valves and electromatic safety valves for separator, superheater and reheater (as applicable) ,Safety valve escape pipings and start up vent line with silencers, drip trays, shock absorbers etc.			
475.	Vol. II, Section 2	5.6.0 Steam Generator Integral Piping, Valves, Fittings and Mountings	21 of 66	• Silencers shall be provided for boiler start up vent, all first lowest and second lowest set pressure spring loaded safety valves and electromatic valves.			
476.	Vol. II, Section 2	3.3.0 Coal preparation and firing System	4 of 66	• Pneumatically operated sliding type shut off gate at each Coal bunker outlet gates with proper approach and Electrically operated (shut off gate at each coal feeder inlet).Chain wheel and chain shall be provided for above said shut off gates for manual operation for from feeder floor.	Bidder proposes to supply manual isolation Rod gate at bunker outlet and Motor operated isolation gate at Feeder inlet.	Bidder standard design	Bidder to follow specification.

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477.	Vol. II, Section 2	3.4.0 Combustion air System	5 of 66	• Two (2) steam coil air preheaters in secondary air bypass duct, complete with common condensate tank, integral piping, control and isolation valves for steam and condensate along with necessary controls. The condensate to be feed to the flash tank through steam trap.	As per the bidder standard, Condensate tank will not be provided for SCAPH. However, the condensate from SCAPH will be fed to the flash tank through Steam trap.	Bidder standard practice	Bidder to follow specification.
478.	Vol. II, Section 2	3.7.0 Steam Generator Accessories	5 of 66	• Electrically operated automatic sequential type intelligent soot blowing system for furnace, super heaters, convective and radiant heating surfaces ,air preheaters and economizer complete with necessary piping, PRDS valves, spray control valve and other specialties with instruments and controls as required for carrying out on load cleaning. Washing water hoses and supply lines for off load cleaning of heating surfaces.	Bidder proposes to supply conventional sequential based soot blowers.	Bidder standard practice	Bidder to follow specification.
479.	Vol. II, Section 2	5.18.0Flue Gas Side Cleaning Equipment	41 of 66	The soot blowers shall be capable of selective operation in areas of ash deposition (SMART) type or equivalent			
480.	Vol. II, Section 2	3.7.0 Steam Generator Accessories	5 of 66	• Two(2) Numbers of 3000 kg capacity passenger-cum-goods lift for each Steam generator with necessary landings and interconnecting platforms to the TG buildings at required elevations.	Bidder propose to supply one number goods cum passenger elevator with 3000kg capacity and one number passenger elevator with 1088kg capacity.	General industry practice	Bidder to follow specification.

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481.	Vol. II, Section 2	4.6.0 Operation without HP heaters in service	9 of 66	Steam generator shall be designed for continuous operation with HP heaters out of operation. The steam generator heat output under HP heaters out condition shall be equal to at least 100% BMCR heat output with HP heaters in service.	Kindly note that the operation with all HP heaters out condition, the heat output may be limited to 100%TMCR heat duty.	Clarification	Bidder to follow specification.
482.	Vol. II, Section 2	4.10.0 Furnace	10 of 66	c) Furnace cooling factor in kcal/h/m2 is the ratio of NHI or heat available and effective projected radiant heat absorbing surface (EPRS). Calculated EPRS shall be reduced by at least 10% to account for deterioration of furnace walls surface condition due to fouling and slagging.	As per bidder standard, 100% effective projected radiant heat absorbing surfaces of water walls for EPRS calculation is considered.	Bidder standard design	Bidder to follow specification.
483.	Vol. II, Section 2	4.11.0	11 of 66	Design pressure of the Steam Generator pressure parts shall be at least 1.05 times the maximum operating pressure, or as required by IBR/ other international codes, whichever is higher. Further, maximum operating pressure for design of the steam generator parts up to separator(s) inlet shall be arrived at by adding an additional margin for the increased pressure drop in the evaporator tubing due to scaling during operation over a period of time. This additional margin shall be equal to	In case of once through boiler, the boiler pressure varies along the water steam path. Design pressure of the Steam Generator pressure parts shall be at least 1.05 times the maximum operating pressure of that heating surface and in accordance with the requirements of IBR. No additional margin considered due to scaling	Bidder standard design	Bidder to follow specification.

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				atleast 5% of maximum operating pressure with evaporator tubing without scaling or actual expected increase in the pressure drop in water wall/ evaporator section, which ever is higher.			
484.	Vol. II, Section 2	4.21.0 Flue Gas Ducts and Air Ducts	14 of 66	Minimum thickness of 7 mm shall be provided for flue gas ducts before ESP and 6 mm from ESP outlet to chimney.	Bidder propose to apply the duct thickness as follows: Gas ducting - 6mm	Bidder standard practice	Bidder to follow specification.
485.	Vol. II, Section 2	5.15.1 Duct Work	35 of 66	The flue gas ducts shall be fabricated from minimum of 7 mm thick Carbon steelplates before ESP and minimum of 6 mm thick carbon steel plates after ESP.			
486.	Vol. II, Section 2	ANNEX 2.1.1 AIR AND FLUE GAS DUCT	59 of 66	Flue gas duct plate minimum thickness mm 7 mm before ESP. 6 mm from ESP outlet to chimney.			
487.	Vol. II, Section 2	5.2.0 Economizer	17 of 66	Erosion allowance of minimum 1mm in addition to IBR requirements shall be considered while arriving the economiser tube thickness. Apart from this, minimum 10% thinning allowance on bends shall be considered.	Thinning allowance for Tube bends shall be considered as per bidder design practice / IBR	Bidder standard design / Code guidelines	Bidder to follow specification.
488.	Vol. II, Section 2	5.4.0 Furnace and water wall	18 of 66	Minimum 10% thinning allowance shall be provided wherever there is bend in the tubes of furnace and water walls.			

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489.	Vol. II, Section 2	5.5.0 Superheaters and Reheaters	20 of 66	c) Minimum thinning allowance of +10% shall be provided on bends in addition to the above.			
490.	Vol. II, Section 2	5.5.0 Superheaters and Reheaters	20 of 66	c) Minimum thinning allowance of +10% shall be provided on bends in addition to the above.			
491.	Vol. II, Section 2	5.4.0Furnace and water wall	18 of 66	The thickness of water wall tubes shall be increased by minimum 0.6 mm over and above the calculated thickness as per IBR to account for tube erosion and corrosion. Further, an additional tube thickness of 1.0 mm over and above the thickness of water wall tubes as calculated above shall be provided on all water wall tubes coming within a radius of half a meter of each wall blower to guard against premature tube failure due to soot blowing. Alternatively, fasciated tubes may be provided in the soot blowing radius to guard against impact of soot blowing.	Bidder does not envisage the consideration of additional erosion allowance for the leading edges of the bank and other Balance of tubes: * SS erosion protectors are provided on leading tubes for the horizontal banks (1RY SH & 1RY RH) and also for those tubes facing the soot blowing steam. *	Bidder standard design	Bidder to follow specification.
492.	Vol. II, Section 2	5.5.0 Super heaters and Reheaters	20 of 66	a) Leading tubes of each bank shall be provided with additional thickness of minimum 1.0 mm as erosion allowance over and above the calculated thickness as per IBR.			

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493.	Vol. II, Section 2	5.5.0 Superheaters and Reheaters	19 of 66	f) Maximum depth of tube bank sections in the direction of gas flow shall be 2 meters or maximum soot blowing radius whichever is lower.	Maximum depth of tube banks/sections in the direction of gas flow shall be as per Bidder standard.	Bidder standard design	Bidder to follow specification.
494.	Vol. II, Section 2	5.5.0 Superheaters and Reheaters	19 of 66	b) Even temperature distribution shall be ensured at gas and steam side by criss crossing the steam paths between LHS and RHS.	As per the bidder proven boiler design offered, even gas and steam temperature distribution between LHS and RHS is achieved by individual right/left spray control system for the superheater and with the help of gas biasing damper control for Reheater temperature balancing. Hence criss-cross arrangement in SH and RH line is not envisaged. Further with twin fire vortex boilers, heat flux distribution is uniform compared to single fire vortex due to lesser gas side imbalance. This brings down steam temp imbalance between LHS & RHS within the tender specified limits	Bidder standard design	Bidder shall provide the details along with bid.
495.	Vol. II, Section 2	5.5.0 Superheaters and Reheaters	20 of 66	a) For supherheaters and reheaters elements placed before furnace exit plane (in the direction of gas flow), chromel-alumel thermocouples on at least two elements of every fifth assembly between the two headers shall be	Kindly note that total no. of metal thermocouples to be installed in boiler is as per bidder's standard practice.	Bidder standard design	Bidder to follow specification.

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				provided for tube metal temperature detection out of gas path (in SG casing). b) In addition to the above, adequate number of chromel-alumel thermocouples for measurement of tube metal temperatures outside the gas path shall also be provided. Total number of thermocouples including those at (a) above shall, however, not be less than 2 (two) thermocouples per RH/SH assembly between the two headers.			
496.	Vol. II, Section 2	5.5.0 Superheaters and Reheaters	20 of 66	vii) Maximum number of material grades that can be used in one tube bank shall be limited to three (3).	The maximum grades in a bank in flue gas path may extend up to three (3). However, dissimilar welding shall be limited at site.	Bidder standard design	Bidder to follow specification.
497.	Vol. II, Section 2	5.20.3 Steam Generator Enclosure, Casing and Framing	45 of 66	Dissimilar metal welds (DMW) between austenitic and ferritic steels, martensitic and austenitic steels, martensitic and ferritic steel shall be avoided inside the Steam Generator enclosure for the pressure parts which are exposed to hot flue gases.			
498.	Vol. II, Section 2	5.10.8 Coal mills	27 of 66	• One (1) no. of Rota probe shall be provided for each steam generator for coal sampling as per ISO 9931. Further, four (4) nos. of Dirty Pitot tubes shall be provided for steam generator and shall	Coal sampling system shall be as per ASME PTC 4.1	Code guidelines	Bidder to follow specification.

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				be suitable for measurement of coal-air velocity in the coal pipes.			
499.	Vol. II, Section 2	5.12.8 Flow measuring devices	32 of 66	• The draft plant shall include aerofoil type flow elements in the air system for total air flow measurements and control, each with three pairs of tapping points.	As per the bidder standard Primary air flow will be measured with slant orifice at mill inlet. For secondary air flow measurement, pressure difference at the inlet of the fan is considered.	Bidder standard design	Bidder to follow specification.
500.	Vol. II, Section 2	5.14.0 Regenerative air heaters	34 of 66	The drive system shall consist of one (1) no. peripheral AC drive and One(1) no. standby AC drive (supply feed from emergency DG set) with gear box and automatic clutching/ declutching facility, and one (1) no. independent air motor drive with its gear box and automatic clutching facility for rotation during non availability of AC drive system.	Bidder would like to clarify that since air motor is available during emergency condition, DG set back-up is not required for AC drive Air motor operation is independent of AC motor and will engage in case of the AC motor failure/stoppage. In the OEM's standard design, Common Gear box for AC MOTOR and air motor with automatic clutching & declutching arrangement is provided.	Clarification	Bidder to follow specification.
501.	Vol. II, Section 2	5.15.1 Duct Work	37 of 66	The expansion joints shall be of metallic type suitable for the service conditions.	As per bidder's design practice non-metallic expansion joints will be considered in our boiler design.	Bidder standard practice	Bidder to follow specification.
502.	Vol. II, Section 2	5.15.2 Dampers	37 of 66	On each hot air and cold air duct to each of the mills. : Guillotine gate type	Bidder would like to use the following dampers. 1. Flap type damper in each hot air and cold air duct to	Bidder standard practice	Bidder to follow specification.

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503.	Vol. II, Section 2	5.15.2 Dampers	37 of 66	At discharge of each of PA fan. : Guillotine gate type	each of the mills. 2. PA fan discharge damper - Electrically operated Double multi louvered damper.		
504.	Vol. II, Section 2	5.18.0 Flue Gas Side Cleaning Equipment	41 of 66	ii) Vertical pendent section : Two nozzles in diametrically opposite side, long retractable type. iii) For horizontal : Long rotary, multiple nozzle exchanger sections (rear pass) retractable type. iv) Air pre- heaters : Long retractable multi-nozzle soot blower for regenerative air preheater.	Bidder proposal is to use following sootblowers. Furnace : wall blowers SH & RH bank: Long retractable soot blowers Economiser : half retractable Soot blower APH: Semi retractable soot blowers.	Bidder standard practice	Bidder shall provide the details along with bid.
505.	Vol. II, Section 2	ANNEX 2.1.1 SUPERHEATERS AND REHEATERS	54 of 66	Maximum average flue gas velocity in sections/tube banks with transverse tube pitching 600mm or less and with 25% excess air at economiser outlet. m/s 10 (The maximum localized velocity across the cross section shall not exceed 12m/s)	With reference to point no.4 boiler will be designed considering 15% excess air at ECO outlet, hence maximum average flue gas velocity will be 10 m/sec considering 15% excess air at eco outlet at 100% BMCR firing.	Bidder standard design	Bidder to follow specification.
506.	Vol. II, Section 2	ANNEX 2.1.1 ECONOMIZER	54 of 66	Maximum average flue gas velocity through inter-tube space of the economiser banks (the gas velocity shall be calculated considering 25% excess air at economiser inlet). m/s. 8			

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507.	Vol. II, Section 2	ANNEX 2.1.1 Pressure Parts Materials :	54 of 66	c) Upto & including 605 deg C Alloy steel to ASME SA-335/213:P-91/T-91, T-92, or approved equivalent.	Bidder proposes to use Alloy steel to ASME SA-335/213:P-91/T-91, T-92, or approved equivalent Upto & including 610 deg C	Clarification	**Pressure Parts Materials** Above 605 deg C : Austenitic stainless steel, Super 304H, TP347H or equivalent shall be provided. Bidder shall meet the process parameters as per specification.
508.	Vol. II, Section 2	ANNEX 2.1.1COAL MILLS	55 of 66	Number of Mills (N) corresponding to maximum 90% mill loading :N+1 : 100% BMCR with worst coalN+2 : 100% BMCR with design coal(preferred total Number of Mills 8 (Min))	Bidder is offering supercritical boilers with Twin fire vortex. In these boilers, one mill serves eight (8) burners at one elevation which results in significant reduction in heat input per burner. In this scenario, criteria of minimum number of mills may easily be dispensed with, while leaving to the bidder to select the number of mills based on mill operating requirements. Moreover, CEA also specifies 6 nos. mills as minimum for 660 MW unit and NTPC too, in the latest tender for 4 X 1000 MW Pudimadaka Tender, has specified minimum 7 mills for 1000	Bidder standard practice/ Code guideline	Bidder to follow specification.

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					MW unit size.Further, for this project design coal and worst coal have higher GCV. Hence we request Owner to decide on the number of coal mills, meeting all mill operating requirements.		
509.	Vol. II, Section 2	ANNEX 2.1.1 COAL MILLS	55 of 66	Maximum permissible mill loading for selection of mill capacity/type even during worn-out condition: 80% of guaranteed capacity	There is a discrepancy in the mill loading specified. Based on the above point, The maximum mill loading shall be 90%.	Clarification	There is no contradiction in the specification. Bidder shall note the following. a) Under normal condition, the mill loading shall not be more than 90% with the mill combination as per specification. b) Maximum permissible mill loading for selection of mill capacity/type even during worn-out condition shall not be less than 80% of guaranteed

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							capacity.
510.	Vol. II, Section 2	ANNEX 2.1.1 PRIMARY AIR FAN	56 of 66	**Case (A):** Air Pre heater air in Leakage % 15% of primary air leakage in RAPH or Guaranteed value whichever is higher **Case (B):** Air Pre heater air in Leakage % 15% or Guaranteed value whichever is higher	15% AH leakage indicated for fan sizing is on higher side, this will make the fan oversized and subsequently fan efficiency at operating point will decrease. Bidder shall consider guaranteed AH leakage for fan sizing.	Bidder standard design	Bidder to follow specification.
511.	Vol. II, Section 2	ANNEX 2.1.1 FD and ID fans	58 of 66	**FD fans and ID Fans: Case (A):** Excess air requirement % 20% over stoichiometric air requirement **Case (B):** Excess air requirement at Economizer outlet % 20% over stoichiometric air requirement	With reference to point no.4 above, boiler will be designed considering 15% excess air at ECO outlet. Hence 15% excess air shall be considered for Fan design also.	Bidder standard design	Bidder to follow specification.
512.	Vol. II, Section 2	ANNEX 2.1.1 AIR AND FLUE GAS DUCT	59 of 66	Maximum velocity in flue gas ducts (the velocity shall be calculated considering 20% excess air at economiser outlet, worst coal firing at 100% BMCR load) m/s 13(before ESP) 16(after ESP)	With reference to point no.4 above, boiler will be designed considering 15% excess air at ECO outlet. Hence 15% excess air will be considered for air & gas duct design. Further we propose to apply flue gas velocity as follows Boiler to ESP - 15 m/s ESP to chimney - 20 m/s	Bidder standard design	Bidder to follow specification.

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513.	Vol. II, Section 2	ANNEX 2.1.1 AIR AND FLUE GAS DUCT	59 of 66	Maximum velocity in air duct (the velocity shall be calculated considering 20% excess air at economiser outlet, design/ worst coal firing at 100% BMCR load whichever gives maximum air/gas flow) m/s 16	With reference to point no.4 above, boiler will be designed considering 15% excess air at ECO outlet. Hence 15% excess air will be considered for air & gas duct design. We propose to apply air velocity as follows Cold air – 15-20 m/s Hot air - 20 m/S	Bidder standard design	Bidder to follow specification.
514.	Vol. II, Section 2	5.0.0 PIPING LAYOUT CONSIDER ATIONS	8 of 31	A minimum 2.5 meter headroom shall be maintained to the lowest point of all piping components or insulation in walking areas	Bidder shall endeavour to ensuring 2 meters clear head room above walkways since it will be very difficult for supporting purposes.	Bidder standard design	Bidder to follow specification.
515.	Vol. II, Section 1.0	7.7.0 Safety	44 of 191	Insulation along with aluminium cladding shall be provided for all the equipment/surfaces (excluding coal pulverisers) having skin temperature more than 60°C considering wind velocity of 0.25 m/sec. (0.5 m/sec where the heat loss is not the criteria.	Since there is a difference in design considerations of Insulation (i.e Ambient temperature & Wind velocity) from Volume I & Volume II, Bidder will follow the design considerations as stipulated in Volume -II.	Clarification	Bidder shall consider the Insulation criteria as per Vol. II, Section 1.0, Clause 7.7.0. page 44 of 191 and clause 11.11.5.2 page 80 of 191.
516.	Vol. II, Section 1.0	11.11.5.2 Steam Generator & Auxiliaries	80 of 191	23. Surface temperature of thermal insulation with ambient temperature of 45°C at surface velocity of 0.25 m/s.			
517.	Vol. II, Section 2	ANNEX 2.1.1 Insulation and Cladding	60 of 66	Insulation and cladding: Insulation, lagging, cladding & refractories Ambient temperature = 40°C, Surface velocity = 1 m/s, Insulation surface temperature			

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				= 60°C.			
518.	Vol. II, Section 2	ANNEX – 2.21.1 SPECIFIED DESIGN DATA	4 of 4	Specified design data Ambient temperature = 40°C, Surface velocity = 1 m/s, Insulation surface temperature = 60°C.			
519.	Vol. II, Section 2	5.21.6 Equipment and provisions for standstill conservation	49 of 66	At flue gas duct entrance into the chimney, a damper shall be provided to separate the Steam Generator air flue gas side from outside during shutdown	Separate damper is not required as the dampers after ID fan can serve the purpose.	Clarification	Bidder shall follow the specification.
520.	Vol. II, Section 2	5.20.1 Steel structure	43 of 66	All nuts, bolts and washers must be galvanized or cadmium-coated, and properly protected against corrosion before installation.	As per Bidder Standard practice, Bolts, nuts and Washers shall be black bolts and nuts only. However, after Installaion, a coating of Primer shall be applied at site.	Bidder standard practice	Bidder shall follow the specification.
521.	Vol - II, Section 5	5.3.5 HAND RAILS	4 of 11	Handrail shall be a three-rail system with elevations of each rail from floor level shall be as listed below. - the top rail at 1250 mm - the intermediate rail shall be at 850 mm - the bottom rail shall be at 450 mm For platforms at elevation more than 30m, top rail shall be at 1500 mm and the intermediate rails at 450 mm and 1000 mm.	As per Bidder Standard practice, two rail system handrails shall be adopted.	Bidder standard practice	Bidder shall follow the specification.

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522.	Vol- 1, Section - 1.0	6.1	11 of 44	The overall project schedule for design, engineering, supply__ _	Owner is requested to review the requirement of PG Test prior to COD, as duration is only 42 months, which is extremely stringent for both the units.	As per standard practice PG Test is done after COD.	Bidder shall follow the specification.
523.	Volume 1/ Section 3	32.2.1	17 of 26	No space will be provided by the Purchaser for the Contractor's labour. All facilities for labour housing shall be the sole responsibility of the Contractor.	Employer is requested to provide land for labour colony.	Project Requirement	Bidder shall follow the specification.
524.	Volume 1/ Section 3	32.2.2	17 of 26	Available area for the project site is less. Only minimum area can be spared for construction purpose. The bidder shall visit the site and if required shall make his own arrangement for extra space if required at his cost.	Area required for storage & site fabrication are as follows: 11 lakhs sqm. Employer is requested to provide above areas for construction and storage.	Project Requirement	The Bidder is requested to Ref. Vol-I,/Section-3/clause 32.2,2 Available area for the project site is less. Only minimum area can be spared for construction purpose. The balance requirement of space over and above what is allotted by TANGEDCO shall be met by the Contractors through their own means.

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525.	Vol- 1, Section - 4.0,Special Conditions of Contract	6.1	4 of 21	Clause 5.0 - Work Completion period	The overall completion period is extremely stringent. Owner is requested to allow 48 months for Unit #1 and 54 months for Unit#2.	1) Considering execution time of recent / ongoing projects, we are indicating the execution schedule. 2)The gap between two units required is minimum 6 months.	Bidder shall follow the specification.
526.	Volume II Section 2 DTS Mechanical	4.18.0	16/605	The Mills offered by the bidder cab be of Vertical spindle Bowl type	Vertical Spindle - Roller Mill shall be provided as per OEM standard.	As per LMB Design	Bidder shall follow the specification.
527.	Volume II Section 2 DTS Mechanical	5.10.08	30/605	Adequate numbers of access doors/windows with access ladders shall be provided to facilitate access to various parts of mill. The access doors shall be suitable for on load inspection and maintenance of the mill. The oil pumps and filters shall be readily accessible.	The access door shall be suitable for inspection and maintenance of pulveriser, during no load or stoppage. On load inspection & Maintenace ifor mill internals is not envisaged owing to safety reasons. Externally mill can be accessed from platform, Suitable access doors will be provided in maintenance platform to have access around mill during operation for inspection of mill externally.	Bidders Standard Practice	Bidder to note that coal mill shall have provision for inspection & maintenance in event of mill stoppage with fully loaded condition.
528.	Volume II Section 2 DTS Mechanical	5.10.08	29/605	Mill grinding ring / race shall be segmental	Table liners will be segmental while roller line will be in single piece.	As per LMB Design	Mill shall be vertical spindle Bowl type as per specification. Bidder to follow specification.

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529.	Volume II Section 1 GTS	ANNEX 1.4	129/191	Mandatory Spares	Please confirm Mandatory Spares required for Pulveriser/Coal Mills. Also please specify the definition of sets.	Clarification	Bidder shall refer to specification Volume II Section 1 GTS, Annex-1.4, pg 155 of 191 for spare list of Mill. Bidder to note that "set" is comprising of complete assembly as per description specified in the specification.
530.	Volume II Section 1 GTS	ANNEX 1.4	129/191	Mandatory Spares	Please change the Quantity in for Pressure part spare as below: Sl. No. 1 (Various spec tube of water wall system/superheater /reheater/economizer etc.,) - 100 ~~160~~ M	Clarification	Bidder to follow specification.
531.	Volume II Section 1 GTS	ANNEX 1.4	129/191	Mandatory Spares	Dampers - Quantity not specified. Please specify.	Clarification	Bidder shall refer to specification Volume II Section 1 GTS, Annex-1.4, pg 155 of 191 point no. 16 for spare list of Boiler.

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532.	Flow Diagram	-	-	Flow diagram shows 2W+2S SSC below each Boiler.	Owner may also allow as an alternative1W + 1 S Submerged Scrapper Chain (SSC) below each boiler of required capacity.	The proposed arrangement will need less space and maintenance requirements. Similar configuration of plants are running world wide including India.	Bidder to follow specification for Scrapper chain conveyor
533.	Flow Diagram	-	-	BA Handling System- Two stage crusher	Flow diagram shows two stage BA crushing, however single stage crushing with 2 (1W+1S) clinker crushers will be adequate.	SSC being water impounded type there will be less chance of larger clinkers falling from SSC outlet. Hence single stage crushing is sufficient similar to water impounded type BA handling.	Single stage crushing shall be considered at the outlet of scraper chain conveyor.
534.	Vol. - II, Section 2.0	-	-	BA Handling System	A mixing tank is required below the outlet of SSC for proper mixing of ash with water. Jet pumps (1W+1S) shall be placed below the mixing tank.	Proper mixing of Ash with water is essential for proper conveying of jet pump.	Noted.
535.	Vol. - II, Section 2.0	-	-	The maximum linear speed of chain is listed as 0.8 m/min.	The maximum speed at duty condition shall be selected based on AHP suppliers proven & proprietary design practice.	Speed of chain shall be selected based on ash conveying capacity and maximum width of the conveyor.	Noted. This will be reviewed during detailed engineering stage. However bidder to limit the speed within 1.5m/min.
536.	Flow Diagram	-	-	2W+2S SSC below each boiler	Bidder is proposing conventional Water impounded type BA hopper with Jet pumping system	SSC system with BA slurry pumping through jet pumps does not serve the purpose of	Bidder to follow specification.

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					below each boiler.	dewatering BA in SSC.	
537.	Vol. - II, Section 2.0	4.0.0	-	MOC of Chain, Scrapper, Guide/Drive wheel etc	MOC shall be as per manufacturers standard practice.	Similar MOC is operating satisfactorily without trouble in many plants and bidder is guaranteeing to meet NIT requirement with the selected MOC.	Bidder to follow specification.
538.	Vol - II/ Sec - 2.1	4.22.0	15 of 66	The minimum specific collection area shall ..... be 180 m2/m3/s for worst coal firing with one field out of service at 100% BMCR condition.	The minimum SCA is guaranteed in TMCR condition with all fields in service.	As per industry standard SCA is defined at Guarantee Point with all fields in operation.	Bidder to follow specification. Bidder shall also note that ESP shall be designed for outlet emission as per specification with one field out of service in each stream.
539.	Vol - II/ Sec - 2.1	5.17.0	41 of 66	Physical scale modeling as well as CFD modeling of ESP shall be conducted.	We'll be conducting CFD modeling only.	We'll be conducting CFD modeling only, as it is a much advanced and globally accepted technology, which offers more iterations than physical modeling. With CFD modeling being employed, there is no reason for additional physical modeling.	Bidder to follow specification.
540.	Section 2-2 ST and Aux System /	4.0.0	5 of 27	The proposed steam turbine set should be operating under	As per Vol. II, Section 1.0 General Technical	Please note that Boiler will be designed for any	Bidder clarification noted.

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	Vol-II Section 1- GTS / Vol-II Section 1- GTS / Vol-II Section 2-2 ST and Aux System / Vol-II	7.3.0 (iii) 4.0.0 9.2.0	42 of 191 7 of 27 24 of 27	constant pressure mode from zero to 40% rated load, sliding pressure mode from 40% to rated load.... The unit shall be designed for constant pressure and sliding pressure operation. The unit shall be designed to operate at constant pressure from zero to 40% rated load, sliding pressure mode from 40% to rated load. The throttle reserve shall be adjustable to minimum 0% for pure sliding pressure mode of operation. Unit shall also be capable to operate in modified sliding pressure mode of operation. During sliding pressure mode, throttle pressure shall slide from 100% to 40% of rated pressure corresponding to 30% load. a) .....60% TMCR (Constant and Sliding pressure operation).....	Specification, clause no. 7.3.0, the unit will be designed to operate at constant pressure from zero to 40% rated load, sliding pressure mode from 40% to rated load. Also, from rated load to 105% of rated load it will be constant pressure mode.	one of the following condition. - Pure sliding pressure condition - Modified sliding pressure condition. Design can be done for any one of the above operating philosophy. Owner may please clarify.	
541.	Vol. II, Section 1.0	7.3.0 Plant Operational Requirements	42 of 191	Load Ramps The Facility shall be capable of the following normal and emergency ramp rates for sliding pressure operation. Normal Emergency	The ramp rates shall be as per OEM recommendations based on proven experience. Start-up curves of Turbine OEM shall be provided with offer. Owner's acceptance is requested.	Bidder standard design	Bidder to follow specification.

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				Sliding pressure 3% / min 5% / min			
542.	Vol. II, Section 1.0	7.3.0 Plant Operational Requirements	43 of 191	The facility shall meet the following maximum required start up times from the initial conditions Cold Start : 7 hrs from lighting the burners to full load Warm Start : 4 hrs from lighting the burners to full load with start-up bypass system Hot Start : 1.5 hrs from lighting the burners to full load.	The start-up times shall be as per OEM recommendations based on proven experience. Start-up curves of Turbine OEM shall be provided with offer. Owner's acceptance is requested.	Bidder standard design	Bidder to follow specification.
543.	Vol-II,Section-2-10-0 R0	2.10.0,Coal Handling System	3 of 15	**Coal stockpiles, stacking and reclaiming:** Bypass chute will be provided to bypass screen and crusher.	Please confirm whether bypass arrangement is required or not for screen & crusher.	There is a discrepancy in the flow sheet & specification, request Owner to clarify whether a bypass arrangement is required in the crusher house.	Bidder shall consider Bypass chute to bypass screen and crusher.
544.	Drg.No-00-115112-M-007-Rev-0,Flow diagram, Coal handling system.	-	-	Flow sheet does not indicate bypass arrangement			
545.	Drg.No-00-115112-M-007-Rev-0,Flow diagram, Coal handling system.	-	-	Profile of Conv.BCN-1A/1B	We are assuming that the Conv.BCN1A/1B shall be starting from ground level in JNT-1.Also we have assumed an inclination of 6 degree at feed end of BCN-1A/1B to achieve the required height in crusher	Details not furnished.	Shall be finalized during detailed engineering.

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					house. Please provide your acceptance.		
546.	Drg.No-00-115112-M-007-Rev-0,Flow diagram, Coal handling system.	-	-	Note no-6:JNT-1 is in port scope. In JNT-1 the scope of contractor as follows,BCN-1A/1B,**Coal sampling unit**,.....& control and instrumentation requirement.	Request client to furnish details of inlet conveyors EBCN-1A/1B for deciding the coal sampling unit parameters.	Details of conveyors required to design the CSU.	Shall be furnished during detailed engineering.
547.	Drg.No-00-115112-M-007-Rev-0,Flow diagram, Coal handling system.	-	-	Qty of Stacker reclaimers-2 no.'s on BCN-4 & 2 no.'s on BCN-6	Please let us know the philosophy of working of 2 no.s stacker cum reclaimers on each yard conveyor.	Normally one stacker cum reclaimer is sufficient to stack and reclaim coal from two stock yard. Hence total two nos. of stacker cum reclaimer is sufficient for four stock piles.	Bidder to follow specification.
548.	Vol-II Sec 2-10-20 Stone picking arrgmnt_R0	-	-	-	Please furnish the min. stone picking chute size & Material of construction & its thickness.	Details not furnished.	Bidder shall design the same as per good engineering practice. The same shall be reviewed during detailed engineering.
549.	Vol-II Sec 2-10-2 Crushers_R0, ANNEX – 2.10.2.1 SPECIFIED DESIGN DATA	6	2 of 2	Materials of Construction	Material of construction of different crusher components shall be as per manufacturer's recommendation which may be equal to or superior than	MOC may vary from manufacturer to manufacturer.	Bidder to follow specification.

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					that of the material specified in NIT. Client to confirm.		
550.	Vol-II, Sec 2-10-0, Main section_R0	5.2.0	5 of 15	The sizes of the junction towers, transfer houses and crusher house and the floor elevations shall be finalized by the Contractor considering a **minimum clear walkway space of 1500 mm** around the equipment in each floor.	Please clarify the sizes of walkway around the equipment in junction towers. As per our experience 1200mm walkway will be adequate for safe working around equipment.	Discrepancy noted in different parts of specification.	Bidder shall follow Vol-II, Sec 2-10-0, Main section_R0
551.	Vol - II, Section 5 - Civil,5.2 Description of Bldgs, Structures & Facilities	5.2.14.2	18 of 38	5.2.14.2 Junction houses:The sizes of the junction towers, transfer house and crusher house and the floor elevations shall be finalized by considering a **minimum clear walkway space of 1200 mm** around the equipment in each floor.			
552.	Drg.No-00-115112-M-007-Rev-0,Flow diagram, Coal handling system.	-	-	Layout of crusher house	In order to economise the height of crusher house(approx.3 to 4m height can be reduced when compared with the arrangement as shown in flow sheet, we propose to provide a small hopper at the head end of conv.BCN-1A/1B (Attached Drawing Annexure-I). Also note that a similar arrangement has been implemented by us in one of	Alternate arrangement proposed to optimized the size of crusher house.	Concept is noted. However it shall be reviewed during detailed engineering based on the guidelines in the specification.

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					our recent projects & is running without any issues. Please furnish your acceptance for the same.		
553.	-	-	-	-	Please confirm whether CHP layout can be optimized by bidders by relocating/addition/ deletion of transfer points, relocating Crusher house & Coal Shed, etc.	Clarification.	Bidder to follow specification.
554.	-	-	-	-	Please let us know whether any debris chute is required in the Transfer towers. If required, Please specify the qty/Tower & its specification.	Clarification.	Refer vol-II sec 2.10.0 clause 5.5.0. Bidder to follow specification.
555.	-	-	-	-	Please furnish Sieve analysis of input material.	For design of Screen.	Shall be furnished during detailed engineering.

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556.	-	-	-	-	Please furnish the rating above which HT motor to be considered	To select the coupling type.	Refer Vol-II Sec-3 Section 3.16 Motors Clause 3.3.0 page 230 of 353. Bidder to follow specification.
557.	Drg.No-00-115112-M-007-Rev-0,Flow diagram, Coal handling system.			1. Suspended magnet 2. Elevator 3. Travelling tripper 4. Rod gate 5. Coal sampling unit 6. Vibration isolation system	Please furnish detailed specification of items mentioned	Detailed specification is not furnished in the tender specification.	1. Suspended magnet : Refer vol-II sec 2.10.8 similar to ILMS as applicable. 2. Elevators : Refer Vol-II Sec-3 Section 3.19 3. Travelling tripper : Refer vol-II sec 2.10.1. page 5 of 9 4. Rod gate : Bidder to propose. Same shall be reviewed during detailed engineering. 5. Coal sampling unit : Refer vol-II sec 2.10.7. 6. Vibration isolation system : Shall be as per relevant design standards.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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558.	-	-	-	-	We assume that for making drive units of double stream conveyors/dual drives interchangeable and for determination of spares, handing of gearboxes need not to be kept identical, Please confirm.	To reduce quantity of spares.	Bidder to follow specification.
559.	Tender Specification Document. Vol-II, SEC-2.10.4		221 of 605	Average & Design Reclaiming capacity indicated as 3300 T/h are same. (at pg. no. 194 this is indicated as 3000 T/h)	To achieve avg. reclaiming capacity of 3300 TPH Peak / design Reclaiming rate should be 4125 TPH. Please confirm.	Machine capacity is not mentioned.	Reclaiming capacity shall be as per specification.
560.	Tender Specification Document. Vol-II, SEC-2.10.4		221 of 605	As per data sheet "the Machines are Unidirectional" but at page no. 203 this is mentioned as reversible.	It is considered as Unidirectional S/R with Hyd. actuator operated Diverter gate. Please confirm.	Discrepancy noted in different parts of specification.	SCR are Unidirectional as per Vol-II, SEC-2.10.4
561.	Tender Specification Document. Vol-II, SEC-2.10.4		220 of 605	Operator's cabin shall be supported by Hydraulic Cylinder & Shock absorbers shall also be provided.	The Hydraulic. cylinder controlled Operator's cabin automatically adjusted its levelling, So, there are no need to provide Shock absorbers additionally.	AS per OEM standard.	This shall be reviewed during detailed engineering based on the specification requirements.
562.	Tender Specification Document. Vol-II, SEC-2.10.4		222 of 605	Data sheet of S/R indicated Long travel drive with Hydraulic motor.	At CHP area it is not suggested to use Hydraulic Motor for LT drive because Synchronization of such multiple drives are very much difficult, which lead to inferior performance & also those are very much maintenance prone. So, now a days Geared motor are recommended for its compactness and better efficiency. Please confirm	For better maintainability & performance.	Noted. However this will be reviewed Detailed design engineering

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					acceptance.		
563.	Tender Specification Document. Vol-II, SEC-2.10.4			Boom conveyor drive of S/R machine.	It shall be provided with Electro-mech drives with induction type SCIM motor, reducer, Fluid coupling and EHT brakes. Please confirm.	Detailed specification is not furnished in the tender specification.	Drive arrangement including other technical requirements for Boom conveyor shall be followed inline with other conveyors.
564.	Tender Specification Document. Vol-II, SEC-2.10.4		212 of 605	Boom conveyor parameters of S/R machine.	with the inputs of Yard conv. as Belt width 2000 mm and speed 2.9 m/s, Boom conv Belt width & speed considered as 2000 mm & 3.4 m/s. Please confirm.	Detailed specification is not furnished in the tender specification.	This shall be reviewed during detailed Engg based on the specification requirements.
565.	Tender Specification Document. Vol-II, SEC-2.10.4		220 of 605	Rail track CRS will be 20% of Boom length.	Bidder considering the track CRS as 9.0 m for 44 m Boom length. Please confirm.	Detailed specification is not furnished in the tender specification.	Bidder to follow specification.
566.	Tender Specification Document. Vol-II, SEC-2.10.4			Cable reeling drum of S/R machine.	Bidder is suggesting to consider a barrel type Composite Cable reeling drum. Please confirm.	Detailed specification is not furnished in the tender specification.	Bidder to follow specification.
567.	Vol-II Section 2 DTS Mechanical_R0	Annex 2.10.6.1	230 of 605	Crusher House	We are considering Dry fog system at "crusher house" at receipt & Discharge points. please confirm.	Detailed specification is not furnished in the tender specification.	Bidder to follow specification.

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568.	Drg No: 00-1115112-M-007 Coal flow diagram			Dry fog DS system	In the flow diagram it is mentioned DE, But in write up the same is given DFDS So,we are considering "Dry fog system" at JNT-9,JNT-10,JNT-11 & JNT-12 conveyor receipt & Discharge points. Please confirm.	Discrepancy noted in different parts of specification.	There is no discrepancy in specification. Bidder to follow specification.
569.	Vol-II Section 2 DTS Mechanical_R0	Annex 2.10.5.1	227/605	Bag Filter & cyclone separator	We are considering "Bag Filter & Cyclone separator efficiency" of 80% down to 10-micron particle size and it is made of 6 mm thick MS plate. Please confirm	Detailed specification is not furnished in the tender specification.	This shall be reviewed during detailed engineering based on the specification requirements.
570.	Vol-II Section 2 DTS Mechanical_R0	2.17, 3.2.0	430/605	Ventilation	We are considering 15 air changes/hr for "Battery rooms ventilation and 12 air changes/hr for MCC switch gear rooms" ventilation. Please confirm.	Detailed specification is not furnished in the tender specification.	Bidder to follow specification.
571.	Vol-II Section 2 DTS Mechanical_R0	2.17, 2.1.2	428/605	Air conditioning	We have considered air cooled Package AC for the load more than 5.5 TR and Split Ac for the load below 5.5TR.Please confirm	Detailed specification is not furnished in the tender specification.	Bidder to follow specification.
572.	General			Dry Fog DS system	We have not envisaged any utility system for the Existing conveyors & building(JNT-1 & ETC) (DS,SW,CW,DW, Fire fighting system & FDA system). Please confirm.	Detailed specification is not furnished in the tender specification.	Bidder to follow specification. Refer Vol-II sec 1.0 page 15 of 191.

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573.	Sec. 2.0 / Chapter 2.10.0 / Vol. II Sec. 7.0 / Vol. II	2.0.0 B/7	1 of 15 -	Sr. No. 9. Inline conveyor scales Drg. No. 00-1115112-M-007 : Flow diagram coal handling system	Please specify the quantity / location of conveyor scales.	Detailed specification is not furnished in the tender specification.	Minimum no. of conveyor scales is already mentioned in the flow diagram for coal handling system. Bidder shall provide conveyor scales required for - proper blending operation from all stockpiles - coal stored in each stockpiles.
574.	Sec. 2.0 / Chapter 2.10.0 / Vol. II	4.0.0	4 of 15	Barricading (Wind Barrier) is provided around coal yard to avoid flying of coal dust. The height of the barricading will be 12m from FFL including RCC retaining wall of 1.0 M height .	We understand that wind barrier is not required in-between the four stockpile. Please confirm.	Understand the requirement	Bidder's understanding is inline with the requirement.
575.	Sec. 2.0 / Chapter 2.10.0 / Vol. II	6.3.2.3	8 of 15	Further the power consumption for the equipment being fed from CHS board/LT board but not to be considered for guaranteed power consumption shall be measured separately at their respective MCC/LT & HT switchgear input terminals and shall be subtracted from the total power consumption measured. However, if conditions permit such equipment may not be operated during power	We understand that following items shall not be considered during measurement of guaranteed power consumption :- 1) Lighting 2) Hoist 3) Sump Pump 4) Coal sampling unit 5) Elevator 6) DS, DE, AC, Ventilation, Service water, Potable water system. Please confirm.	Clarification.	Hoist, Sump Pump, Coal sampling unit, Elevator shall not be considered for Auxiliary power consumption.

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				measurement duration.			
576.	Sec. 2.0 / Chapter 2.10.0 / Vol. II Sec. 3.0 / Chapter 3.19/ Vol. II	2.0.0 2.0.0	2 of 15 255 of 353	Sr. No. 26. Elevator Sr. No. i) 884 kg capacity Passenger elevator for other buildings of height 15 M and above.	We understand that only 2 Nos. of elevator is required for coal handling system. 1 No. in Crusher house and 1 No. in JNT-8. 15 M height criteria is not applicable for coal handling system.	Clarification .	Referred clause will be applicable for buildings such as ''Switchgear cum control building'' for coal handling system.
577.	Sec. 1.0 / Vol. II	2.1.0	16 of 191	b) Coal feeding at JNT-7 for stage-II c) Coal feeding at JNT-3 for stage-II d) Coal feeding at JNT-4 for stage-II	Please clarify the scope of work for the handling arrangement (Monorail + hoist) for stage-II conveyor.	Clarification for requirement	Monorail required for the stage-II shall be provided as part of the JNT 3,4 and 7. Refer vol-II sec 1.0 page 15 of 19 clause 10.0.

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578.	Vol. - II, Section 2.0	6.3.2.1 (iii)	7 of 15	In case of direct flow path, Guarantee test should include operation of the travelling trippers provided on conveyors **However, for purpose of measurement of guaranteed power consumption the coal shall be discharged into the last bunker of unit-1**.	As per flow diagram, we understand that Direct path from JNT-1 to last bunker of Unit-2 bypassing the stock pile will be the longest path and the same will be considered for guaranteed power consumption. Please confirm.	As there is a discrepancy in different parts of specification.	As per flow diagram, Direct path from JNT-1 to last bunker of Unit-2 bypassing the stock pile will be the longest path and the same will be considered for guaranteed power consumption.
579.	Sec 7.0 / Vol. II	-	Plot Plan Dwg. No. 00-1115112-G-001	Unit nos. are not marked on the drawing.	Bidder shall number the units as per his considerations. Please confirm acceptance.	insufficient data	Refer 00-1115112-M-007 Flow diagram Coal handling System
580.	Sec 7.0 / Vol. II	-	Plot Plan Dwg. No. 00-1115112-G-001	-	Column A1 is not legible.	data not legible	Refer AutoCAD file of Plot Plan already furnished.
581.	Sec 7.0 / Vol. II	-	Plot Plan Dwg. No. 00-1115112-G-001	-	We understand that bidder has the option to develop optimized layout keeping the location /orientation of the main power block, power evacuation corridor in place as indicated in the bid document. Bidder will develop suitable layout for the equipment offered. Please confirm the understanding.	clarification	The plot plan provided by the owner along with this tender specification is indicative only. It is the intent of the owner to provide extensions in future for four more units in adjacent land. The bidder shall develop a plot plan for 2 x 660MW

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							considering the future requirements of TANGEDCO and submit the same along with Bid.
582.	Sec 7.0 / Vol. II	-	Plot Plan Dwg. No. 00-1115112-G-001	-	Bidder proposes common electrical building for both units. Please confirm acceptance.	deviation	Bidder to follow specification. Refer Vol-II, Section-1, GTS, Cl. 6.2.2.2, Page : 33 of 191
583.	Sec 2-3 / Vol. II	4.1.0	4 of 12	C.W. expansion joints made from high quality natural / synthetic rubber with carbon steel reinforcement rings and with flanges of 125 LB as per ANSI-B16.25.	125 LB flanges shall be as per ASME B16.1 and not as per ANSI B16.25.	deviation	Bidder shall follow flanges as per Class D of AWWA C 207.
584.	Sec 2-5 / Vol. II	5.1.0 - Turbine Exhaust Pipe	15 of 22	Turbine exhaust shall be separately piped to the condenser of main TG unit in the downward direction.	As BFP at 0.0 M is also acceptable in specification , TD and MDBFPs shall be located on the Ground floor (0.00 M) of the TG building. Hence, turbine exhaust shall be routed in the upward direction. Please confirm acceptance.	deviation	Bidder to follow specification.
585.	Sec 2-14 / Vol. II	3.1.0	2 of 34	-	One each piping for compressed air for cleaning of Intake Velocity cap shall be considered up to the Sea water intake cap.	Please provide details regarding injection of chlorina or hypo chloride solution.	Bidder shall ensure that the velocity cap area is disinfected to avoid marine growth. Detailing is in bidder scope.
586.	Sec 2-14 / Vol. II	3.1.5	5 of 34	...Sea water outfall pipes shall only be routed as per the following:....	Bidder understands the following:A. sea water outfall pump house to sea	clarification	Bidder to follow the specification.

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					shore piping shall be buried and of GRP, with 250 mm concrete encasement.B. sea shore to outfall location piping shall be routed along the conveyer deck and be of GRP.C. conveyer deck to sea water outfall location pipe shall be buried in sea bed and be of HDPE.Please confirm the understanding.		
587.	Sec 2-20 / Vol. II	5.0.0	8 of 31	A minimum 2.5 meter headroom shall be maintained to the lowest point of all piping components or insulation in walking areas...	In general, Bidder shall follow 2.5 m minimum clear headroom within Main Plant Building. However, considering complexity of layout inside TG building, 2.1 m minimum headroom will be followed only at few places.Please confirm acceptance.	deviation	Bidder to follow specification.
588.	Sec 2-20 / Vol. II	5.1.0	9 of 31	Steam piping systems shall be designed and analysed using CAESAR II software (latest version)....	Flexibility of all critical / power cycle piping shall be done using Bidder's in-house software. Please confirm acceptance.	deviation	Bidder to follow specification.
589.	Sec 2-20 / Vol. II	5.2.0	10 of 31	...Under no circumstances shall any part of the building steel work be drilled....	Requirement of drilling building steel work may arise during installation of U-bolts for pipe supports. However, necessary design margin shall be considered in such cases, if required. Please confirm acceptance.	clarification	The same clause says "without prior permission of the owner...."

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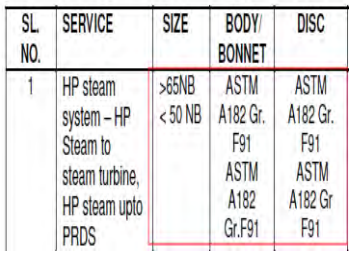
590.	Sec 2-20 / Vol. II	7.2.0	24 of 31	7.2.0 Valve Material Specifications  SL. NO. / SERVICE / SIZE / BODY/ BONNET / DISC 1 / HP steam system – HP Steam to steam turbine, HP steam upto PRDS / >65NB < 50 NB / ASTM A182 Gr. F91 ASTM A182 Gr.F91 / ASTM A182 Gr. F91 ASTM A182 Gr F91	For valve sizes > 65 NB, Body / Bonnet and disc material shall be ASTM A217 C12A. Please confirm acceptance.	deviation	Bidder to follow specification.
591.	Sec 2-20 / Vol. II	5.0.0	8 of 31	Suitable Walkways of 750mm width for maintaining pipes and cables shall be provided on the pipe rack along with access ladders at suitable intervals.	A walkway of 600 mm shall be provided all along the length of the pipe rack for maintenance of cables and ash pipes only. Please confirm acceptance.	clarification	Bidder to follow specification.
592.	Sec 2-20 / Vol. II	5.0.0	8 of 31	50% extra space for the routing of future pipes for stage –II shall be provided in the pedestals and pipe rack. While designing the pipe rack / pedestal, extra 50 % load shall be taken in order to meet the future pipes. Number of the future pipes will be finalized during detailed engineering.	Bidder requests owner to identify specific pipes which shall be laid on the pipe rack for Stage II.	clarification	The plot plan provided by the owner along with this tender specification is indicative only. It is the intent of the owner to provide extensions in future for four more units in adjacent land. The bidder shall develop a plot plan for 2 x 660MW considering the future requirements of TANGEDCO and submit the same along with Bid.

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593.	Sec 2-2 / Vol. II	5.1.0 - Non-Return Valves	13 of 27	The valves shall be full bore type designed for minimum pressure drop.	Bore of the valves shall conform to the requirements of ASME B16.34. Please confirm acceptance.		Bidder to follow specification in accordance with relevant code.
594.	Sec 2-20 / Vol. II	3.0.0	5 of 31	...Minimum thickness for stainless steel pipes shall be Sch 40S as per ANSI B36.19.	Minimum thickness for stainless steel pipes of sizes DN 50 & smaller shall be Sch 40S as per ANSI B36.19. For pipe sizes DN 80 & larger, minimum thickness shall be Sch 10S.Please confirm acceptance.		Bidder to follow specification.
595.	Sec -1.0 / Vol. II	6.2.4	36 of 191	Necessary space shall be provided in the layout for interconnection of Stage I infrastructure with that of Stage II.	Bidder requests owner to clearly identify the equipment/systems for which space should be considered for future expansion.	clarification	The plot plan provided by the owner along with this tender specification is indicative only. It is the intent of the owner to provide extensions in future for four more units in adjacent land. The bidder shall develop a plot plan for 2 x 660MW considering the future requirements of TANGEDCO and submit the same along with Bid.
596.	Volume II/ Section - I	2.1.0	12 of 191	C) CT Make up : Terminal point for interconnection of	Bidder requests owner to provide the distance / co-	owner to provide more data/information.	Shall be furnished during detailed

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				Stage I with Stage-II shall be provided with valve and blind flange near the sea water intake pump house.	ordinate & terminal pressure required at the terminal point for inter connection with stage-II.		engineering.
597.	Volume II/ Section - I	2.1.0	13 of 191	Service water supply for Township: One no. pipe with isolation valve and blind flange shall be provided at the bottom of the tank for the following for service water application. At the bottom of the overhead tank, space required for the 1W+1S pumps for colony service water application shall be provided.	Bidder understands that service water supply pumps for plant colony are excluded from our scope of work. Please confirm our understanding.	clarification	Refer Vol II section 1.0 clause 2.1.0 3b
598.	Volume II/ Section - I	2.1.0	13 of 191	Service water supply for Township: One no. pipe with isolationvalve and blind flange shall be provided at the bottom of the tank for the following for service water application. At the bottom of the overhead tank, space required for the 1W+1S pumps for colony service water application shall be provided.	Bidder requests owner to provide the quantity of water to be considered for the plant service water application , same will be considered in our water balance diagram.	owner to provide more data/information.	Refer Vol II section 1.0 clause 2.1.0 3c
599.	Volume II/ Section - I	2.1.0	13 of 191	Potable water supply for Township (Drinking water quality)One no. pipe with isolation valve and blind flange shall be provided at the bottom of the tank for the following for potable water application. At the bottom of the overhead	Bidder understands that plant potable water supply pumps for plant colony are excluded from our scope of work. Please confirm our understanding.	clarification	Refer Vol II section 1.0 clause 2.0.0

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				tank, space required for the 1W+1S pumps for colony potable service water application shall be provided			
600.	Volume II/ Section - I	2.1.0	13 of 191	Potable water supply for Township (Drinking water quality)One no. pipe with isolation valve and blind flange shall be provided at the bottom of the tank for the following for potable water application. At the bottom of the overhead tank, space required for the 1W+1S pumps for colony potable service water application shall be provided	Bidder requests owner to provide the quantity of water to be considered for the plant service water application , same will be considered in our water balance diagram.	owner to provide more data/ information.	Refer Vol II section 1.0 clause 2.0.0
601.	Volume II/ Section - I	2.1.0	15 of 191	Fire Protection System: Terminal point for Stage-II shall be provided with gate valve and blind flange.	Hydrant pump head will be sized for stage-I requirement , further a tap-off to stage-II will be provided near the hydrant pumps. Please confirm bidder's understanding.	clarification	Noted. Bidder's understanding is inline with the contract requirements.
602.	Volume II/ Section - I	6.2.2.1	33 of 191	If the fuel with high Sulphur content is used, then FGD plant will have to be installed as per the norms. The space for FGD plant shall also include requirement of Waste Water Treatment required for FGD plant effluent. The mechanical, electrical and control &instrumentation design for the plant shall consider provision for the future	Bidder requests owner to provide information on space to considered for provision of FGD waste water effluent plant & its location.	owner to provide more data/information.	Same shall be furnished during detailed engineering.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				installation of FGD.			
603.	Volume II/ Section - I	6.2.3	35 of 191	Balance of plant Area: Debris filter shall be located above ground with covered shed outside the TG building.	Bidder may please be allowed to provide debris filter as per optimized layout & standard engineering practices.	clarification	Bidder to follow specification.
604.	Section 2-16 Compresed Air System / Vol-II Section 7 Drawings / Vol-II	3.0.0 Compressored Air Flow diagram	1 of 9	Three (03) numbers Instrument Air receivers and three (03) numbers of service air receivers of adequate capacity shall be provided along with accessories..... As per Flow Diagram Two (2) Service Air receiver indicated.	As per compressed air flow diagram we have considered Two(2) numbers of Service Air receiver for 2 x 660 MW Power Plant. Please confirm.	discrepancy in specification.	Three numbers of instrument air receiver & three numbers of service air receiver quantity was mentioned in the tender specification is for the receiver to located near the compressor house. Tender drawing (00-1115- 12-M-006/ R0) five air receiver shown for instrument air. as follows: 3nos. near the compressor house. 1 No. near the unit I Boiler area. 1 No. near the unit-II boiler area. Regarding the service air receiver, 3 nos. shall be provided near the compressor house. For receiver

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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							capacity, Refer Vol II sec 2.16.1 clause 5.0.0 page 8 of 9.
605.	Section 2-16 Compresed Air System / Vol-II	4.0.0	2 of 9	Pressure requirement shall be based on the data furnished by BTG and other packages. Instrument air required for the coal handling system and ash handling system shall not met by these compressors....	As dedicated compressors are provided for AHP and CHP area, we are not considering CHP and AHP service air requirement while calculating plant service air compressor capacity. Please Confirm.	clarification.	Noted.
606.	Section 2-16 Compresed Air System / Vol-II	Annex - 2.16.1 2.0.0 and 3.0.0	7 of 9 and 8 of 9	MOC of Air compressor	MOC for air compressors within compressor skid shall be as per reputed manufacturer standard. MOC outside skid shall be as per specification. Similarly instruments within Compressor canopy shall be as per manufacturer's standard. Similarly MOC for air drying plant internals shall be as per reputed manufacturer standard. Please confirm	clarification.	Bidder to follow specification.

Udangudi 2 X 660 MW Super Critical Power Project Stage-I

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1.	Vol. II Section 2 / Chapter 16	4.0.0	2 of 9	Pressure requirement shall be based on the data furnished by BTG and other packages. Instrument air required for the coal handling system and ash handling system shall not met by these compressors. Capacity shall be considered for the maximum compressed air required for BTG operation (simultaneous starting of the two units.)	Bidder requests owner to consider 0.4 diversity factor /usage factor for intermittent air requirement of plant to determine instrument air requirement. The same is a standard practice in power plant industry.	This is proposed based on contemporary tender specifications for supercritical power plants.	Noted.
2.	Section-2/Subsection-2.7/Volume-II	3.1.4	2 of 13	Two nos. resin separation/ regeneration vessels, one no. mixed resin vessel and one no. mixed resin storage vessel (to hold charge of one service vessel) shall be provided along with all internals, fittings and appurtenances for these vessels.	No. of regeneration vessels shall be as per CPU OEM's proven technology. Please confirm the acceptance.		Bidder to follow specification.
3.	Section-2/Subsection-2.7/Volume-II	3.1.4	2 of 13	Acid ejectors shall take suction from 2x100% acid measuring tanks and alkali ejectors from2x100% alkali day tanks.	Bidder would like to clarify that one(1) no. acid measuring tank and one (1) no. alkali measuring tank (as per capacity criteria mentioned in the same clause) are sufficient for this application and Bidder has followed same philosophy for similar projects. Please confirm the acceptance.		Bidder to follow specification.
4.	Section-2/Subsection-	3.2.0	4 of 13	Each unit shall be provided with independent and skid	We understand that 2x100% metering pumps	clarification.	Bidder to follow specification.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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	2.7/Volume-II			mounted dosing system for Ammonia and Hydrazine dosing. Each chemical dosing skid shall consist of 1x100% capacity measuring tank, 2x100% capacity preparation/ storage tanks and 2x100% metering pumps per dosing system (Condensate system, deaerator system) per unit complete with strainers, piping, valves, fittings, instrumentation and control panel etc.	for condensate system and another 2x100% metering pumps for deaerator system shall be provided. However, per unit, dosing skid (including 1X100% capacity measuring tank and 2X100% capacity preparation/storage tanks) shall be common between condensate & deaerator system. This shall be applicable for both, ammonia & hydrazine dosing system. Please confirm Bidder's understanding.		
5.	Section-2/Subsection-2.7/Volume-II	3.1.4	4 of 13	Neutralizing pit shall be in two (2) sections of RCC construction and each section shall have a holding capacity of 1.5 times the waste effluent from each regeneration. Two nos. (1W+1S) Neutralized Waste Recirculation / Disposal pumps of horizontal centrifugal type with priming arrangement shall be supplied for waste recirculation and disposal to the Purchaser's central monitoring basin. Provision of dosing acid and alkali shall be provided to	Owner is requested to clarify regarding N-pit as there is discripency between sub section of CPU and DM plant. We understand that common N-pit, Neutralized Waste Recirculation / Disposal pumps, acid & alkali dosing facility to neutralise N-pit effluents between CPU and DM plant shall be provided. N-pit will be with 2 a compartment and capacity of each compartment will be 1.5	Clarification	Bidders understanding is In line with our requirement.

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				neutralise effluents before disposal.	times the waste generated from regeneration of MB and CPU unit. Please confirm the acceptance.		
6.	Section-2/Subsection-2.14/Volume-II	3.2.2	9 of 34	Neutralizing pit shall be in 2 compartments with each compartment sized to collect the regeneration effluent from both CPU and DM plant. Recirculation cum disposal pumps shall be provided. DM Plant effluents shall be transferred to central monitoring basin for further use. Regeneration system for condensate polishing units shall be located in the DM Plant area.	Vessel freeboard shall be provided as per OEM/CPU supplier's proven technology. Please confirm the acceptance.		Bidder to follow specification
7.	Section-2/Subsection-2.14/Volume-II	3.2.2	9 of 34	SAC, SBA, Mixed Bed and CPU regeneration effluents shall be collected in neutralizing pit, treated and neutralized effluent shall be transferred to central monitoring basin			
8.	Section-2/Subsection-2.14/Volume-II	ANNEX – 2.14.1	28 of 34	Neutralization System: Capacity (each compartment): 1.5 times the waste generated from regeneration of MB and CPU unit.			
9.	Section-2/Subsection-2.7/Volume-II	5.3.0	8 of 13	Minimum permissible freeboards are as follows:• Mixed resin storage vessel – 50%• Resin separation vessel – 75%• Anion and cation			

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				regeneration vessels- 100%• Activated carbon filter- 75%In case resin separation vessel is also used as regeneration vessel then the free board shallbe 100%.			
10.	Section-2/Subsection-2.14/Volume-II	3.3.1	12 of 34	Hypo chlorite required for potable water disinfection shall be procured separately and hypo chlorite generated from electro chlorination system shall not be used for potable water disinfection.	Owner is requested to clarify the discrepancy between cl. No. 3.3.1 and ANNEX – 2.14.1 regarding Hypo chlorite required for potable water disinfection system. Owner to clarify that whether Hypo chlorite required for potable water disinfection shall be procured separately OR shall be used from common hypostorage tanks.	Discrepancy	Bidder to note that hypo chlorite required for potable water disinfection shall be procured from the market. Hypo chlorite generated from electro chlorination plant shall not be used for potable water disinfection.
11.	Section-2/Subsection-2.14/Volume-II	ANNEX – 2.14.1	30 of 34	Hypo Storage Tanks: Two (2) Nos. Common for Cooling water system, Pretreatment plant, Potable water system, STP and other if any.	Bidder understands that one no. standby electrolyser stream will be provided at each chlorination station. Owner is requested to confirm.	Quantity of electrolysers & standby requirement is not clear in the specification. This is required to bring all Bidders at par.	Bidder to note that two streams of electro chlorination plant shall be provided in line with specification requirement and No of electrolyzers per stream shall be decided by bidder based on capacity.
12.	Section-2/Subsection-2.14/Volume-II	ANNEX – 2.14.1	29 of 34	Electro Chlorination for 2 x 660 MW: No. of streams: 2 Capacity of each stream: To meet requirement for 2 x 660 MW units			
13.	Section-2/Subsection-2.14/Volume-II	ANNEX – 2.14.1	29 of 34	Electrolysers: Quantity: As per system requirement	Capacity of Crane/hoist shall be selected based on	Clarification for requirement	Bidder to follow specification.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				Capacity: As per system requirement	margin given in Cl. No. 3.1.0 of Chapter 2.19.0.		
14.	Sec. 2.0 / Chapter 2.19.0 / Vol. II Sec. 2.0 / Chapter 2.19.1 & 2.19.2 & 2.19.3 / Vol. II	3.1.0 3.0.0 & 2.0.0 & 2.0.0	4 of 8 5 of 9 & 2 of 7 & 2 of 6	The TG hall crane capacity shall be taken as 10% more than the single heaviest equipment/component to be lifted. And other cranes and hoists capacity shall be selected by considering 20% margin over the weight of the component to be lifted. Motor ratings shall be 25% (at least) over the maximum power requirement. The hoist motors shall be rated to lift 125% of the design load at rated speed.	Further, motor margin 25% shall be considered over the maximum power requirement. Additional margin (i.e. motors shall be rated to lift 125% of the design load at rated speed) is not required. Please confirm.		
15.	Vol. II Section 2 / Chapter 19	2.0.0	1 of 8	Supply of Crane at Following Locations : f) gates & screens	As per layout constraint & standard practice bidder will provide hoist for gates & screens.	Clarification.	Noted. Same shall be reviewed during detailed engineering.
16.	Vol-II, Sec-2, 2.8 Dwg. No. 00-1115112-M-004	3.0.0	1 of 9	Steam generator and BOP auxiliaries - 2X100% CCCW. BOP Auxiliaries like compressors of IA/SA, MRHS & AHP are being provided cooling water from SG CCCW pump.	Bidder may please be allowed to decide source of DM cooling water supply to BOP Auxiliaries, duly considering layout constraints, operational requirements & overall benefit to project.	Since this is an EPC project, the Bidder may please be allowed to implement appropriate DMCW scheme.	Bidder to follow specification.
Plant Cooling Water system							

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17.	Vol-II, Sec-2, 2.13	5.3.1	6 of 21	The pump suction bell diameter shall be such as to limit the flow velocity at the maximum flow to within 1.5 m/sec	The pump suction bell diameter may please be allowed to be designed as per Hydraulic Institute Standard.	HEI standards & OEM practice may please be allowed.	Bidder to follow specification.
18.	Vol-II, Sec-2, 2.13,	Annexure 2.13.1	20 of 21	CONDENSER COOLINGWATER PUMPS(for ConcreteVolute pump) : No of pumps : 3 x 50% for each unit	Bidder to would like to propose 2X50% CW pumps for each unit and 1X50% common standby CW Pumps.	Concrete Volute pumps are known for high reliability in the industry hence standby CW pump for each unit is redundant.	Bidder to follow specification.
19.	Vol-II, Sec-2, 2.13, Vol-II, Sec-1,	Annexure 2.13.1 5.2.0	18 of 21 28 of 191	**Cooling Tower Datasheet Design Relative Humidity : 75 %** As per volume II section 1.0 clause no.5.2.0 Bidder shall collect the actual data for a period of 20 years from the meteorological department pertaining to Thoothukudi location and design for plant accordingly. Design condition shall be subjected to owner's approval. **Adverse condition of the above two shall be taken for the design condition without any commercial implication.** Meteorological data corresponding to Tuticorin observatory station shall be adopted.	Design Relative Humidity is important factor for NDCT design which may have significant cost implication. Owner is requested to finalize the design relative humidity to form a common design basis for all Bidders.	Clarification to bring all Bidders at par.	Bidder to follow specification.
20.	Vol-II, Sec-2,	Annexure	18 of 21	COC in CW system :	Owner is requested to	Clarification to bring all	Bidder to follow

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	2.13,	2.13.1		1.3 (MOC and other requirements shall be suitable for operating COC of 1.5)	elaborate on "other requirements" to be considered for operating COC of 1.5.	Bidders at par.	specification. COC of 1.5 shall be considered for MOC selection.
21.	Vol-II, Sec-2, 2.13,	Annexure 2.13.1	20 of 21	CONDENSER COOLING WATER PUMPS(for Concrete Volute pump) : Delivery rate :Suitable to supply cooling water to condenser **+10% Margin.**	CW Pump rated flow is proposed to be designed considered cooling water requirement to condenser plus 5% margin.	CW pump margin of 5% is proposed based on contemporary tender specifications of supercritical plants.	Bidder to follow specification.
Fire Protection System							
22.	Vol-II, Sec-2, 2.15	2.0.0	1 of 33	The material of construction for the pumps, piping and isolation gate valves (Duplex stainless steel) shall be rated for seawater duty.	MOC of Fire water pump located in sea water intake pump house shall be considered as mentioned in section 2.14, Page 19 of 34 (MATERIAL OF CONSTRUCTION FOR SEA WATER HANDLING PUMPS). Fire water Pipe from sea water intake pump house to stock pile area shall be considered as GRP. Similarly all fire water pipes carrying sea water shall be of GRP MOC. Please confirm acceptance.	Clarification	Bidder to follow specification.
23.	Vol-II, Sec-2, 2.15	3.0.0	7 of 33	FIXED FOAM PROTECTION SYSTEMThe water for the foam system shallbe tapped	As per specification it should be Bladder tank foam protection system for	Clarification	Bidder to follow the technical specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				from the Hydrant system. The system will consist of at least two nos. of AFFF foamconcentrate tank (2 x 100% capacity of SS foam tank), foam pumps, foam inductors, balance proportioners, foam makers with discharge outlets, associated interconnection (SS and GI)piping, valves, fittings, instrumentation etc	which water will be tapped off from hydrant line. Hence, No separate pump will be required for foam system. However, shed for foam protection system will be provided. Please confirm our understanding.		including the foam pumps.
24.	Vol-II, Sec-2, 2.15	Annexure 2.15.1	16 of 33	Fire Water Pumps for Hydrant System and Spray System : Material of Construction : Casing : SS 304	Fire water pumps for Hydrant and spray system shall be provided with Casing MOC as IS 210 GR FG 260. Please confirm.		Bidder to follow the technical specification.
25.	Vol. II Section 2 / Chapter 15	2.0.0	2 of 33	Nitrogen injection based fire protection system in addition to automatic high velocity spray system shall be provided for transformers of 220Kv or higher voltage.	Provision of Nitrogen injection based FPDS system in addition to HVW spray system for all the transformers higher than 220 KVs is not envisaged, same shall be provided as per TAC requirement.		Bidder to follow the technical specification.
Hydrogen generation Plant							
26.	Vol-II, Sec-2, SECT-2018 (Hydrogen Generation Plant)	4.0.0	2 of 8	All the piping material shall be SS316L grade.	For DM water and Hydrogen gas pipes, MOC of the pipe shall be SS. However for cooling water and other services, other suitable material shall be provided. Please confirm compliance.		Bidder to follow specification.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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27.	Vol-II, Sec-2, SECT-2018 (Hydrogen Generation Plant)	4.0.0	2 of 8	Hydrogen gas is generated by Electrolysis of water with KOH as electrolyte	Please confirm that other than KOH, solid electrolyte used in other bi-polar designs shall also be acceptable.		Bidder to follow specification.
28.	Vol-II, Sec-2, SECT-2018 (Hydrogen Generation Plant)	5.1.0	3 of 8	Sampling of H2 gases from each cell with sight glass shall be provided for safe sampling.	Bidder confirm that necessary sampling arrangement to ensure purity of the gases shall be provided, but the sampling arrangement shall be as per OEM's standard design. Please confirm acceptance.		This shall be reviewed during detailed engineering.
29.	Vol-II, Sec-2, SECT-2018 (Hydrogen Generation Plant)	6.0.0	5 of 8	L=Normal leakage rate per day (Shall be assumed as minimum 5 cylinders a day)	Bidder confirm that necessary sampling arrangement to ensure purity of the gases shall be provided, but the sampling arrangement shall be as per OEM's standard design. Please confirm acceptance.		Bidder to follow specification.
30.	Vol-II, Sec-2, SECT-2018 (Hydrogen Generation Plant)	Annexure 2.18.1, Sr No 1	7 of 8	Capacity not less than 12 Nm3 / hr	We understand that the capacity specified is net capacity of two electrolysers, We have considered capacity of 6 NM3 / hr for each electrolyser. Please confirm.	Clarification	Capacity of each electrolyser shall be not less than 12nm3/h as per Vol-II sec 2.18 page 7 of 8. Bidder to follow specification.
31.	Vol-II, Sec-2, SECT-2018 (Hydrogen Generation Plant)	Annexure 2.18.1, Sr No 10	8 of 8	Compressor and accessories	We have considered 3 compressors each having net capacity of 6 Nm3/hr. Please confirm.	Clarification	Bidder to follow specification
MRHS							
32.	Vol. II, Section 2.12 Mill Reject	6.0.0	4 of 13	Mill reject compressor shall be located along with the AHS	Mill reject compressor shall be placed at Main	Main compressor house will be located nearer to	Bidder to follow specification.

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	Handling System			compressor.	compressor house instead of AHS compressor house.	boiler area, hence compressor size can be optimized.	
Fuel oil handling system							
33.	Vol-II, Sec-2, 2.9	4.11.0	4 of 19	Electrical Trace Heating shall be used for the HFO piping (both supply and return lines) between pump house area and the boiler front and HFO piping in fuel oil unloading, storage and forwarding pump house area. The Electric Trace Heating shall be of the self-regulating typ	Bidder has considered steam tracing for all HFO, drain oil piping i.e. unloading, storage and forwarding system. Please confirm.	As there is a discrepancy in different parts of specification.	Refer Vol-II sec 2.9 page 4 of 19 clause no: 4.4.0
34.	Vol-II, Sec-2, 2.9	Annexure 2.9.1	16 of 19	HFO Heater Datasheet : Type: Shell (OIL) and tube(STEAM) type with U type seamless tube bundle heater	A106 Gr B is pipe material. We will provide heaters with u tubes of SA179 Material. Please confirm.		
35.	Vol-II, Sec-2, 2.9	Annexure 2.9.1	16 of 19	HFO Heater Datasheet : Type: Shell (OIL) and tube(STEAM) type with U type seamless tube bundle heater Material of construction : A106 Gr B		As there is a discrepancy in specification & code.	Bidder to follow specification.
36.	Vol-II, Sec-2, 2.9	Annexure 2.9.1	16 of 19	HFO Cooler Datasheet : Type:Shell (OIL) and tube(STEAM) type with U type seamless tube bundle heaterMaterial of construction : A106 Gr B	A106 Gr B is pipe material. We will provide coolers with u tubes of SA179 Material. Please confirm.	As there is a discrepancy in specification & code.	Bidder to follow specification.
37.	Vol-II, Sec-7 00-1115112-M-005	Flow Diagram for Fuel Oil		As indicated in flow diagram, 3 Nos. 3 (2W + 1 S) nos.) HFO pressurizing pump connection	If Connection of HFO forwarding pumps shall be taken from Stage-I suction	Clarification	Note. Bidder understanding is

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		System (3 Sheets)		with isolation valve for future 2X660 MW units shall be provided in Stage-1.	header as indicated in flow diagram, Bidder to design HFO suction system as under. 1. Sizing of Suction heaters of HFO tanks shall be done considering 4X660 MW Units. 2. Sizing of Pump Suction headers, Suction strainers shall be done considering 4X660 MW units. Please confirm.		inline with the contract requirements. However pump configuration shall be similar to Stage-I.
38.	Vol-II, Sec-7 00-1115112-M-005	Flow Diagram for Fuel Oil System (3 Sheets)		As indicated in flow diagram, 3 Nos. 3 (2W + 1 S) nos.) HFO & HSD forwarding pump connection with isolation valve for future 2X660 MW units shall be provided in Stage-1.	Bidder to design fuel oil forwarding pump house considering various equipment (HFO forwarding pumps, HFO heaters, HFO coolers, HSD forwarding pumps & associate system) for future 2X660 MW. Please clarify.	Clarification	Space provision for future pump house shall be provided in the fuel oil area.
39.	Vol-II, Sec-7 00-1115112-M-005	Flow Diagram for Fuel Oil System (3 Sheets)		As indicated in flow diagram, 3 Nos. 3 (2W + 1 S) nos.) HSD forwarding pump connection with isolation valve for future 2X660 MW units shall be provided inStage-1.	If Connection of HSD forwarding pumps shall be taken from Phase-I suction header as indicated in flow diagram, Bidder to design HFO suction system as under. 1. Sizing of Pump Suction headers, Suction strainers shall be done considering 4X660 MW units. Please confirm.	Clarification	Note. Bidder understanding is inline with the contract requirements. However pump configuration shall be similar to Stage-I.
40.	Vol. II, Section 1.0	11.11.3.4 (4)	74 of 191	i) Fuel oil unloading system: 0.1	Please clarify the type of fuel (HFO & HSD) to be	Clarification	HFO shall be considered.

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				ii)Fuel oil forwarding system: 0.1	considered for fuel oil system guaranteed power calculation.		
41.	Vol. II, Section 1.0	7.1.0	39 of 191	TANGEDCO have applied for the MOEF clearance with 100% imported coal and it will be given to contractor during the detailed engineering stage. **Contractor has to fulfill the requirement of the MOEF without any cost implication.** TANGEDCO have already obtained the Environmental & CRZ clearance for coal jetty, coal conveyor and seawater intake and outfall system and the approval letter is attached in Volume III – Attachments to Tender Documents. Contractor shall fulfill the MOEF CRZ clearance requirements as applicable for his scope of work.	The price bid will be submitted based on information available in bid specification. Relevant cost & schedule implication can be discussed & mutually agreed, in case of any change in statutory requirements.	Clarification.	Environmental clearance by MOEF is already attached with the specification. Refer Volume III.
42.	Section-5/Volume-II	5.2.28	38 of 38	The structural part of caisson is to be fabricated in two parts i.e. Bottom portion and top portion. After the assembly of caisson structures hydro testing is to be carried out to ensure water tightness of whole caisson structure, suitable for towage to intake well location	From this clause we understand that hydro-testing of velocity cap shall be done off shore. Please confirm.	Please clarify Bidder understanding	The hydraulic testing shall be done at assembly point
43.	Vol. II, Section 1.0	20.2.0	117 of 191	Contractor shall comply with the following Environmental	Owner is requested to provide the referred	Clarification.	Environmental clearance by MOEF

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				clearance obtained for the project, as applicable for the EPC scope: • Environmental Clearance (EC) • CRZ clearance for captive port, seawater intake and outfall • Consent to Establish (CTE) issued by TNPCB	documents to Bidder. The price bid will be submitted based on information available in bid specification. Relevant cost & schedule implication can be discussed & mutually agreed, in case of any change in statutory requirements.		and CRZ clearance for captive port, seawater intake and outfall are already attached with the specification. Refer Volume III. Consent to Establish (CTE) issued by TNPCB is uploaded in the TANGEDCO website as Annexure-2
44.	Sec 1.0 / Vol. II	6.2.2	32 of 191	The turbine repair bay area shall be sized for minimum of 20 M X 30 M.	Bidder understands that repair bay of 20 M X 30 M is total maintenance area requirement for the TG set in AB bay common for both units. Please confirm our understanding.	Clarification is sought to bring all Bidders at par.	As per Vol-II section-1.0 Page 33 of 191 - One transverse bay with adequate space shall be provided for each Unit in TG building for unloading and maintenance purposes. As per Vol-II section-1.0 Page 32 of 191, The turbine repair bay area shall be sized for minimum of 20 M X 30 m common for both units. Bidder to follow

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							specification.
45.	Vol-II, Sec-1,	2.1.0 (1-a)	12of 191	Sea water supply : Terminal point at Stage-II intake channel after desilting basin. The Stage –II channel shall be provided with blanked wall. During detailed engineering interface with stage II shall be reviewed and finalized by the owner. After the desilting basin bay, the intake channel shall be divided into two (one for present 2 x 660 MW and another for future 2 x 660 MW).	Owner is requested to furnish terminal point location for stage-II location. Bidder understands that the same is at 1 meter away from channel bifurcation point.	Clarification is sought to bring all Bidders at par.	Bidder shall consider minimum of 5m length away from bifurcation and layout shall be decided based on the CFD analysis of Channel and Desilting basin. This shall be reviewed during detailed Engg.
46.	Vol. I, Section – 4.0, SCC	23.2	19 of 21	EVALUATION / LOADING CRITERIA & PENALTY: ..... 2: Total Auxiliary power consumption for the plant * (1320 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85: Rs.4,70,72,094 for every 0.01 % increase (considering 5.5 % Auxiliary Power Consumption	Owner is also requested to clarify the evaluation loading on other Bidders if a Bidder quotes Aux Power consumption below 5.5%.	Clarity is required to establish base for loading on Aux Power Consumption.	Loading for evaluation of shortfall in performance shall be considering 5.5% Auxiliary power consumption as base. If bidder quotes Aux power consumption, below 5.5%, the same shall be considered as 5.5% only, for loading purpose.

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				as base)			
47.	VOL-II Section-5 Civil	5.6	2 of 16	5.6.1.j	Structure	We are considering lattice type structure for 400kV outdoor yard equipment. Please confirm.	Noted
48.	VOL-II Section-3 Electrical	3.29	325 of 353	4.2.0	Interpole cabling	Interpole cabling & cabling from equipment to trenches, shall be in PVC pipes for outdoor yard. Please confirm.	Bidder to follow specification.
49.	VOL-II Section-7 Drawings				AUTOCAD Drawings	i) Please provide AUTOCAD copy of Plot Plan Dwg No - 00-1115112-G-001,Rev-0 for measurement purposes. ii) Please provide AUTOCAD copy of 400kV GIS Switchyard Layout Dwg No - 10-1115112-E-224,Rev-0 for measurement purposes.	i). **AUTOCAD** Drawing uploaded in the TANGEDCO website. ii) Bidder responsibility to develop the 400 KV GIS switch yard based on the tender specification and proposed equipment sizing.
50.	VOL-II Section-3 Electrical	3.14	214 of 353	2.0.0.c,d	Battery & battery charger rating	Please provide minimum AH rating required of 220V & 48V Switchyard battery & minimum current rating required of 220V DC switchyard battery charger.	Bidder shall consider minimum 150 AH for 48 V switchyard battery. For other Batteries the rating shall be selected by the Bidder as per specification requirement and the load cycle. This

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							will be firmed up during detail Engineering stage.
51.	VOL-II Section-1 GTS		19 of 191	2.2.0.a)	Switchyard Terminal Points	i) Please note that bidder terminal point for 400kV GIS switchyard shall be at the outgoing gantry of 400kV Lines. Tension Insulators at line gantries not in bidder scope. Please confirm. ii) Please confirm that OPGW terminal equipment needs to be provided for 400kV Udangudi GIS Switchyard end only. iii) Please confirm that OPGW terminal equipment & 48V DC system (if any) for remote end sub-station is excluded from bidder scope. iv) Please confirm that supply/installation/stringing of OPGW wire of outgoing transmission line feeders is in TANGEDCO scope.	i) Bidder's scope is up to 400kV line gantry Tension Insulators. ii) As stated in the tender specification for OPGW remote end communication equipment with in plant boundary are in Bidder's scope only iii) Confirmed. iv) The supply/ installation / stringing of OPGW wire of outgoing transmission line feeders is up to Line gantry of proposed power plant is in the scope of EPC contract.
52.	VOL-II Section-3 Electrical	3.3	53 of 353	15.0.0	CVT	Kindly provide the following details not available in the Technical Specifications:	Please refer the tender drawing No.10-1115112-E-203. Instead of

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						a)CVT Parameters (i.e. No. of Secondary Cores / Voltage Ratio / Accuracy Class / Burden / Purpose of each core) for outgoing line feeder CVT's.	outdoor 400 kV CVT, EMVT shall be provided as a part of GIS switchgear, to meet the metering & protection requirement specified.
53.	VOL-IISection-7Drawings				GIS Switchyard Layout	Please confirm whether building marked as owner's future use shown in" 400kV GIS Switchyard Layout Dwg No - 10-1115112-E-224,Rev-0" is in present scope.	In the referred drawing, Building marked as owner's future use is not in present scope of bidder.
54.	VOL-II Section-7 Drawings				GIS Switchyard Layout	Please confirm whether "OH line" between GT/ST/BR & GIS is overhead Conductor. Please confirm type of conductor to be used (quad/twin ACSR/AAC).	As per tender drawing and Specification overhead line of adequate size and type shall be provided between GT/ST/BR & GIS by bidder. Considering additional 10% margin. All the insulators shall be polymer based.
55.	VOL-II Section-5 Civil	5.10.4	9 of 10	5.10.4.7	Gravelling	Please provide depth of gravel filling required for outdoor area of switchyard.	As per clause 5.10.4.7., "Entire switchyard area shall be provided with 100 mm thick paving using M15

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							grade PCC."
56.	VOL-II Section-3 Electrical	3.3	48 of 353	5.4.0	GIS Circuit Breaker	Please confirm whether PIR is required to be provided in circuit breaker of Spare bay of 400kV GIS also.	PIR is required in circuit breaker of Spare bay (Equipped) of 400kV GIS.
57.	VOL-II Section-3 Electrical	3.3	46 of 353	4.1.0	GIS Scope	"Two numbers spare bay (Unequipped)" - Please confirm whether only space provision needs to be provided in 400kV GIS building for Two numbers spare bay (Unequipped).	All required provisions to be made for two numbers spare bay(Un equipped) in all aspects.(Switch yard and switch yard control room).
58.	VOL-IISection-3Electrical	3.3	67 of 353	23.1.0	Type Tests	We are not considering type testing of GIS/any switchyard equipment/items. We shall submit only valid type test reports for GIS/Switchyard equipment. Please confirm.	Bidder to follow specification.
59.	VOL-II Section-5 Civil	5.6	9 of 10	5.10.4.8	GIS Hall & Switchyard Control room	Please provide minimum dimensions (lxbxh) of switchyard control room building & 400kV GIS hall.	Building size shall be decided by the Bidder as per equipment layout, complying with tender drawings and specification requirements. The same will be reviewed during detailed engineering

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60.	VOL-II Section-3 Electrical	3.28	317 of 353	4.1.31.4	Grounding Of GIS	i) Please provide soil resistivity data for GIS/Outdoor Pothead Yard area. ii) Please provide size of Copper flat to be used as Earth conductor embedded in concrete in GIS building.	i) Soil resistivity test results are available in Geotechnical investigation. ii) Copper earth mat shall be sized as per the requirements of technical specification and GIS supplier.
61.	VOL-II Section-2 Mechanical	2.19.0	1 of 8	2.0.0.b)	GIS EOT crane	Kindly confirm type and minimum tonnage for GIS hall EOT crane.	The EOT crane capacity shall be based on the weight of heaviest equipment/ component to be handled during maintenance. The type of crane shall be as per clause 3.1.0, section 2.19.0, Volume II of tender specification.
62.	VOL-II Section-3 Electrical	3.3	50 of 353	9.0.0	GIS Current Transformers	Kindly provide the following details not available in the Technical Specifications: a)CT Parameters (i.e. No. of Cores / Current Ratio / Accuracy Class / Purpose of each core) for GT/ST/Reactor/Line	Please refer the tender drawing No.10-1115122-E-203. For differential and REF protection PS class CT shall be provided and for over current

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						Feeders, Tie Bays.	protection 5P20 class shall be provided. Further parameters shall be selected by the Bidder as per the requirements of tender drawings and specification for the type of relays and meters being offered.
63.	VOL-II Section-3 Electrical	3.3	51 of 353	10.0.0	GIS Voltage Transformers	Kindly provide the following details not available in the Technical Specifications: a)VT Parameters (i.e. No. of Secondary Cores / Voltage Ratio / Accuracy Class / Burden / Purpose of each core) for GT/ST/Reactor/Line Feeders, Tie Bays.	Please refer the tender drawing No.10-1115122-E-203. VT parameters shall be selected by the Bidder as per the requirements of tender drawings and specification for the type of relays and meters being offered.
64.	VOL-II Section-3 Electrical	3.3	45 of 353	3.0.0.f)	IEC 61869-2 Additional requirements for current transformers	Please confirm if CT type Tested as per IEC-60044-1 shall suffice.	Bidder to follow specification.
65.	VOL-II Section-3 Electrical	3.3	47 of 353	4.6.0	Future extension shall be accessible without any shut down of operating bays.	Please note that the future extension installation may be done without shut down of operating bays. However, at the time of physical connection between the existing	Noted

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						GIS to the Future Extension, at least one bus needs to be shutdown at a time and the other Bus bar shall be in live condition .Please confirm.	
66.	VOL-II Section-3 Electrical	3.3	47 of 353	4.6.0	10 % margin in equipment sizing	Subject clause mentions - "Unless specified otherwise, at least 10 % margin shall be considered in equipment sizing over and above the calculated load current / fault current / power requirements."- Please provide the calculated (actual level) fault current/load current/power requirement.	Calculated fault current / load current / power requirement shall be calculated by the Bidder as per specification.
67.	VOL-IISection-3Electrical	3.3	47 of 353	4.9.0	Rated Current	We understand that the Rated Current for the Feeder Circuit Breaker is 2000A and that of Bus & Bus - Sectionaliser is 4000A. Kindly confirm whether our understanding is correct.	Bidder to follow specification.
68.	VOL-II Section-7 Drawings	SLD DWG.NO 10-1115112-E-203,Rev-0			Circuit Breaker current is mentioned as 2000A,Feeder Current is mentioned as 2000 A Bus bar current is mentioned as 4000 A & Sectionalizer current is		

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					mentioned as 4000A.		
69.	VOL-II Section-3 Electrical	3.3	47 of 353	4.10.0	GIS enclosures burn through	Subject clause mentions - "The GIS enclosures shall be suitable to withstand an internal flash over without burn through for a period of 0.3 sec. The GIS Enclosures shall be suitably designed to withstand a fault for a period of back up protection relay to clear the fault (i.e. for approximately 0.3 sec for 63 kA minimum)." - Please note as per IEC-62271-203, the internal flash over without burn through for ≥ 40 kA short circuit current is 100ms.Please confirm whther GIS design inline with IEC-62271-203 for internal flash over without burn through shall suffice.	Bidder to follow specification.
70.	VOL-II Section-3 Electrical	3.3	48 of 353	5.1.0	Circuit breaker mounting	Subject clause mentions - "The Circuit breakers shall be horizontal mounted and shall withstand the forces imposed during earthquake." - We presume that though	Bidder to follow specification.

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						the specification is calling for CB horizontal mounting, CB with vertical mounting is also acceptable. Since, functionally there may be no difference between the two designs and Vertical mounted CB in GIS may also have been Type Tested & may have been in successful operation in varied geographical conditions. Please confirm.	
71.	VOL-II Section-3 Electrical	3.3	48 of 353	5.4.0	PIR	Subject clause mentions - "For all line feeders pre insertion resistor (PIR) shall be provided. Further, switching controllers shall be provided in circuit breakers used for switching shunt reactors for lines /buses and transformers. The switching controller shall enable the optimization of switching behaviour." - Please confirm if Controlled Switching Device can be provided for line circuit breakers and Reactor circuit breakers being similar to	Bidder to follow specification.

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						operation of PIR.	
72.	VOL-II Section-3 Electrical	3.3	49 of 353	6.5.0	Isolator	Subject clause mentions - "Isolators shall be fitted with an optical indicator per pole located between pole & driving rod so that open or closed contacts of the isolator are visible from floor level." - Please confirm if Viewing glass (Inspection Window) can be provided for visual inspection of contact position of disconnector.	Bidder to follow specification.
73.	VOL-II Section-3 Electrical	3.3	49 of 353	6.3.0	Isolator	Subject clause mentions - "All these interlocks shall be of failsafe type. Suitable individual interlocking coil arrangements shall be provided. The interlocking coil shall be suitable for continuous operation from DC supply and within a variation range as stipulated." - In case Electrical interlocking is provided, interlocking coil shall not be applicable for isolator. Please confirm.	Bidder to follow specification.
74.	VOL-IISection-3Electrical	3.3	49 of 353	7.1.0	MAINTENANCE EARTH SWITCHES	Subject clause mentions - "Maintenance Earth	Bidder to follow specification.

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						switches shall form an integral part of the isolator." - Please note that Maintenance Earth Switch may be a separate device and may have separate mechanism. Please confirm.	
75.	VOL-II Section-3 Electrical	3.3	49 of 353	7.1.0	MAINTENANCE EARTH SWITCHES	Subject clause mentions - "The maintenance earth switches shall be constructionally interlocked with the isolator so that the maintenance earth switches can be operated only when the isolator and circuit breaker is open and vice versa. The constructional interlocks shall be built in the construction of isolator and shall be in addition to the electrical interlocks." - Please confirm if only Electrical Interlock can be provided between Maintenance Earth switch & Disconnector. Both the Maintenance Earth switch & Disconnector may be separated and may have	Bidder to follow specification.

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						separate mechanism, thus mechanical interlock may not be satisfied. Please confirm.	
76.	VOL-IISection-3Electrical	3.3	49 of 353	7.2.0	MAINTENANCE EARTH SWITCHES	Subject clause mentions - "The earth switch shall have three poles, group operated, with one motor operated mechanism per three poles and additionally with an emergency manual operation using operating handles or hand cranks." - Please confirm if Maintenance earth switch can be of Single pole design with group operated.	Bidder to follow specification.
77.	VOL-II Section-3 Electrical	3.3	49 of 353	7.3.0	MAINTENANCE EARTH SWITCHES	Subject clause mentions - "The earth switch shall also comply with the requirements of IEC-601129, in respect of induced current switching duty as defined for Class-B Earth switches." - We would like to inform you that Maintenance Earth Switch does not have any induced current switching duty like High speed Earth switch. It is used only during maintenance	Bidder to follow specification.

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						period. Please confirm.	
78.	VOL-II Section-3 Electrical	3.3	50 of 353	7.4.0	MAINTENANCE EARTH SWITCHES	Subject clause mentions - "Maintenance earth switch shall be provided with indicators on each pole for visual inspection of each switch contact position." - Please confirm if only one position indicator can be provided in Mechanism box of maintenance earth switch for three phases because it is three phase gang operated.	Bidder to follow specification.
79.	VOL-IISection-3Electrical	3.3	50 of 353	8.3.0	FAST ACTING EARTH SWITCHES	Subject clause mentions -"Fast acting Earth switches shall be constructionally interlocked with their associated circuit breaker such that the grounding switches cannot be closed if the circuit breakers are closed." - Please confirm if only the Electrical Interlock between Fast acting earth switch, Circuit breaker & Disconnector can be provided The Fast acting earth switch, Circuit breaker & Disconnector may be separate and	Bidder to follow specification.

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						may have separate mechanism, so mechanical interlock may not be satisfied.	
80.	VOL-II Section-3 Electrical	3.3	50 of 353	8.4.0	FAST ACTING EARTH SWITCHES	Subject clause mentions -"Fast acting earth switch shall be single pole operated, with one motor operated mechanism per single pole and additionally with an emergency manual operation using operating handles or hand cranks. These shall be fitted with a stored energy closing system to provide fault making capability." - Please note that Fast acting earth switch is a single pole design and may have operating mechanism commonly for three phases(Gang operated).Please confirm.	Bidder to follow specification.
81.	VOL-II Section-3 Electrical	3.3	50 of 353	8.5.0	FAST ACTING EARTH SWITCHES	Subject clause mentions - "Fast acting earth switch shall also comply with the requirements of IEC - 622271-102 in general and IEC-601129, in respect of induced current switching duty as	Bidder to follow specification.

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						defined for Class-B Earth switches" - Please confirm if Fast acting earth switch type tested as per IEC-62271-102 only shall suffice.	
82.	VOL-II Section-3 Electrical	3.3	50 of 353	8.6.0	FAST ACTING EARTH SWITCHES	Subject clause mentions - "Fast acting earth switch shall be provided with indicators on each pole for visual inspection of each switch contact position." -Please confirm if only one position indicator can be provided in mechanism box of fast acting earth switch for three phases because it is three phase gang operated.	Bidder to follow specification.
83.	VOL-II Section-3 Electrical	3.3	50 of 353	9.1.0	Current Transformers	Subject clause mentions - "The current transformers shall be of metal enclosed, inductive type, non-resistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The transformers shall be effectively shielded against high frequency electromagnetic transients. Short time rating of CTs shall be	Bidder to follow specification.

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						not less than that of the associated switchgear." - Please confirm if the current transformers can be of Externally mounted type(Around the Enclosure).	
84.	VOL-II Section-3 Electrical	3.3	50 of 353	11.1.0	Local Control Cubicle	Subject clause mentions - "For each bay, a separate local control cubicle including gas monitoring kiosk shall be provided which shall be installed in respective bay for local control & monitoring. The LCC shall be equipped with suitable hardware & software for remote control operation." - Please confirm whether Gas indicating system can be placed in the LCC itself and separate gas monitoring kiosk may not be required.	Bidder to follow specification.
85.	VOL-IISection-3Electrical	3.3	52 of 353	12.2.0	GIS ENCLOSURE	Subject clause mentions - " The bus enclosure should be sectionalized in a manner that maintenance work on any bus disconnector can be carried out by isolating and evacuating the small effected section and not the	Bidder to follow specification.

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						entire bus." - We would like to inform you that during maintenance work on any disconnector the specific busbar may be in shut down until the maintenance work is completed. Please confirm.	
86.	VOL-II Section-3 Electrical	3.3	52 of 353	14.1.0	Gas to Air Bushing	The Connection between overhead line and SF6 gas equipment shall be done using 'gas to air' bushing. - We would llike to inform you that as per our understanding the termination for all bays is SF6 to Air Bushing. Kindly confirm.	Termination up to line side gantry (ie., from SF6 air bushing to gantry) is in the scope of EPC .
87.	VOL-II Section-3 Electrical	3.3	65 of 353	22.0.0-1.k,l,m,o	TECHNICAL PARAMETERS OF GIS SWITCHYARD	We would like to inform you that pt. 1. k,l,m,o are not applicable to GIS switch gear. Please confirm.	Bidder to follow specification.
88.	VOL-II Section-3 Electrical	3.3	66 of 353	22.0.0- 2.c	TECHNICAL PARAMETERS OF GIS SWITCHYARD	Subject clause mentions - "2. Circuit Breaker: c) Dynamic rating 163 kA (peak)" - We would like to inform you that the Dynamic rating for circuit may be maximum of 158kAp (63*2.5=157.5kAp). Please confirm.	Bidder to follow specification.

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89.	VOL-II Section-3 Electrical	3.3	66 of 353	22.0.0- 4.b	TECHNICAL PARAMETERS OF GIS SWITCHYARD	Subject clause mentions - "4. Current Transformer - b) Radio interference voltage at 1.1 Un/ 3 and frequency range 0.5 to 2 MHz is 1000 micro volts." - We would like to inform you that Radio interference is not applicable.	Bidder to follow specification.
90.	VOL-II Section-3 Electrical	3.3	68 of 353	23.7.2	Site tests	Subject clause mentions - "The following tests shall be carried out before and during erection, testing and commissioning" - Please confirm whether site tests conducted as per IEC shall suffice.	Bidder to follow specification.
91.	VOL-II Section-3 Electrical	3.1	16 of 353	6.7.0 & 6.8.0	Experience Requirement	Subject clause mentions - "The Contractor whose equipment are offered should have designed, manufactured, tested and supplied the same for the specified system voltage and which are in satisfactory operation for at least five (5) years as on date of bid opening. Type test certificates for test conducted on similar rating shall be furnished. Equipment offered shall be of type	Bidder to follow specification.

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						tested and proven type. In case type test reports are not found to be meeting the specification requirements, Contractor shall conduct all such type tests according to the relevant standards at his cost and the Owner will not absorb such cost." - Please confirm whether GIS Equipments can also be supplied from such Indian manufacturers who have recently established GIS facility in India, based on technical collaboration with its Principals. GIS manufacturer may supply GIS from its facility in India, similar to that manufactured and type tested by its Principal. In such case, please confirm whether criteria mentioned under clause no. 6.7.0 and 6.8.0 can also be met by the Principal company for supply of GIS equipments from Indian company.	

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92.	Section 3.1/ Volume II	4.14.0	9	LT Auxiliary Supply: 3 Ph 4 Wire	Our proposal to use 3 Ph 3 wire distribution may please be accepted. We will provide DBs with unit ratio LV transformers wherever 1 Ph loads are required to be fed. This is to reduce fault level at LV 1 Ph bus.	As per standard practice followed for power projects.	Bidder to follow specification
93.	Section 3.1/ Volume II	5.1.0 5.10 5.13 5.30	11 13 13 15	Cable spreader room shall be provided for each Electrical room, Control room and Control equipment room.	Cable spreader room will be provided by us in large switchgear/control rooms like Main Plant. In other control/switchgear rooms Trench will be provided as it will suffice the requirement.	Based on ease of engineering /execution/procurement in recent power projects.	Bidder to follow specification
94.	Section 3.1/ Volume II	5.9.0	12	Following minimum clearance	Minimum clearance as per manufacturers' recommendation will be provided by us. Kindly accept.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
95.	Section 3.1/ Volume II	5.11	13	Overhead Cable Racks	We propose cable sleepers for ease of maintenance and replacement. Kindly accept.	Ease of engineering/ execution/ procurement Ease of Maintenance	Bidder to follow specification
96.	Section 3.1/ Volume II	5.12	13	A separate cable gallery shall be provided with walkway along the conveyor gallery.	Instead of a separate cable gallery with walkway, we propose to use vertically installed trays with covers along with conveyor galleries. Our proposal may please be accepted.	Optimization	Bidder to follow specification

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97.	Section 3.1/ Volume II	5.17	13	This rail track shall be independent of main road.	We propose Track laid along Road center line. Our proposal may please be accepted.	Ease of engineering/ execution/ procurement	Bidder to follow specification
98.	Section 3.1/ Volume II	5.18	13	Where oil capacity of the transformer (individual or aggregate) is >2300 liters and <5000 liters	We will provide Fire walls as per TAC/ standards requirement. Our proposal may please be accepted.	As per standard practice followed for power projects.	Bidder to follow specification
99.	Section 3.1/ Volume II	5.21	13	if oil in one transformer exceeds 2275 liters and the soak pit shall be sized to hold total quantity of oil.	Oil filled Aux transformers that may have such small oil quantity (UAT/SAT/AHPT) will be located in Transformer yard, which will have connection with burnt oil pit. Hence, we do not envisage sizing of Soak pit for total oil quantity. Our proposal may please be accepted.	As per standard practice followed for power projects.	Bidder to follow specification
100.	Section 3.3/ Volume II	9	50	Current Transformers	Owner may please confirm CT ratios required for outgoing lines.	Information not available in tender document.	Please refer the tender drawing No.10-1115112-E-203.
101.	Section 3.3/ Volume II	20.15.0	60	The control hierarchy level shall be as follows: Level 3 : Remote DCS / generator control panel (for GT CB & Tie CB)	As we have GCB scheme, Owner may please reconfirm requirement of controlling GT CB and tie from DCS.	Ease of engineering/ execution/ procurement Ease of Operation.	These aspects will be addressed during detail engineering stage.
102.	Section 3.4/ Volume II	3.14.0	74	Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps, the	Hot spot temperature shall be 150^{O}C as per CBIP clause 3.14.0, Section A will be provided by us.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification

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				transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140°C.	Same may please be accepted.		
103.	Section 3.4/ Volume II	3.16.0	74	Transformer tank shall be dispatched filled with oil or pure dry inert Nitrogen gas.	We propose transportation of Dry Air filled transformers as per reputed manufacturers' practice. Same may please be accepted.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
104.	Section 3.4/ Volume II	3.19.0 c)	75	The transformer shall be provided with off circuit tap changer. For tap changer, potential free contacts of GT Tap position shall be provided for remote communication to RLDC.	Tap position indication of OCTC tap changer at remote location is not being offered by manufacturers. Hence, Bidder is unable to consider this requirement in the offer. Same may please be accepted.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
105.	Section 3.4/ Volume II	3.20.0 b)	75	The transformer shall be standby to Unit transformer and Station transformers It shall be rated to backup one unit transformer and station transformer together, or two unit transformers together at any time.	MDBFP running/ starting on Standby Transformer is not envisaged by us as MDBFP will be fork connected to another unit transformer. Same may please be accepted.	Optimization	Bidder to follow specification
106.	Section 3.4/ Volume II	4.2.0	77	10 kV	Subject to manufacturers' acceptance.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
107.	Section 3.4/ Volume II	4.18.0	85	The Numerical Tap Changer-cum Transformer Monitoring	Alternatively, tap changer unit will be housed in RTCC	OEM/ Manufacturer's constraints/	Bidder to follow specification

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				Unit (NTCMU) shall be provided housed in transformer relay panel.	panel instead of relay panel. Type of tap changer controller is subject to manufacturers' practice. Same may please be accepted.	recommendation	
108.	Section 3.4/ Volume II	4.24.0	87	transformers rated above 20 MVA shall be provided with a dedicated Nitrogen Injection system	MVA/ kV rating for suitability of Nitrogen injection system is subject to manufacturers' acceptance.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
109.	Section 3.6/ Volume II	3.19.0	75	Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator	As VWO condition is specified, which is maximum power delivery condition, 10% design margin over and above VWO condition is not envisaged by us. However, Voltage variation and power factor as per generator capability curve will be considered. Same may please be accepted.	As per standard practice followed by NTPC and other state utilities for power projects.	Generator Transformer Rating shall be 3X275MVA (Single phase) as per specification Vol-II, Section-3, DTS-Electrical, page 91 0f 353. The last sentence of referred clause ''Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator.'' is withdrawn.
110.	Section 3.6/ Volume II	4.21.9	112	List of shorting links	Owner may please provide us separate list for Conductor shorting arrangement and Enclosure shorting arrangement.	Insufficient information	Bus duct shorting links shall be provided as specified. For bus duct enclosure also shorting links shall

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							be provided as applicable to make the system complete.
111.	Section 3.8/ Volume II	2.0.0 j)	132	33 kV Switchgear	Owner may please provide no. of outgoing feeders and their ratings.	Information not available in tender document.	Bidder to refer tender drawing No. 10-1115112-E-229 Single Line Diagram For 33kV HT Switchgear.
112.	Section 3.8/ Volume II	4.8.0 i)	135	To feed external coal handling system, 33 kV supply is envisaged, which shall be derived from 11 kV Station switchgear through 11/34.5 kV transformer, 33 kV VCB isolation panels shall be located in the power house building	LV Charging current for ECHP step up transformer for these ratio is typically 10-12 times. We propose to use 3 winding ST. 3rd winding will be rated for 33 kV which shall feed power to 33 kV ECHP switchgears. This will avoid use of step up ECHP Transformer and charging requirement of these ECHP Transformer from LV. Bidder's proposal may please be accepted.	Ease of Operation. Ease of engineering/ execution/procurement	Bidder to follow specification
113.	Section 3.8/ Volume II	4.10.0	136	In each bus section 20% spare feeders shall be provided	We propose to offer One no of largest rated motor/ transformer feeder in each switchgear as spare. Bidder's proposal may please be accepted.	As per standard practice followed for power projects.	Bidder to follow specification
114.	Section 3.8/	4.1.9	137	Total height of the switchgear	Enforcement of this tender	Difficulties experienced	Bidder to follow

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	Volume II			panels shall not exceed 2500 mm.	clause may please be reviewed during detail engineering as switchgear max height is subject to no. of components in LV chamber, its makes, and panel width offered by OEM.	in past projects.	specification
115.	Section 3.8/ Volume II	5.3.4	138	Trip circuit supervision shall be provided.....	TCH will be part of Numerical protection relay. Kindly accept.	As per standard practice followed for power projects.	Bidder to follow specification
116.	Section 3.10/ Volume II	5.12.1	171	10 No's potential free contacts	Subject to relay manufacturers' acceptance.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
117.	Section 3.10/ Volume II	5.12.15	171	USB Port	Subject to relay manufacturers' acceptance.	OEM/ Manufacturer's constraints/ recommendation	Bidder to follow specification
118.	Section 3.10/ Volume II Section 3.1/ Volume II	8.0.0 2.a) 8.0.0 4.0 e) 8.0.0 5.0 b) 4.17.0 d)	181 182 183 10	65 kA 1sec above 2500 kVA..... 415V: 65 kA/ 50 kA for 1 Sec	Selection of fault current shall be based on engineering calculation. Owner may please confirm.	Optimization	Bidder to follow specification
119.	Section 3.12/ Volume II	3.2.2	201	The IEMS system shall have dedicated redundant servers, gateways, Ethernet switches, HMI workstation, display units, A4 laser color Multi-function printer, furniture, interconnecting communication cables, fiber optic cables, proven software, etc.	Specification write up describes dedicated network for IEMS, however, Architecture diagram indicates common Ethernet ring between EMS and IEMS. We propose to use dedicated network for EMS. Bidder's proposal may	Selection from options given in tender	Bidder may offer dedicated redundant network or combined network for EMS & IEMS, as per proven practice, which will be firmed up during detail engineering.

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					please be accepted.		
120.	Section 3.12/ Volume II	3.2.6	202	Transducers shall be provided in all the buses so that algebraic summation in electrical system shall be Zero.	Owner may please elaborate the requirement as it is not clear.	Clarification	Transducers shall be provided in all incoming and outgoing feeders such that total incoming current is equal to sum of outgoing currents.
121.	Section 3.12/ Volume II	3.3.0	202	Control from DCS/ Respective control system	As intelligent MCCs are specified, we propose to provide all control/alarm/indication at DCS through soft serial signal. Bidder's proposal may please be accepted.	Ease of engineering/ execution/ procurement	Bidder to follow specification MCC status feedback & commands from DCS shall be hard wired .
122.	Section 3.12/ Volume II	3.1.22 3.3.0	202	Various functions of (IEMS) system Control from DCS/ Respective control system	We understand from specification that except measurement and relay parameterization all other functions of IEMS and DCS are same. Hence, we propose following for the plant: 1. SAS- for GIS. 2. IEMS- for Energy measurement of EHV, HV/MV and LV PMCCs. 3. Plant DCS OR respective PLCs- for control. alarm, indication, measurement and Event recording. HV/MV and LV systems	Clarification	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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					(Relays and Intelligent PMCC/MCCs) will be connected to DCS through data concentrator. Relay parameterization will be done locally through laptop. Our proposal may please be accepted.		
123.	Section 3.13/ Volume II	2.0.0 4.1.0	205 206	SMPS based modular charger Technical requirements	Alternatively Bidder would like to propose conventional IGBT/Thyristor based battery chargers. Owner may please accept.	Alternative proposal	Bidder to follow specification
124.	Section 3.14/ Volume II	2.0.0	214	Lead acid Plante battery	For loads situated at distance, cable sizes becomes so high that those cables cannot be terminated in equipment, even if modification in equipment terminal box. Hence, we propose 1X100% SMF batteries for small and micro UPS used for such loads like CCTV, Admin building etc. with non redundant UPS without static bypass. Bidder's proposal may please be accepted.	Difficulties experienced in past projects.	Bidder to follow specification
125.	Section 3.15/ Volume II	3.0.0	219	CODES AND STANDARDS	IEEE 944 may please also be included in applicable	Information not available in tender	Noted. IEEE 944 can be followed.

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					standards.	document.	
126.	Section 3.15/ Volume II	4.9.0	220	3 Ph 4 Wire	UPS input will be 3 Ph 3 wire in line with Bidder's proposal to use 3 Ph 3 wire distribution. Same may please be accepted.	As per standard practice followed for power projects.	Bidder to follow specification
127.	Section 3.16/ Volume II	3.3.0	230	Fault withstand rating of motor terminal box (Breaker operated): 50 kA for 0.2 sec for 11 kV 415 V system : 50/65 kA	Bidder clarifies that, the terminal Box fault level withstanding capacity is HT Motors - 40kA for 0.2 Sec LT Motors - 50kA for 0.25 Sec and the explosion vent is as per OEM standard. 415 V system : 50 kA	As per standard practice followed by NTPC and other state utilities for power projects.	Bidder to follow specification
128.	Section 3.16/ Volume II	3.8.0	231	For HT and LT motors, it shall be IE3 class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.	May please refer IS12615 clause no. 1.1 . It states that this standard is applicable only for 415V motors and not for HT motors. Hence for HT motors, efficiency shall be as per manufacturers' standard. Kindly accept.	OEM/ Manufacturer's constraints/ recommendation	For HT motors the efficiency shall be over 95%.
129.	Section 3.22/ Volume II	2.0.0	272	Quantity of phones, PA booths	No of IP/Analogue/ cordless phones PA stations etc. will be arrived based on final plot plant and architectural details during detail engineering. Kindly accept.	Clarification.	Bidder to follow specification

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130.	Section 3.23/ Volume II	4.3.0 16.	285 of 353	lux level requirement in cable galleries	We understand that this requirement of illumination is inside cable vaults below switchgear rooms. May please confirm.	Clarification.	Bidder to follow specification
131.	Section 3.23/ Volume II	5.3.7	289 of 353	Receptacle panel shall be provided with 415 V AC, 63 Amp, TPN MCB with ELCB as incomer,6 Nos. 20 Amp, 240 V AC, single pole MCBs for outgoing circuits, Separate neutral at terminal block for each outgoing circuit.	Lighting receptacles can be fed from nearest lighting panel. Hence separate receptacle panel is not envisaged. Bidder's proposal may please be accepted.	As per standard practice followed for power projects.	Bidder to follow specification
132.	Section 3.23/ Volume II	4.1.1 4.2.0	283 284	Tubular Day Lighting system	1) Owner may please convey approved vendors for Tubular Day Lighting system. 2) Owner may please confirm areas/buildings/ floors where tubular day lighting is required. 3) Due to limited vendor availability, bidder suggest to use this lighting in main control room desk area only.	Additional information	200 nos. Tubular Day Lighting system. Bidder to follow specification. Specific details will be worked out during detail engineering.
133.	Section 3.24/ Volume II	5.0.0	300 of 353	Type tests, special tests and acceptance tests shall be carried out on 1 drum selected on random basis, out of every 10 or less number of drums of each type and size of cable of each lot.	Bidder will provide type tests Certificates for Owner's review. Please confirm.	Ease of engineering/ execution/procurement	Bidder to follow specification . Type test certificate for owners review. If not available, then only the bidder have to

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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							carryout the type test as per the standards.
134.	Section 3.28/ Volume II	4.1.31	318 of 353	size of earthing material LT transformers- 75x8mm GS flat LT PCC/MCC/Bus duct- 75x8mm GS flat	Bidder would like to clarify that the size of earthing material shall be designed as per touch & step potential requirement.	As per standard practice followed for power projects.	Bidder to follow specification.
135.	Section 3.28/ Volume II	4.1.3 4.1.9 4.1.31	314 314 317	63 kA 65 kA 40mm	We propose: GIS grid: 63 kA earth fault current Other Plant: 50 kA earth fault current Dia of rod: as per our calculation based on IEEE DDE	Clarification.	Bidder to follow specification
136.	Section 3.29/ Volume II	4.1.0	325 of 353	A clear head room clearance of 1800 mm shall be provided in the cable spreader room.	A clear head room clearance of 1800 mm will not be possible below cable trays. Kindly accept.	Clarification.	Bidder to follow specification
137.	Section 3.29/ Volume II	4.6.0	325 of 353	Cables for the standby drives shall preferably be taken through the alternative route.	This is not practically feasible, hence working and standby drives shall be routed in the same route/tray. Kindly accept.	Optimization	Cables for the standby critical and life saving drives shall be taken through the alternative route and this will be reviewed during DDE.
138.	Section7.0/ Volume II	-	-	Key SLD	Bidder understands that the Key SLD shall be further modified based on	Clarification.	Bidder to follow tender SLD. Any tail end

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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					feasible distribution of loads applicable to the plant layout.		modification based on plant layout will be subject to Owner's approval, during detail engineering.
139.	Vol II /Section - III/ Electrical	4.27.0	123 of 353	GCB: The circuit breakers shall be designed for natural air cooling in general.	We understand as follows: " Type of Cooling: Natural / Forced " Please confirm.	Clarification.	Bidder to follow specification
140.	Vol II /Section - III/ Electrical	8.0.0	130 of 353	Type of Cooling: Natural			
141.	Vol II /Section - III/ Electrical	4.28.0	123 of 353	In place of active cooling (e.g.**forced air cooling),** passive cooling by means of a heat pipe cooling system can be offered, provided the cooling system is proven one and is in successful operation for the past three years.			
142.	Vol II /Section - III/ Electrical	5.19.0	127 of 353	Operating Mechanism a) The circuit-breaker operating mechanism shall be of the stored energy type...	Owner to please note that there is an ambiguity in the clauses. We understand as follows: Operating Mechanism: Spring- spring / Hydraulic -spring Please confirm.	Different manufacturer has different methodology to operate the breaker meeting specification/codal requirement. Since there are only two manufacturers available worldwide, specifying one mechanism will limit the vendor availability.	Operating Mechanism shall be Spring- spring / Hydraulic -spring type
143.	Vol II /Section - III/ Electrical	8.0.0	130 of 353	GCB TECHNICAL PARAMETERS 2 h) Mechanism: **Hydraulic Spring,** 3pole gang operated			
144.	Vol II /Section - III/ Electrical	9.0.0 1 b)	153 of 353	Type of cooling - natural air cooled	Owner may please allow forced cooling for the	This is in line with NTPC specification for various	Forced cooling for the panels rated

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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145.	Vol II /Section - III/ Electrical	5.1.8	137 of 353	The switchgear shall be cooled by natural air flow and forced cooling shall not be accepted.	panels rated above 3000A. This is in line with NTPC Specification for various power projects.	power projects.	above 3000A is acceptable with redundant cooling fans
146.	Vol II /Section - III/ Electrical	9.0.0 1 b)	153 of 353	Type of cooling - natural air cooled	Bidder would like to inform that 11 KV switchgear having 50KA/3 sec fault level with natural cooling is not available. Hence, bidder proposes fault level of 40KA/1 sec as per general practice based on short circuit study of similar rated power project. Owner may please accept.	Clarification.	Bidder to follow specification
147.	Vol II /Section - III/ Electrical	5.1.8	137 of 353	The switchgear shall be cooled by natural air flow and forced cooling shall not be accepted.			
148.	Section 3.1/ Volume II	4.17.0 b)	10	11 kV: 50 kA, 3 Sec			
149.	Vol. II, Section 1.0	11.11.3.4	75 of 191	5) ELECTRICAL SYSTEM	Owner to please clarify whether Illumination loss is to be taken into account or not. If it is to be considered, kindly mention the load duty factor for indoor and outdoor lighting.	Missing information / Clarification	Bidder to follow specification. Plant lighting is included in the auxiliary power consumption. Duty factor to be followed as given in the specification.
150.	Vol. II, Section 1.0	11.11.3.4	75 of 191	5) ELECTRICAL SYSTEM e) e) Losses in Bus ducts (at rated load conditions) • Isolated Phase Bus Duct • Phase segregated busduct	Owner to please clarify whether NSPBD loss is to be taken into account or not.	Missing information / Clarification	Bidder to follow specification. Contractor to list any continuously running equipment for auxiliary power consumption, as mentioned in the specification.

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151.	I / 3.0	32.3.1	17 of 26	As the Project Construction activities cannot be confined to a particular point, the Contractor shall be provided with 33kV HT power supply at one location inside the plant site near boundary for erection works at the rates prevailing at the time of usage on chargeable basis for which the contractor has to make an application with SE/EDC/Thoothukudi **deposit and other connection charges** shall be paid by the contractor.	Owner may please specify connection **charges** to be paid by contractor for availing the 33kV construction power.	Missing information / Clarification	Read the clause 32.3 in full . It is self explanatorily.
152.	II / 1	42	8 of 191	Cable trays, Bolted (Unistrut) type supports, fittings and accessories	Alternatively, bidder would like to propose welded type support. Owner may please confirm acceptance.	Specification does not allow to drill into the structural member. Hence, it would be impossible to use bolted type cable tray support structure.	Bidder to follow specification
153.	II / 1	2.2.0 (b)	19 of 191	External coal handling system: The External Coal Handling system (ECHS) power requirement is about 25 MVA. EPC contractor has to provide 2Nos. of 33kV feeders at Sea Water intake pump house as per Tender SLD drg No. 10-1115112-E-201.	Bidder understand that two number of 33kV feeder up to Sea water PH & 33kV Switchgear shall be provided by bidder. Downstream distribution of 33kV Sea Water PH Switchgear shall be by Owner. Owner may please confirm	Clarification.	Bidder also to refer tender drawing No. 10-1115112-E-229 Single Line Diagram For 33kV HT Switchgear.

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					bidder's understanding.		
154.	II / 6	36	182 of 302	PLCC Name of the manufacturer Model no. Reference standard Type Rating Features provided	As per detail technical specification, there is a requirement of switchyard optical fiber communication system and hence the PLCC mentioned in referred clause is not required and not proposed. Owner may please confirm.	Clarification.	It is confirmed that PLCC is not applicable.
155.	Vol. II, Section 3.10			LV switchgear	Bidder has considered Soot blower contactor panel for soot blower motors located at Boiler area due to low current rating of incomer. The Soot Blower motor is having maximum rating of 1.1KW. As per SB operation, maximum of Two Nos of Soot blower can be operated at a time and load Consumed is 2.2KW maximum. Total incomer rating is only 32A. Kindly accept.	Clarification.	Bidder to follow specification
156.	Vol. II, Section 3.16	3.5.0	230 of 353	All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty	Bidder clarify that motors which are operating continuously throughout the plant operation only will be considered. The equipments which are only operating for small period or fractional horse	Clarification.	Bidder to follow specification
157.	Vol. II, Section 3.16	3.8.0	231 of 353	All the duty motors shall be energy efficient type. For HT and LT motors, it shall be IE3			

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				class as per IS 12615. For VFD controlled HT and LT motors, it shall be IE2 class as per IS 12615.	power motors shall not be covered under IE2 such as follows: a) Soot blower Motors- operates only during soot blowing sequence b) Seal air fan motor for damper sealing operation- operated only during maintenance and motors used for similar application.		
158.	Vol. II, Section 3.16	3.10.0 (c)	231 of 353	The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes.	a) Bidder clarify that Motor shall be capable of running satisfactorily at seventy five (75) percent nominal voltage for one second as Motor OEM standard. b)Bidder clarify that for mill motor , minimum starting voltage shall be 90% due to high starting torque.	Clarification.	Bidder to follow specification
159.	Vol. II, Section 3.16	3.13.0 (c)	231 of 353	The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by at least three seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible. In case the	Bidder clarifies that speed switch requirement will be as per Motor OEM standard. Kindly accept.	Clarification.	Bidder to follow specification

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				speed switch is required,it shall be indicated by the bidder in his offer			
160.	Vol. II, Section 3.16	3.18.0	234 of 353	For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired up to the terminal box. Each bearing shall be provided with dial type thermometer	Bidder clarifies that, 2 Nos duplex RTD will be provided for Each side as per OEM standard	Clarification.	Bidder to follow specification
161.	Vol. II, Section 3.16	3.18.0	234 of 353	Lub oil pressure transmitters shall be provided to DCS for remote monitoring. Lub oil pressure very low trip to HT equipment shall be 2 out of 3 logic.	Bidder clarifies that HT equipment tripping logic will be as per OEM standard. However HT motor, 2 of 3 logic may not be feasible due to space constraint.	Clarification.	Bidder to follow specification
162.	Vol. II, Section 3.16	4.0.0	235 of 353	Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance	Bidder clarifies that, the Starting Current is limited to 300% / OEM standard.	Clarification.	Noted. DC system and associated electrical system shall be designed for the applicable starting current.
163.	Vol. II, Section 3.16	6.0.0	236 of 353	Finish shade shall be 631 of IS: 5 (smoke grey).	Bidder clarifies that for imported motors equivalent shades will be used as per Motor OEM standard.	Clarification.	Final shade equivalent to 631 of IS 6 (smoke grey is acceptable)
164.	Vol. II, Section 3.17	3.15.0	239 of 353	Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply	Bidder clarifies that, the space heater supply is internally derived through the Control Transformer. Hence control supply	Clarification.	Bidder's clarification noted. Space heater for actuator is not required. This is

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					voltage level is applicable for Space Heater.		applicable for only sub zero areas.
165.	Vol. II, Section 3.17	3.17.0	239 of 353	Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature. It shall be designed for remote control from DCS/Respective control system. Required interposing relays for receiving open/close/stop command from DCS/Respective control system shall be provided. Potential free contacts and transducers shall be provided to provide status indication at remote DCS/Respective control system..	Bidder do not provide SMART actuators as per bidder proven practice. Kindly accept.	Clarification.	Bidder to follow specification. SMART type actuators not envisaged.
166.	Vol. II, Section 3.17	3.20.0 & 3.21.0	239 & 240 of 353	The following individual Status annunciation LED's and fault annunciation LED's shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring. • Actuator in local mode • Actuator in remote mode • Actuator running in OPEN direction • Actuator running in CLOSE direction • Actuator in inching mode.	Bidder clarifies that, these signals shall be as per OEM standard to meet operational requirement. Kindly accept.	Clarification.	Bidder to follow specification

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				• Actuator in self-retaining mode • Limit switch OPEN trip • Limit switch CLOSE trip • Control voltage availability The following individual fault annunciation LED's (Colour-Red) shall be provided locally.(Integral to Actuator) Torque switch OPEN • Torque switch CLOSE • Thermo switch trip • Electronic overload relay trip • Motor single phasing • Common fault (Inclusive of any one or combination of above fault)			
167.	Vol. II, Section 3.24	4.7.0	297 of 353	Cables for 415/230 V AC and 220 V DC shall be rated for 1.1 kV grade.	Bidder clarifies that power cables for specific application like Crane, elevator etc., will be as per OEM standard. Kindly accept.	Clarification.	Bidder to follow specification
168.	Vol. II, Section 3.33	3.5.0	352 of 353	The scope of work shall include supply, installation, testing and commissioning of the following items. a) 33 kV overhead line ring main b) Required 33/0.433 kV distribution transformers distributed at various locations	Alternatively, bidder would like to propose 11kV overhead line ring main network by stepping down 33kV voltage through 33/11.5kV Transformers and will further distribute power by 11/0.433kV transformer to various construction area within	Clarification / Optimization	Bidder to follow specification.

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					plant area. Owner may please accept above proposal as the construction power is temporary network.		
169.	Vol. II / Section 3.3	DWG No. 10-1115112-E-202 Rev.0	–	–	The partitioning concept of the gas compartments of the GIS substation plays the vital role for maintaining the service continuity during repair & maintenance of GIS components. IEC 62271-203 provides the detail recommendation in this regard in the Annexure F. Enclosed is a PGCIL gas scheme which represents this recommendations. Two major highlights are: 1. Bay wise gas segregation of the busbar. 2. CB in the separate gas compartment. Same is also described in clause no. 12.2.0 in tender speciation but is not reflecting in the GIS SLD. Inline with this, bidder request to kindly make the necessary changes in the GIS scheme.	Clarification	Bidder to follow specification. Gas segregation shown in GIS SLD is indicative only. Detailed aspects of gas segregation will be firmed up during detail engineering stage.

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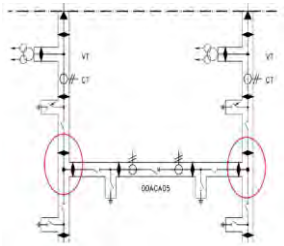
170.	General	DWG No. 10-1115112-E-202 Rev.0	_	Additional earth switch at 'T' point	In GIS schemes, the are not accessible for earthing during maintenance unlike AIS schemes. Hence, same is recommended to be incorporated. Enclosed PGCIL SLD can be referred for arrangement. 	Clarification	Bidder shall provide necessary earthing switches for all "T" points. However these aspects will be firmed up during detailed engineering stage.
171.	II / 3	6.5.0	49 of 353	Isolators shall be fitted with an optical indicator per pole located between pole & driving rod so that open or closed contacts of the isolator are visible from floor level.	Easily visible open & close indications shall be provided on the drives. Also for verification of physical isolation of Isolator contacts, inspection windows of sufficient size are provided. Hence, requirement of optical indicators are not envisaged.	Clarification	Bidder to follow specification.
172.	II / 3	7.3.0	49 of 353	The earth switch shall also comply with the requirements of IEC-601129, in respect of induced current switching duty	The induced current switching duty shall be applicable to the exit Earth switch i.e. FAES which shall	Clarification	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				as defined for Class-B Earth switches.	be of Class-B as required by clause 8.5.0. Maintenance Earth switch shall not subject to induced switching duty of Class-B type.		
173.	II / 3	8.3.0	50 of 353	Fast acting Earth Switches shall be constructionally interlocked with their associated circuit breaker such that the grounding switches cannot be closed if the circuit breakers are closed. The constructional interlocks shall be built in construction of isolator and shall be in addition to the electrical interlocks.	Fast acting Earth switch is electrically interlocked only with associated disconnector along with padlock facility for maintenance purpose. No built in constructional interlock provided.	Clarification	Bidder to follow specification
174.	II / 3	9.1.0	50 of 353	The current transformers shall be of metal enclosed, inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation.	The current transformers should be outside of the SF6 compartment to avoid any degradation of the SF6 insulation due to any problem in CTs, and, easy access and maintainability of the current transformers.	Clarification	Bidder to follow specification
175.	II / 3	11.1.0	51 of 353	For each bay, a separate local control cubicle including gas monitoring kiosk shall be provided which shall be installed in respective bay for local control & monitoring. The LCC shall be equipped with	1. Kindly elaborate requirement of gas monitoring kiosk. Does this mean a 'online gas monitoring system' with local HMI and provision for SCADA	Clarification	Bidder to follow specification

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				suitable hardware & software for remote control operation.	interface for remote monitoring? 2. The offered LCC shall be conventional type as per the standard design and it shall contain no software. If it is referring to BCU then it should be a part of remote CRP Panels.		
176.	II / 3	12.4.0	52 of 353	The enclosure shall be manufactured and tested according to the pressure vessel code.	IEC does not have a pressure vessel code & ANSI is more appropriate for Mechanical equipments. For GIS, the applicable standard is CENELEC standard. Request to confirm.	Clarification	Applicable IEEE / CENELEC code can also be followed.
177.	ANNEX - 1.4 MANDATORY SPARES		129 of 191	GENERAL Quantity of Spares	We understand that the quantity of spares mentioned in the list is common for two units. Please confirm.	Clarification	Bidder understanding is in order
178.	ANNEX - 1.4 MANDATORY SPARES	133 /191		CPU 1) Service & regeneration vessels(for each type & size)	Bidder understands that item no 2 to 9 are to be provided for each type /size of service & regeneration vessel. Further any service vessel & regeneration vessel is not to be provided as mandatory spares. Please confirm bidder's	Clarification	Bidder to follow specification. Service and regeneration vessel shall not be provided as mandatory spares.

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					understanding.		
179.	Volume - II / Section - 3.2 Generator	5.2.1	26 of 353	5.0.0 CONSTRUCTIONAL FEATURES 5.2.0 Generator Auxiliaries 5.2.1 The following monitoring systems shall be provided for the generator. b) Vibration monitoring system comprising six (6) numbers of optical sensor type vibration pickups at each end of overhang portion of the winding, symmetrically located around the periphery with connection to Turbine Supervisory system for vibration monitoring and analysis. Additionally, six numbers optical sensors shall be supplied for future use.	Bidder's proposed generator design envisages advanced stator coil end support system for large capacity water cooled generator is established through research and development and proven by successful operation record. The generator is equipped with large resin cone with sufficient rigidity is used for support of stator coil end which ensures reliable full load operation with smaller coil end vibration. Therefore, Generator coil end winding vibration monitoring system (CEVM) is not included in bidder's scope of supply as per standard and proven design practice.	OEM design specific point	Bidder to follow specification.

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180.	Volume - II / Section - 3.2 Generator	5.2.1	26 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.2.0 Generator Auxiliaries5.2.1 The following monitoring systems shall be provided for the generator…d) Online Partial Discharge (PD) monitoring system permanently connected with independentsensing unit for each generator, along with necessary terminal equipment and software.	d) Bidder's proposed generator winding is tested for partial discharge during shop test. Taking this data as reference, Condition of insulation deterioration can be confirmed by measuring the partial discharge at the maintenance period because insulation deterioration is long-term phenomenon.In addition, Since the stator winding temperatures are measured in the proposed generator, abnormal condition of stator winding insulation can be detected. In view of this, it is not necessary to measure the partial discharge of stator winding during operation.Hence, Generator online partial discharge monitoring (PDM) system is not included in bidder's scope of supply.	OEM design specific point	Bidder to follow specification.
181.	Volume - II / Section - 3.11 CONTROL AND RELAY PANEL FOR GENERATOR AND TRANSFORMERS	4.4.9	189 of 353	4.4.9 Disturbance Recorder (DR)	Bidder's proposed numerical have in-built facility for disturbance and fault recording facility. Hence, it not included in bidder's scope of supply.	OEM design specific point	Bidder to follow specification.

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				Pre Bid Reply			
182.	Volume - II / Section - 3.2 Generator	5.2.4	29 of 353	5.2.4 Stator Water Cooling Systemh) The inlet and outlet lines of mixed bed demineralized shall have conductivity analyzers with LCD digital display and these signals are to be connected to unit DCS.	There is no need for conductivity meters at the inlet of demineralisers. Hence, conductivity meters at outlet of demineraliser shall only be provided. It will be interfaced with Turbine Control System (TCS).	OEM design specific point	Bidder to follow specification.
183.	Volume - II / Section - 3.2 Generator	5.3.12 5.3.13	30 of 353	5.3.0 Generator Excitation System 5.3.12 Pulse transmission & control path to each convertor bridge shall be independent and daisy chain topology is not acceptable. 5.3.13 Built-in provision to perform off-line simulation tests on excitation system shall be provided.	Bidder's standard and proven system shall be provided.	OEM design specific point	Bidder to follow specification.
184.	Volume - II / Section - 3.2 Generator	5.3.19	30 of 353	5.3.19 The rectifier bridges shall have 'N+2' redundancy where N is the number of bridges required to deliver rated excitation current and 'N+1' number of bridges shall deliver the ceiling voltage/current	Bidder's proposed excitation system shall be having N+1 rectifier bridges redundancy where N is the number of bridges required to deliver rated excitation current based on standard design philosophy.	OEM design specific point	Bidder to follow specification.

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185.	Volume - II / Section - 3.2 Generator	5.3.24	31 of 353	5.3.24 PSS shall be adaptive to varying operating conditions with features to compute optimumstabilizing signal along with suitable scheme for identifying external reactance of the generator.	Bidder's proposed static excitation system and AVR shall be provided with PSS of 2A or 2B type.	OEM design specific point	Bidder to follow specification.
186.	Volume - II / Section - 3.2 Generator	5.5.8	33 of 353	5.5.0 Static excitation system 5.5.8 The initial field flashing shall be from the station's 415 V auxiliary AC supply. Suitable rectifier filters, etc. required for converting this AC supply to the required DC supply shall be housed in the excitation system cubicle	Bidder's proposed static excitation system is provided with DC field flashing only as a standard and proven design practice.	OEM design specific point	Bidder to follow specification.
187.	Volume - II / Section - 3.1 General	Annex 3.1.1	18 of 353	ANNEX -3.1.1 : SPECIAL TOOLS & TACKLES FOR ELECTRICAL	Bidder kindly requests owner for provision to allow supply of OEM standard "special tools and tackles" because list of special tools and tackles varies from OEM to OEM based on their design and construction requirement. The list of such special tools and tackles shall be submitted along with technical bid.	OEM design specific point	Bidder to follow specification. In addition "special tools and tackles" as recommended by OEM which are not covered in this specification shall also be supplied.
188.	Volume - II / Section - 3.2 Generator	4.10.0	23 of 353	4.0.0 DESIGN CRITERIA 4.10.0 - In the event of one cooler being out of service, the	Bidder's proposed Generator H2 Gas Cooler is of "sectionalized" design. Therefore, there is	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				generator shall be capable of carrying at least two thirds rated load continuously without exceeding class B temperature limits.	difference in terminology being used by bidder and owner. Bidder's proposed Generator is capable of delivering more than two third of rated MVA **with one gas cooler section** out of service keeping temperature limits of Thermal Class 130 (B). Also, This is inline with clause 4.21 of IEC 60034-3: 2007. Clause 5.1.15 of this section of tender specification mentions "H2 Gas Cooler Section".		
189.	Volume - II / Section - 3.2 Generator	5.1.6	24 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.1.0 Generator5.1.6 Self-aligning type sleeve bearings either mounted on separate pedestals or on the end shields shall be provided.	Bidder's proposed Generator bearing is of "Tilting Pad" Type.Bidder kindly requests owner to allow bidder's standard and proven practice.	OEM design specific point	Noted.
190.	Volume - II / Section - 3.2 Generator	5.1.9, 5.1.10	25 of 353	5.0.0 CONSTRUCTIONAL FEATURES 5.1.0 Generator 5.1.9 For rotor earthing, brush shall be provided. For shaft	<1> Bidder's standard and proven design practice envisages shaft voltage detection for alarm purpose. All necessary	OEM design specific point	Bidder to follow specification

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				voltage monitoring earthing brushes shall be provided at the turbine end bearing pedestal. It should be possible to increase the brush pressure while generator is working. 5.1.10 Shaft voltage monitoring system complete with all software and hardware will be provided as per Manufacturer's proven practice integrating with DCS system. 5.1.12 Earthing brushes shall be provided at the turbine end bearing pedestal. It should be possible to increase the brush pressure while Generator is working.	hardware required for this facility is included in bidder's scope of supply. This is annunciated in "Generator Metering and Transducer panel" (GMTP) being provided as a part of scope of supply under this project by bidder. <2> For generator rotor shaft earthing purpose, copper braid is provided as a standard and proven design practice of bidder. Hence, there is no need for pressure change during generator operation.		
191.	Volume - II / Section - 3.2 Generator	5.1.14	25 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.1.0 Generator5.1.14 Generator drying arrangement complete with all accessories and controls to enable drying out operation of the generator with hot air circulation shall be provided.	Bidder's standard and proven design practice for Generator drying arrangement envisages vacuum pump. This pump is provided as a "Special Tool" as a part of bidder's scope of supply.	OEM design specific point	Noted.
192.	Volume - II / Section - 3.2 Generator	5.1.15	25 of 353	5.0.0 CONSTRUCTIONAL FEATURES 5.1.0 Generator 5.1.15 The following detectors	Bidder's proposed Generator temperature detectors shall be RTD or thermocouple. This shall be	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				shall be provided for the generator. All these remote detectors shall be connected to Unit DCS. Resistance temperature detectors (RTD) shall be shall be provided as stated below, located at points where highest Temperature is likely to occur during operation. ... All the process based interlocks, annunciations and protections for generator & auxiliaries (like seal oil system, stator water system, etc.,) shall be integrated in unit DCS.	based on standard and proven design practice. Also, for remote monitoring purpose, all generator related detectors are connected with Turbine Control System (TCS).		
193.	Volume - II / Section - 3.2 Generator	5.1.15	25 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.1.0 Generator5.1.15 The following detectors shall be provided for the generator. ... • Twenty four (24) numbers duplex RTD uniformly distributed along the circumference of the stator and located at the hottest possible zones. • Twenty four (24) numbers duplex RTD for stator core out of which twelve (12) shall be located in the end zones where maximum temperatures	Bidder's proposed Generator envisages following **duplex** temperature detectors for Generator as a standard and proven design:(a) Stator coil temp. (between top coil and bottom coil)Type: RTD, Number: Twelve (12)(b) Stator core temp.Type: Thermocouple, Number: Six (6), at suitable locations based on bidder's design experience(c) Warm gas temp. (Inlet of gas cooler)Type: RTD, Number:	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				are expected. • Two (2) numbers duplex RTD per H2 gas cooler section for measurement of inlet and outlet gas temperature..... • Two (2) numbers duplex RTD per bearing for measurement of Babbitt metal and drain oil temperature. • One (1) numbers duplex RTD per bearing for measurement of drain oil temperature.	One (1);Cold gas temp. (Outlet of gas cooler)Type: RTD, Number: Three (3) (one (1) of which is for gas temperature control valve)(d) Bearing metal temp.Type: Thermocouple, Number: Two(2)/bearing; Bearing drain oil temp.Type: RTD, Number: One(1)/bearing		
194.	Volume - II / Section - 3.2 Generator	5.1.15	25 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.1.0 Generator5.1.15 The following detectors shall be provided for the generator. ... • One (1) numbers duplex RTD for primary water inlet and three (3) detectors for primary water outlet for stator winding. • Four (4) numbers duplex RTD installed appropriately inside the generator for measurement of cold H2 gas. • Four (4) numbers duplex RTD installed appropriately inside the generator for measurement of hot H2 gas. • One (1) number Temperature indicator per H2 gas cooler section in the pipe lines for measurement of inlet	Bidder's proposed Generator envisages following **duplex** temperature detectors for Generator as a standard and proven design: (a) Stator Cooling Water Inlet and Outlet Temperature (for Main Piping):Type: RTD, Number: One (1) for inlet and One (1) for outlet (b) Requirement for cold & hot H2 gas temperature is already covered in above point (Sr. No. 14). It is being repeated in tender	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				and outlet gas temperature. .• Generator casing temperature indicator with vibration absorbent and temperature element for remote.	specification. (c) One (1) number Temperature indicator per H2 gas cooler section in the pipe lines for measurement of inlet and outlet gas temperature is not provided as bidder's standard and proven design practice. Hence, it is not included in bidder's scope of supply. (d) Generator casing temperature indicator with vibration absorbent and temperature element for remote is not provided as a standard and proven design practice.		
195.	Volume - II / Section - 3.2 Generator	5.2.1	26 of 353	5.0.0 CONSTRUCTIONAL FEATURES 5.2.0 Generator Auxiliaries 5.2.1 The following monitoring systems shall be provided for the generator. .. e) Online harmonic monitor	e) Owner requirement is not clear. Please provide more details. Bidder understands that owner requirement is for multi function meter which has one function of	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				and analyzer.	Harmonic Analyzer. Due to lack of details, Online harmonic monitor and analyzer is not included in bidder's scope of supply.		
196.	Volume - II / Section - 3.2 Generator	5.2.2	26 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.2.0 Generator Auxiliaries5.2.2 Gas Systemh) At standstill, a suitable hot air blowing system complete with blower, heater and thermostatic control etc. shall be provided to prevent condensation during long shut down.	As per bidder's standard and proven practice, dry air with desiccant is used during long shut down. Hence, suitable hot air blowing system complete with blower, heater and thermostatic control etc. is not included in bidder's scope of supply.	OEM design specific point	Bidder to follow specification
197.	Volume - II / Section - 3.2 Generator	5.2.2	27 of 353	5.0.0 CONSTRUCTIONAL FEATURES 5.2.0 Generator Auxiliaries 5.2.2 Gas System Thermal conductivity type gas analyzer (microprocessor based) shall be provided to continuously analyse the gas discharged from the casing during purging and shall also analyse samples of the casing hydrogen during normal operation.	Bidder's proposed Generator H2 Gas analyzer of "Density Type". This is based on standard and proven practice.	OEM design specific point	Thermal conductivity type or density type gas analyzer (microprocessor based) shall be provided to continuously analyze the condition of gases available in the generator.
198.	Volume - II / Section - 3.2 Generator	5.2.2	27 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.2.0 Generator Auxiliaries5.2.2 Gas Systeml) The local control panel shall be	H2-CO2 Gas system can be divided in mainly following sub-systems/units:1. Gas Pressure/Purity Monitoring	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				provided complete with all control, indications, instrumentsetc. and shall be interfaced with DCS for complete operation.	Unit2. Gas Drier3. CO2 Supply unit4. H2 Supply UnitThe mentioned instruments in this clause [5.2.2, (l)] shall be installed either of above mentioned parts of system. There is no single dedicated local control panel for H2-CO2 gas system.Also, alarm and annunciations related to H2-Co2 systems are given on Seal Oil System local control panel.Bidder's proposed generator auxiliary system parameters are interfaced with Turbine Control System (TCS).		
199.	Volume - II / Section - 3.2 Generator	5.2.2	27 of 353	5.0.0 CONSTRUCTIONAL FEATURES5.2.0 Generator Auxiliaries5.2.2 Gas Systemn) Redundant H2 gas pressure transmitters for generator casing pressure shall be provided and shall be connected to Unit DCS.o) H2 gas pressure transmitter shall be provided at the hydrogen gas manifold Also H2 gas pressure transmitter at generator entry level and shall be connected to Unit DCS.	Bidder's proposed Generator-H2-Co2 system is provided with "Gas Pressure-Purity Monitoring Unit". This takes care of Generator internal gas pressure monitoring. The parameter will be sent to Turbine Control System (TCS) for monitoring purpose.	OEM design specific point	Bidder to follow specification
200.	Volume - II /	4.21.15	114 of	4.21.15 Current Transformers	Bidder's proposed current	OEM design specific	Noted.

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				Pre Bid Reply			
	Section - 3.6 BUSDUCT		353	(CTs) a) The current transformers shall be epoxy cast-resin, single core ring type conforming to IS:2705. It shall be mounted within the bus duct enclosure and suitable for operation at an ambient temperature existing within the bus duct enclosure which may be in range of 90 degree C to 100 degree C. Mounting arrangement of CT shall be so designed so as to avoid equalizing connections between live conductor and CT inner surface.	transformers are installed at Generator Terminal Bushings and are of dual-core type.	point	
201.	Volume - II / Section - 3.16 Motors	4.0.0	235 of 353	4.0.0 DC MOTORS...DC Motors shall be sized for operation with fixed resistance starting for reliability.	Bidder's proposed DC motors shall be designed with multi-stage resistance starting facility.	OEM design specific point	Bidder to follow specification
202.	Volume - II / Section - 3.11 CONTROL AND RELAY PANEL FOR GENERATOR AND TRANSFORMERS	4.5.6	190 of 353	4.5.6 The following digital meters of 0.5 class shall be provided in GCP. For Measurement and display of the following parameters on the DCS, Transducers of 0.5 class shall also be provided. All transducers shall be of dual output, Programmable, multifunction type. ...	Bidder's proposed modern digital excitation system does not envisage Auto/Manual Null balance meter. It takes care of auto-manual channel transfer internally which is of "Bump-less" type.	OEM design specific point	Noted.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				• DAVR – Auto / Manual Null Balance Meter			
203.	Volume - II / Section - 3.11 CONTROL AND RELAY PANEL FOR GENERATOR AND TRANSFORMERS	4.4.4	187 of 353	4.4.0 Generator protection 4.4.4 Each set of protection system shall comprise the following protection functions. For each group, separate relay panel shall be provided. Stator Inter-turn Fault Protection (95G)	Stator inter-turn fault protection is not applicable for bidder's generator design since it is single turn stator winding. Other generator protections and control scheme and its principal shall be discussed and mutually agreed during detail engineering.	OEM design specific point	Bidder shall meet the specification requirement . However Stator inter-turn fault protection aspects will be firmed up during detail engineering.
204.	Volume - II / Section - 3.11 CONTROL AND RELAY PANEL FOR GENERATOR AND TRANSFORMERS	4.5.1	189 of 353	4.5.0 Control Panel For Generator4.5.1 The control, monitoring, measurement, annunciation & synchronizing of generator shall be performed at Generator control panel (GCP). These functions shall also be performed from plant DCS system.	Bidder's proposed Generator Control Panel (GCP) is interfaced with Turbine Control System (TCS). Manual synchronization facility is also part of GCP. There is no separate stand-alone synchronization panel.There is limited functionality possible from TCS and plant DCS system other than auto synchronization system.	OEM design specific point	Bidder to follow specification
205.	Volume - II / Section - 3.11 CONTROL AND RELAY PANEL FOR GENERATOR AND	4.5.3	190 of 353	4.5.0 Control Panel For Generator 4.5.3 Generator control panel shall be complete with the following:	Bidder's proposed Generator Control panel (GCP) does not envisage any kind of semaphore indicators or mimic diagram.	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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	TRANSFORMERS			• Semaphore indicators for ON/OFF status indication of all isolators and earth switches of Generator Transformer bay. • Mimic diagram depicting the position of GCB / EHV circuit breakers, isolators and earth switches of Generator transformer bay and tie breaker bay , Generator, UAT, ST and Excitation system etc.	This facility can be implemented on other electrical panel taking care of other electrical controls of the plant.		
206.	Volume - II / Section - 3.2 Generator	5.2.2	27 of 353	5.2.2 Gas Systeml) The local control panel shall be provided complete with all control, indications, instruments etc. and shall be interfaced with DCS for complete operation....All the signals available at Local control panel shall also be available at DCS including the following:o On line dew point indication and alarms form the monitoring systemo On line thermal conductivitym) Zener protection and explosive proof circuits shall be employed in hydrogen gas circuit remote measurements...p) Provision of H2 make up flow meter with	Bidder's proposed H2-Co2 Gas system envisages following with respect to mentioned clause requirement:- H2 gas dew point alarm- thermal conductivity of H2 gas is not measured as per bidder's standard and proven system.- Meaning of Hydrogen gas circuit remote measurements is not clear. Please inform more details regarding the same.- H2, Co2 make up flow meter is not provided because it is not required. Pressure and purity monitoring unit which takes	OEM design specific point	Bidder to follow specification

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				switching logic for CO2 and H2.	care of pressure measurement takes care of this requirement.		
207.	Volume - II / Section - 3.2 Generator	5.2.2	27 of 353	q) During the transportation and storage the machine/stator coil shall be kept under nitrogen atmosphere..	Bidder's standard and proven practice for transportation and storage uses dry air with desiccant. There is no use for nitrogen.	OEM design specific point	Bidder to follow specification
208.	Volume - II / Section - 3.2 Generator	5.2.3	27 of 353	5.2.3 Seal Oil Systemc) 2X100% AC motor driven pumps and 1X100% DC motor driven pump shall be provided.	Bidder's proposed double flow type seal oil system envisages following pumps:Air Side: 2x100% AC motor driven seal oil pump1x100% DC motor driven seal oil pump H2 Side:1x100% AC Motor driven seal oil pump	OEM design specific point	1x100% DC motor driven seal oil pump shall be provided on H2 side also.
209.	Volume - II / Section - 3.2 Generator	5.2.4	28 of 353	5.2.4 Stator Water Cooling System a) Primary water tank mounted suitably on anti-vibration pads. The empty space in primary water tank shall be with vacuum created by vacuum pump or filled with Nitrogen gas.	Bidder's proposed Generator stator coil cooling water system envisages skid mounted primary cooling water tank installed at ground floor. Hence, anti-vibration pads are not applicable. Also, the primary water tank is filled with H2 gas as a standard design.	OEM design specific point	Bidder to follow specification
210.	Volume - II / Section - 3.2	5.2.4	28 of 353	5.2.4 Stator Water Cooling System	Expansion tank is not envisaged in bidder's	OEM design specific point	Bidder to follow specification

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	Generator			b) .... The expansion tank level transmitter shall be of radar type or ultrasonic type. c) The primary water tanks shall be provided with radar type level transmitters to ascertain the water level and low & very low level switches shall also be provided. Level control shall be envisages in DCS.	proposed stator water cooling water system. Also, primary water tank is provided with only level switch for alarm purpose to be interfaced with Turbine Control System.		
211.	Volume - II / Section - 3.2 Generator	5.2.4	29 of 353	5.2.4 Stator Water Cooling Systeme) 2X100% capacity fine wire mesh filters with magnet bars of unlimited life for removal of all magnetic particles.	Bidder's standard design does not envisage filters with magnet bars because provided demineraliser and filters are sufficient for desired quality of primary water.	OEM design specific point	Bidder to follow specification
212.	Volume - II / Section - 3.2 Generator	5.2.4	29 of 353	5.2.4 Stator Water Cooling System k) Stator water flow very low trip (2 out of 3) shall be derived in Unit DCS using the signals from three DP/DP vortex type transmitters. Three independent DP impulse lines shall be drawn from the orifice plate/ Flow sensor with double	Three differential pressure switch is being provided for generator low cooling water flow condition check. It is used for tripping the generator in case of very low differential pressure. This is as per bidder's standard and proven practice.	OEM design specific point	Bidder to follow specification

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				isolation. Local flow indicator shall also be installed for field monitoring. Additionally 100% sensors shall be supplied for future use. q) Set of flow switches (at least two nos.) to monitor low distillate condition and			
213.	Volume - II / Section - 3.2 Generator	5.2.4	29 of 353	m) One online PH meter with local LCD display shall be provided in the stator water line.n) On line conductivity measurement of stator water (Trip through two out of three logic).o) On line stator water flow indicator (Trip through two out of three logic).	Bidder's standard design philosophy does not envisage online pH meter for stator cooling water.Bidder does not recommend and provide trip through online conductivity and water flow measurements.	OEM design specific point	Bidder to follow specification
214.	Volume - II / Section - 3.2 Generator	5.2.4	29 of 353	5.2.4 Stator Water Cooling System q) Set of flow switches (at least two nos.) to monitor low distillate condition and flow transmitters/ meters for primary water to stator winding and main bushing, make up water etc. t) Set of resistance temperature detectors, local indicators for primary water before and after the Generator	Bidder's proposed generator terminal bushings are hydrogen cooled as per bidder's standard design.	OEM design specific point	Bidder to follow specification

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				winding, bushing and cooler.			
215.	Volume - II / Section - 3.2 Generator	5.2.4	29 of 353	5.2.4 Stator Water Cooling Systemr) Dual pressure switch for auto starting of stator water pumps.v) Alkalising unit to maintain PH value of water within acceptable limit.	Dual pressure switch is not required for bidder's proposed stator cooling water system. Hence, not included in bidder's scope of supply.Bidder's proposed stator cooling water system is of neutral pH type. Hence, Alkalizing unit is not required and not included in bidder's scope of supply.	OEM design specific point	Bidder to follow specification
216.	Volume - II / Section - 3.2 Generator	5.3.20	31 of 353	5.3.20 Suitable on line diode monitoring system shall be provided.	Bidder has proposed static excitation system. Hence, all the clause from complete tender with respect to brushless excitation system shall not be applicable.	OEM design specific point	Noted for static excitation system.
217.	Volume - II / Section - 3.2 Generator	5.3.25	31 of 353	5.5.0 Static excitation system 5.3.25 There shall be provision for doing open circuit test and short circuit test with all protection in force and slow excitation from **DCS.**	For proposed Generator AVR and Excitation System, Generator Control Panel is the main controlling point. As a single point operation philosophy, Bidder's static excitation system envisages no controls/monitoring at local excitation panel. Also, from TCS there are very few controls except controls for auto-synchronization.	OEM design specific point	Bidder to follow specification
218.	Volume - II / Section - 3.2	5.5.6	32 of 35333 of	5.5.0 Static excitation system5.5.1 If static excitation	Bidder proposes its proven design which has	OEM design specific point	Bidder to follow specification.

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	Generator		353	system is offered, it shall be of proven design and shall have a satisfactory field service record on machines of similar size and construction incorporating the type of excitation. The excitation system shall have matching characteristics suitable for satisfactoryparallel operation with other generator….Gate Firing Circuit The firing circuit shall have the following essential features :b) It shall be able to shift the gate pulse in the time over a range of about 150 electricaldegrees under a signal from the regulator.	satisfactory field service record.Gate firing circuit shall have gate pulse time range as per bidder's standard and proven design.		
219.	Volume - II / Section - 3.2 Generator	5.5.9	33 of 353	5.5.0 Static excitation system5.5.9 Field breaker shall be of DC, multipole, air break type, suitable for operation from local panel as well as from remote. The breaker shall have arc quenching arrangement for both the main poles as well as the discharge contacts.	Bidder's proposed field breaker is of AC type as a standard and proven design practice.	OEM design specific point	Bidder to follow specification
220.	Volume - II / Section - 3.2 Generator	5.6.0	34 of 353	5.6.0 Digital Automatic Voltage Regulators (DAVR) a) Auto control range: +/- 10% of rated terminal voltage	Since generator operation is limited to +/5% of rated voltage, bidder's proposed digital automatic voltage regulator (D-AVR) shall be	OEM design specific point	Bidder to follow specification

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				in all modes for voltage level adjustments of generator operation	provided with +/5% voltage adjustment.		
221.	Volume - II / Section - 3.2 Generator	5.6.0	34 of 353	5.6.0 Digital Automatic Voltage Regulators (DAVR)5.6.2 Voltage regulator shall have the following technical features.e) A rotor angle limiter to keep the angle between the direct axis of the machine and network vector within the set reference value as determined by stability, by adjusting the excitation.	Rotor angle limiter is being provided as a "Minimum Excitation limiter (MEL)" as a standard design.	OEM design specific point	Noted.
222.	Volume - II / Section - 3.2 Generator	5.6.5	34 to 37 of 353	5.6.0 Digital Automatic Voltage Regulators (DAVR) 5.6.1 Digital automatic voltage regulators shall be of microprocessor based numerical type, **as per manufacturer's standard and** having negligible dead band suitable for a large interconnected.... 5.6.5 The offered DES shall be based on state-of-the-art digital technology. It shall be of continuous....	Please clarify meaning DES. Due to meaning of DES is not clear, all clauses under main clause 5.6.5 where DES mentioned are not referred. Bidder also requests owner to remove repeated requirements which already mentioned in earlier clause of excitation system / AVR. Regarding requirement of clause 5.6.5, bidder's standard and proven system is provided as mentioned earlier mentioned clause.	OEM design specific point	DES refers to Digital excitation system. Bidder to follow specification

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223.	Volume - II / Section - 3.2 Generator	5.6.5	34 to 37 of 353	5.6.0 Digital Automatic Voltage Regulators (DAVR)5.6.5 The offered DES shall be based on state-of-the-art digital technology. It shall be of continuous....	Also, Bidder's standard and proven excitation does not envisage any dedicated HMI system for AVR and Excitation System. AVR /Excitation system is integrated with Generator control panel & Turbine Control System (TCS) for its operations.	OEM design specific point	Bidder to follow specification
224.	Volume - II / Section - 3.2 Generator	6.0.0	40 of 353	6.0.0 TESTS 6.1.0 Equipment offered shall be of type tested and proven type. Type test reports shall be furnished for generator and exciter. 6.2.0 Tests as listed below shall be carried out at works as per applicable standards. Copies of test reports shall be furnished for approval. 6.2.1 Routine tests on each generator 6.2.2 Electrical Tests on DAVR 6.2.3 Tests on excitation system 6.2.4 Type tests for static excitation system 6.2.5 Type test reports shall be submitted for the following:	Bidder's understands that list of all tests mentioned in clause 6.0.0 for generator and excitation system are indicative and bidder's standard and proven quality checks shall be acceptable to owner. However, QAPs shall be discussed and mutually agreed. 17) AC high voltage testing of the field windings after the heat run test, with the rotor revolving at 3000 rpm and also with the stationary rotor: AC HV test is not applicable for revolving rotor. 44) NFT test on stator overhang portion-Meaning of NFT is not clear.	OEM design specific point	Bidder to follow specification

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				6.2.6 Routine tests for static excitation system	Also, These are type tests which are listed in routine test category. 7) No load heat run & short circuit heat run test at rated hydrogen pressure and with one cooler out of service 10) Measurement of Zero sequence & Negative impedance, 12) Equivalent heat runs to determine temperature rises comprising of an open circuit run at 100% of the rated stator voltage followed by a short circuit run at the rated stator current. (110% of rated voltage not applicable), 21) Retardation test, 25) Measurement of –ve phase sequence impedance, 26) Measurement of zero sequence reactance.		
225.	Volume - II / SUB-SECTION 4.9TG INSTRUMENTATION AND CONTROLS	2.3.0	11 & 12 of 22	2.0.0 INSTRUMENTATION REQUIREMENTS2.3.0 Generator Gas System(a) Cubicle for gas system shall include instruments and regulating valves required to fill and empty the generator casing and to monitor the	(a, b, d) H2-CO2 Gas system can be divided in mainly following sub-systems/units:1. Gas Pressure/Purity Monitoring Unit: for maintaining casing H2/CO2 gas pressure2. Gas Drier: for	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				normal operation of the gas system. A suitable regulator shall be provided within the cubicle to maintain the casing gas pressure at the required value and to take care of any leakage within the hydrogen gas system. Instruments including analyzers to check purity for hydrogen /carbon dioxide, H2 and CO2 manifold pressure, moisture content meter, casing gas pressure etc. Necessary signals shall be provided in DCS for monitoring.(b) On line Moisture measurement in Hydrogen shall be provided.(c) Triple temperature sensors shall be provided for generator hot gas outlet temperature high protection.(d) Generator gas drying system shall be operated from central control room in addition to its local operation.(e) It shall be four temperature elements for cold gas temperature measurement	Moisture (Dew point) alarm3. CO2 Supply unit4. H2 Supply UnitThere is no single dedicated local control panel for H2-CO2 gas system.Also, alarm and annunciations related to H2-Co2 systems are given on Seal Oil System local control panel.Bidder's proposed generator auxiliary system parameters are interfaced with Turbine Control System (TCS).(c,e) Regarding Hot and Cold CO2 measurements, refer relevant point in this list (Generator Temperature Detectors)		
226.	Volume - II / SUB-SECTION 4.9TG INSTRUMENTATION AND	2.3.02.4.0	11 & 12 of 22	2.0.0 INSTRUMENTATION REQUIREMENTS2.3.0 Generator Gas SystemControl & monitoring instruments for Generator Gas System shall	Any additional requirement other than tender specification shall be mutually discussed and agreed based on technical	OEM design specific point	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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	CONTROLS			**not be limited to the following:**..2.4.0 Generator Seal Oil SystemGenerator seal oil system shall include the required instruments **not limited to the following:**	requirement on case to case basis.		
227.	Volume - II / SUB-SECTION 4.9 TG INSTRUMENTATION AND CONTROLS	2.3.0 2.4.0	12 of 22	2.0.0 INSTRUMENTATION REQUIREMENTS 2.4.0 Generator Seal Oil System (d) Flow indicators to measure seal oil flow through seals and cooling water flow through oil coolers. (e) Adequate number of liquid detectors at the bottom of the generator tank to detect any liquid leakage. (f) A water detector with sight glass & drain valves shall be mounted adjacent to the gas manifolds at the end of a pipe connected to the bottom of the generator casing. (g) Oil level indicator shall be provided in the different tanks for visual checking of oil level and level switches shall be provided for tank level low, high alarm.	(d) Necessary seal oil pressure indicators are provided threfore, there is no need for seal oil flow indicators. Hence, it is not being provided. (e, f) Meaning of generator tank is not clear. However, necessary Generator water detectors are provided at lowest level of generator casing. (g) There is no tank for the seal oil system. Hence, there is no instrumentation regarding the same is applicable.	OEM design specific point	Bidder to follow specification
228.	Volume - II / SUB-SECTION	2.3.02.4.0	12 of 22	2.0.0 INSTRUMENTATION REQUIREMENTS2.4.0	(h,l) Necessary seal oil system related	OEM design specific point	Bidder to follow specification.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
	4.9TG INSTRUMENTATION AND CONTROLS			Generator Seal Oil Systemh) Redundant seal oil and H2 gas differential pressure remote measurement shall be installed in individual impulse lines and connected to DCS in addition to the local differential pressure gauge. The DM water seal pots shall be provided in these Sealoil/H2 gas DP measurements.(i) The process interlocks, annunciations and protection of seal oil system shall be in Unit DCS.(j) Duplex RTDs at inlet and outlet seal oil coolers, seal oil pressure transmitters at pump level and at the generator level shall be provided in addition to other process requirement.(k) The local panel shall not comprise of any process interlocks and protection.(l) All remote signals shall be directly connected to unit DCS through zener protection/safety barrier via local junction boxes which shall not be limited to the following....	instrumentation is interfaced with Turbine control system (TCS) for monitoring. "The DM water seal pots shall be provided in these Seal oil/H2 gas DP measurements." requirement is not clear.(i, k, l) Bidder's standard and proven design philosophy envisages all generator auxiliaries related process interlocks and control logics implemented in local control panel.(j) Seal oil temperature indicators shall be provided at inlet and out let of seal oil coolers. Necessary pressure indicators are provided at pump level and generator level. Additionally, Differential pressure switch shall be provided for pumps.		
229.	Volume - II / SUB-SECTION 4.9 TG INSTRUMENTATI	2.5.0	13 of 22	2.0.0 INSTRUMENTATION REQUIREMENTS 2.5.0 Generator Stator Cooling System	Requirements related to "Generator Stator Cooling System" of "Volume - II / Section - 3.2 Generator" is	OEM design specific point	Bidder to follow specification.

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	ON AND CONTROLS				repeated in this sub-section of C&I. Hence, relevant clauses of "Generator Stator Cooling System" of "Volume - II / Section - 3.2 Generator" shall be referred.		
230.	Volume - II / Section - 3.2 Generator	6.0.0	40 of 353	6.0.0 TESTS6.1.0 Equipment offered shall be of type tested and proven type. Type test reports shall be furnished for generator and exciter.6.2.0 Tests as listed below shall be carried out at works as per applicable standards. Copies of test reports shall be furnished for approval.6.2.1 Routine tests on each generator6.2.2 Electrical Tests on DAVR6.2.3 Tests on excitation system6.2.4 Type tests for static excitation system6.2.5 Type test reports shall be submitted for the following:6.2.6 Routine tests for static excitation system6.3.0 Tests as listed below shall be carried out at site as per applicable standards. Copies of testreports shall be furnished for approval.6.3.1 Field tests on each generator6.3.2 Field	Bidder's understands that list of all tests mentioned in clause 6.0.0 for generator and excitation system are indicative and bidder's standard and proven quality checks shall be acceptable to owner. However, QAPs shall be discussed and mutually agreed.For all type tests related to static excitation system and AVR , type test certificates shall be provided.Routine tests for static excitation system and AVR shall be subject to vendor's testing facility.Site tests on generator and static excitation system, AVR shall be subject to feasibility at site. All tests mentioned in this specification are not possible at site.	OEM design specific point	Bidder to follow specification

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				Pre Bid Reply			
				tests static excitation system			
231.	Vol. II, Section 2	5.5.0(vii)	20 of 66	For continuous temperature monitoring, minimum nos. of thermocouples as per following shall be provided: a) For super heaters and reheaters elements placed before furnace exit plane (in the direction of gas flow), chromel -alumel thermocouples on at least two elements of every fifth assembly between the two headers shall be provided for tube metal temperature detection out of gas path (in SG casing). b) In addition to the above, adequate number of chromel-alumel thermocouples for measurement of tube metal temperatures outside the gas path shall also be provided. Total number of thermocouples including those at (a) above shall, however, not be less than 2 (two) thermocouples per RH/SH assembly between the two headers.	Bidder has considered provision of metal tube Temperature Thermocouple in super heaters & reheaters as per bidder standards & proven practice for safe & reliable operation of Boiler.		Bidder to follow specification.
232.	Vol. II, Section 2	5.10.0	23 of 66	Heavy fuel oil and High speed diesel oil trip valves and nozzle valves shall be suitable to	TANGEDCO/FI to note that Class VI leakage class is available only with Soft		Bidder to follow specification.

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				handle oils at temperature and pressure required at the burners. Further, these valves shall confirm to ANSI leakage Class-VI under shut off pressure conditions of respective pumps.	seating. In case of metal seating , class V only can be provided. Hence bidder request TANGEDCO/FI to accept class V leakage with metal seating.		
233.	Vol. II, Section 2	5.10.7	26 of 66	The mass flow of the coal powder shall be adjustable with online orifice adjustment using micro wave based flow measurement.	As this is not a proven system in the Indian power plant, the same is not considered by bidder. TANGECO/FI shall accept.		Bidder to follow specification.
234.	Vol. II, Section 2	5.12.2	30 of 66	PA flow measuring devices shall be provided at air inlet to each mill for total air flow measurement and control. • Independent tapping points with necessary isolating valves shall be provided for control, measurement and performance test. • Location, type and design of flow measuring devices shall be subject to Owner's approval.	Bidder have considered the flow measurement as per bidder standard practice as follows: 1. FD/ID/PA fans inlet flow based on Pressure measuring Annular pipes at inlet box opening and inlet cone 2. Mill inlet air flow is as per bidder proven practice based on slant orifice flow measurement.		Bidder to follow the specification
235.	Vol. II, Section 2	5.18.0	41 of 66	The soot blowers shall be capable of selective operation in areas of ash deposition (SMART) type or equivalent.	Bidder clarify that conventional type sootblower is envisaged as SMART type soot blowing system is not yet proven on Indian coal.		Bidder to follow the specification
236.	Vol. II, Section 4.8	1.3.0	5 of 19	Intelligent system deciding the required soot blower operation by considering the temperature measurements of			

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				boiler surfaces is to be provided. Extra thermal sensors if required for optimizing soot blower action shall be provided. Thermal imaging devices (4 Nos. – 1 No. locked on each side of boiler) are to be provided for effective use of water canons. The data from this thermal imaging devices shall also be utilized for effective optimistic operation of Soot blower.			
237.	Vol. II, Section 4.8	1.8.0	8 of 19	System shall include four nos. of Thermal imaging devices with IR Technology to be located on each side of boiler. Thermal imaging cameras with necessary air cooling shall be preferred. This will give temperature profile of the boiler wall. Also the data from thermal imaging camera shall be used for operating water cannons & soot blowers in order to improve the efficiency. The data from this thermal imaging devices giving temperature profile of boiler walls shall also be utilized for effective optimistic operation of Soot blower.			

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238.	Vol. II, Section 4.8	1.3.0	5 of 19	SBC system shall be implemented in the DCS with adequate safety, diagnostic and redundancy. Related hardware shall be segregated in identifiable cabinet/s with no sharing of I/Os with any other Separate and independent hardware shall be provided for soot Blower controls. All the above control system shall be implemented in the DCS.	TANGEDCO/FI to note that intelligent soot blowing system are proprietary to soot blower vendor and soot blower vendor may not agree for providing logics for DCS implementation. Only convention type soot blowing system can be implemented in DCS.		Smart soot blowing system shall be supplied and implementation part shall be discussed during detailed Engineering.
239.	Vol. II, Section 2	5.18.0	42 of 66	All soot blowers shall be capable of convenient remote and local manual operation under emergency conditions. Complete automatic control equipment with cubicles arranged for automatic sequence control, remote control and indication shall be supplied for installation in the control room.	Bidder clarify that local operation is envisaged only during maintenance.		It is clearly stated the provision for Local Operation is required in case of Emergency, viz loss of control from Control Room. Bidder to follow the specification requirement
240.	Vol. II, Section 4.12	1.1.3(a)	4 of 16	a) Flow nozzles will be used for main steam flow, feed-water flow and other critical measurements where weld-in construction is required. Orifice plates will be used for other liquid flow measurements where flanged construction is acceptable.			

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				Accuracy of the measuring orifice plates, nozzles and annubar shall be minimum +-1%. Ultrasonic type flow meter shall be used for cooling water flow application with an accuracy of minimum +-0.4% of measured flow or better and haste alloy C wetted part material to be used if insertion type is provided.			
241.	Vol. II, Section 4.3	5.3.0	8 of 11	Venturi arrangement for PA flow for each pulverizer. Triple impulse lines + one spare impulse line to be provided in HP&LP of venturi arrangement provided for the PA flow of each pulverizer.	Bidder have considered the flow measurement as per bidder standard practice as follows: 1. FD/ID/PA fans inlet flow based on Pressure measuring Annular pipes at inlet box opening and inlet cone 2. Mill inlet air flow is as per bidder proven practice based on slant orifice flow measurement.		Bidder to follow the specification
242.	Vol. II, Section 4.2	1.1.37	10 of 19	Trip Push Buttons, EWLI, Ammeters, chartless recorders (refer cl no.G of Section 4.23), CCTV for Drum Water & Furnace Flame, & min.15 nos. digital display units for Boiler, Turbine & Generator parameters	Bidder clarify that EWLI is not applicable for super critical boiler application.		Requirement of EWLI shall be decided during DDE.
243.	Vol. II, Section	1.1.6	2 of 11	Automatic single push button	Automatic plant startup		Bidder to follow

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	4.3			start facility from the plant DCS to be provided for the main plant equipments such as BMS, BPS, STG, and other DCS controlled systems.	system will as per boiler OEM standard.		the specification requirement
244.	Vol. II, Section 4.3	5.4.0	10 of 11	Continuous level measurement for unit coal bunker and other bunkers of Coal handling system shall be provided with two (2) numbers of radar type level transmitters for each bunkers with IP 65 protection for each bunker level measurement. Bunker level shall be monitored in Travelling tippler floor and CHP control room/ DCS. Radar type level transmitters shall be FMCWR type with drop in antenna and being operated at 24-26GHz.	Bidder request Tangedco /FI to have an option of using 3D type level scanner with single transmitter for Coal bunker level measurement as it is latest technology. The level transmitter will be connected to CHP PLC. The indication will be available at DCS through OPC linking of CHP PLC with DCS.		Redundant transmitters are required for Continuous level measurement for unit coal bunker and other bunkers of Coal handling system as per specification. The type will be discussed during Detailed Engineering. Bunker level monitoring in the travelling tippler floor shall be provided in addition to the indication in the CHP PLC and the DCS.
245.	Vol. II, Section 4.6	2.1.9	4 of 34	Functional grouping of controllers shall be based on the Unit and Common DCS controller grouping drawing 00-1115112-I-351, Sheet 2 - 4. Conceptual drawing shall be referred for the grouping	Controller grouping, logic implementation and its configuration shall be as per Bidder's OEM practices for the safe and reliable operation		The minimum number of redundant controllers envisaged for the DCS shall be followed as per the

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				criteria and the number of controllers envisaged based on the density of I/Os for the plant capacity.			specification to ensure safe and reliable operation
246.	Vol. II, Section 4.7	2.1.9	4 of 34	PLC based systems of same make and same family of hardware shall be provided for all PLCs offered in the plant.	Bidder will try to minimize the different makes however It is not feasible to comply fully with this requirement owing to numerous packages and suppliers involved across the globe.		Bidder to note that the supply of PLC is limited as it is envisaged only for the few BOP packages. Skid mounted PLCs will be the other additional one (if any).In view of this, bidder to provide PLC of same make and same family of hardware as detailed in the specification.
247.	Vol. II, Section 4.8	1.1.0	1 of 19	Burner Management system shall be implemented in the DCS with adequate safety, diagnostic and redundancy with fault tolerant hardware and software. Related hardware shall be segregated in identifiable cabinet/s with no sharing of I/Os with any other system. Triple modular redundant	"Bidder MHPS will provide proprietary control system(Non-SIL3) and dedicated control system for Burner Management (BMS) and Burner Protection System (BPS) inline with the OEM's standard practice which is also proven in several projects.		Noted. The bidder shall ensure that triple modular redundant configuration (TMR) shall be provided for boiler protections. Each of the three independent channels shall have

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				configuration (TMR) shall be provided for boiler protections. Each of the three independent channels shall have its own dedicated processors, controllers, communication controllers, I/O modules, interface etc. All safety related process inputs shall be fed to each of the 3 channels. All the primary sensors for unit/boiler protection shall be triple redundant.The computed signal for each of the trip condition in each channel will be considered for calculated SOE point	BMS/BPS configuration is tested and proven practice which is adopted in MHPS boilers and projects executed by bidder MHIPSMHPS in India and abroad. Redundancy in main processor, I/O modules, Network interface module, communication cable and power supply shall be as per OEM standard practice. BMS/BPS is proprietary system of bidder which standalone system and will be linked to plant DCS through OPC link for monitoring only."		its own dedicated processors , controllers communication controllers , I/O modules , interface etc., All safety related process inputs shall be fed to each of the 3 channels as per specification. In this case, bidder to provide two (2) no 24″ LED type /keyboard operator stations and One (1) no. 24″ LED type/ keyboard Engineering work station with dedicated printers for SG integral controls of each unit at Central control room. OPC link with plant DCS shall be envisaged for monitoring. The signals required for logic and modulating control between
248.	Vol. II, Section 4.8	1.1.0	1 of 19	Control system shall be designed meeting the criteria of highest reliability and maintainability by incorporating fault tolerant hardware and software including redundant power supplies & power modules, redundant controller modules, redundant communication systems and redundant IO modules			

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							DCS and BMS/BPS (vice versa also) shall be hardwired in addition to OPC link.
249.	Vol. II, Section 4.23	B	12 of 65	**C&I Datasheet-**DCS HARDWARE	SG BMS/BPS hardware will be as per Boiler OEM standard which is tested and proven. The same is working successfully in boilers installed in india and abroad.		The bidder shall ensure that triple modular redundant configuration (TMR) shall be provided for boiler protections. Each of the three independent channels shall have its own dedicated processors , controllers communication controllers , I/O modules , interface etc., All safety related process inputs shall be fed to each of the 3 channels as per specification.
250.	Vol. II, Section 4.8	1.1.0	1 of 19	As a minimum, the BMS for each steam generator shall include....., (g) Secondary air damper control supervision	Bidder clarify that SADC controls are implemented in station DCS		Noted
251.	Vol. II, Section 4.8	1.1.0	2 of 19	DCS shall perform all functions that are required for the	BMS system is standalone system which perform all		Noted

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				complete operation of the Burner Management system. This part of the system shall cover all burners / igniters startup and shutdown sequence and Burner / Ignitor control applications and interface with the field devices. BMS shall interface with all the field devices and flame scanners.	functions that are required for the complete operation of the Burner Management system and BMS will be linked with DCS only for monitoring		
252.	Vol. II, Section 4.8	1.5.0	6 of 19	**Furnace Temperature Probe:** Duplex k-type thermocouple with mineral insulation & SS sheath located in furnace below SH panels; minimum of 2 nos.The junction shall be ungrounded with response time of 2 to 5 seconds. Starter box shall be provided with IP55 enclosure & 3 mm thick sheet. Electric motor with chain drive shall be provided for the lance	Bidder clarify that response time of K type thermocouple will be as per OEM standard		Bidder to follow the specification
253.	Vol. II, Section 4.8	1.7.0	6 of 19	**Furnace flame monitoring system:** The complete system shall provide the discrimination between oil and coal flame. Intensity indicators for main flame shall be provided along with galvanically isolated 4-20 Ma DC signals and hooked to	Bidder clarify that flame scanners are as per OEM proven and standard design suiting to BMS/BPS control system supplied by bidder The flame detectors are directly connected to BMS control system supplied by bidder and BMS system		Noted. However the system (PC with 24" monitor) shall be provided for data acquisition/monitoring

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				DCS.	linked to DCS through soft link for monitoring.		
254.	Vol. II, Section 4.8	1.7.0	7 of 19	**Furnace flame monitoring system:** The system shall be provided with one PC (1) with 24″ monitor and A4 color laser printer to acquire the data and store from the flame scanner system through MODBUS/OPC/Other Protocol			
255.	Vol. II, Section 4.8	1.7.0	7 of 19	**Furnace flame monitoring system:** In case of tangentially fired boiler, the Bidder shall arrange flame detectors in such a manner that coal flame detectors are available both above and below each coal burner and separate oil flame detectors are provided for each oil burner. In case Bidder has discriminating type flame detectors capable of detecting and discriminating both oil and coal flame with the help of a single scanner, the same can also be utilized for monitoring both oil and coal flame. For any other type of firing i.e. non-tangential type, the flame detectors shall be provided for each coal and oil burner responding only to the flame of its associated burner. Bidder	Bidder informed that As per OEM's Boiler design, flame detectors shall be provided for each coal burner and oil burner, which will serve the operational requirement.		Noted

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				shall furnish the details of the flame detector locations and justification for the same.			
256.	Vol. II, Section 4.8	1.7.0	8 of 19	**Furnace flame monitoring system:** Approval from FM / TUV / CE / UL / SIL / CSA / ATEX / CENELAC{LW} / other approved agencies.	Bidder clarify that flame scanners are proprietary design of bidder suiting to BMS/BPS design for safe and reliable operation.		Not acceptable. Bidder to follow the specification requirement
257.	Vol. II, Section 4.8	1.8.0	8 of 19	**Furnace and Flame Viewing System:** The minimum nos. of such flame cameras to be included in the proposal shall be selected by the Bidder appropriate to his boiler design subject to minimum of four (4) numbers.	Bidder clarify that as per OEM boiler design, two cameras are provided which is adequate to meet operational requirement.		Not acceptable. Bidder to follow the specification requirement
258.	Vol. II, Section 4.8	1.10.0	9 of 19	**On line carbon in ash analyzer system** The system shall utilize non-sampling or non-extraction type microwave technology for online monitoring/measurement of the un burnt carbon in fly ash with minimum 4 nos. probes measurement to have complete profile per location. The system shall measure a fly ash at a representative location (Locations shall be decided during detailed engineering). In order to maximize the reliability, the	As this is not a proven system in the Indian power plant, the same is not considered by bidder. TANGECO/FI shall accept.		Noted

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				number of moving parts on the sensor shall be minimized. Fly ash samples shall be measured in the bulk fly ash (first hopper row of the precipitator or in an intermediate bunker. The measurement system shall not use any heating elements for the ash or piping. Each ash sample shall be larger than 100g. System shall be a proven one with the installations and operation record for substantiate the credibility.			
259.	Vol. II, Section 4.8	1.12.0	10 of 19	**Secondary air flow measurement (Left & Right)** In addition to the conventional triple DP measurement techniques involving venture /Airfoil for secondary air flow measurement, One number Flow measurement system each on Left side and Right side shall be provided as redundant/checking measurement for secondary air flow which could be used in the optimization package	Bidder have considered the flow measurement as per bidder standard practice as follows: 1. FD/ID/PA fans inlet flow based on Pressure measuring Annular pipes at inlet box opening and inlet cone 2. Mill inlet air flow is as per bidder proven practice based on slant orifice flow measurement.		The requirement envisaged as per the specification holds good. Bidder to follow the specification
260.	Vol. II, Section 4.8	2.1.0	11 of 19	**INSTRUMENTATION REQUIREMENTS** Minimum redundancy	Redundancy is considered as per bidder proven design		Not acceptable. Bidder to follow the specification

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				requirement (2 out of 3) of measurements and controls are given below.			requirement considering the criticality of these measurements
261.	Vol. II, Section 4.8	2.2.1	12 of 19	**ID Fan**Induced draft fan control shall be either axial flow type with inlet vane control or of variable voltage & variable frequency type additionally with damper control. The drive electronics shall be 2 X 100% redundant with manual/automatic fall back on diagnostic failure and monitoring features for speed and current.	Bidder clarify that FD/ID/PA fan are considered with blade pitch control and instruments are provided as per Fan OEM proven practice		Bidder to follow the specification for the Instruments requirement
262.	Vol. II, Section 4.8	2.2.2	12 of 19	**FD Fan** Forced draft fan control shall be either axial flow type with inlet vane control or of variable voltage & variable frequency type additionally with damper control. The drive electronics shall be 2 X 100% redundant with manual/automatic fall back on diagnostic failure and monitoring features for speed and current. The			
263.	Vol. II, Section 4.8	2.2.3	13 of 19	**PA Fan** Primary air fans shall be provided with Inlet pitch control vanes complete with actuator, converter and			

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				position transmitter for control of air flow through mills.			
264.	Vol. II, Section 4.8	2.2.6	14 of 19	**Boiler Circulating Water Pumps:** Pump & motor bearing vibration in X-Y direction with key phasor (if the BCW pump are HT drive).	Vibration sensor measurement is not feasible in vertical mounted BCP with wet type motor construction		Vibration measurements shall be provided for the Motor (DE & NDE) and the pump DE
265.	Vol. II, Section 4.8	2.3.0	14 of 19	Function Description of Auto loops	Bidder confirm that Auto loops will be as per bidder's proven practice.		The functional requirement of all the control loops as envisaged in the specification to be followed in totality
266.	Vol. II, Section 4.12	1.1.0(t)	1 of 16	Wireless transmitters : For CW sump level, Raw water reservoir level, Turbine oil tank, coal bunkers, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only non contact type level transmitters like Ultrasonic or Radar based shall be provided by the bidders as per the specification and as approved by owner. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling from smart level	Bidder has considered 3D type level scanner with single transmitter for coal bunker level measurement.		The bidder to follow specifications. Implementation part for other applications will be decided during detailed engineering as indicated in the specification .

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				transmitters as specified above. And for other applications, if any shall be decided during Detailed Engineering. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner.			
267.	Vol. II, Section 4.12	1.1.11(e)	3 of 16	Differential pressure transmitters will be supplied with integral mounted three valvemanifolds for air service and 5 way valve manifold for steam & water service. Forpressure and differential pressure transmitters, overall Accuracy: + 0.04% or better ofFSR for BTG package & + 0.065% or better of FSR for BOP packages. Accuracy shallbe + 0.2% for remote seal type transmitter.	Bidder clarify that accuracy requirement will be followed for all general application. For draft pressure range transmitters , accuracy will be as per market availability.		Bidder to follow the specification requirement
268.	Vol. II, Section 4.23	E- A.	18 of 65	**C&I Datasheet-** Pressure Transmitter-			
269.	Vol. II, Section 4.23	E- B.	19 of 65	**C&I Datasheet-** Differential Pressure Transmitter-			
270.	Vol. II, Section 4.12	1.1.11(g)	3 of 16	Dual type control switches such as pressure switches	Bidder clarify that bidder is using transmitters in place		Bidder to follow the specification

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				having two sets of contacts with independently adjustable set points shall not be used where set point adjustment and deadband are a problem (e.g. low pressure and vacuum applications). If a potential problem exists, two single purpose switches shall be used. Switch differential shall be adjustable.	of switches for better reliability.		requirement
271.	Vol. II, Section 4.12	1.1.11(j)	3 of 16	All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not be terminated inside the switch. Cable ends are to be soldered in connector and to be inserted for easy maintenance.	Bidder clarify that screw type terminals are better than amphenol male/female connection for easy maintenance as soldering facility may not be available through out the boiler area.		Bidder to follow the specification requirement
272.	Vol. II, Section 4.12	1.1.2(a)	3 of 16	Thermocouples shall be manufactured in accordance with the ISA Standard MC96.1, Temperature Measurement Thermocouples. All thermocouples shall be Chromel Alumel (Type K) for 300°C< T <850°C. R or S type for T> 850°C.	Bidder clarify that K type thermocouple is used for supercritical boiler as per bidder standard practice.		Noted.
273.	Vol. II, Section 4.23	E- IV-1.	31 of 65	**Thermocouple:** a) Type-T (Copper Constantan) or Type-K (Chromel Alumel) [As per			

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				specification requirement			
274.	Vol. II, Section 4.12	1.1.2(b)	4 of 16	The Mv signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS	TANGEDCO/FI shall clarify contradiction between clauses b&e and (g). (b&e) specifies direct connection to DCS and (g) specifies use of SMART type temp transmitters		Cl.1.1.2 (g) specifies the requirement of temperature transmitters (TT) for the CLCS. TT used for the thermocouple shall have the in built cold junction compensation. And Cl 1.1.2 (b) specifies the temperature measurements used for monitoring
275.	Vol. II, Section 4.12	1.1.2(e)	4 of 16	RTDs shall be directly connected to DCS without any transmitters			
276.	Vol. II, Section 4.12	1.1.2(g)	4 of 16	Temperature transmitters of SMART type are to be provided for all temperature measurements that are used in any CLCS. For thermocouple, cold junction compensation shall be implemented within the transmitter.			
277.	Vol. II, Section 4.12	1.1.4(f)	6 of 16	Electronic level indicator of discrete type based on electric conductivity of water andsteam with 50mm gap between successive electrodes in the measuring range shall be provided in addition to level transmitter. The vessel holding electrodes shall be IBR certified.	Bidder clarify that electronic level indicator is not required as per bidder proven practice.		Noted. For the boiler drum only being super critical.
278.	Vol. II, Section 4.12	1.1.5(o)	7 of 16	All the control valve shall be provided with block and bypass valves. The bypass valves shall be automatic inching valve for critical	Bidder clarify that usage of inching valves are not feasible as manual control is not possible as supercritical boiler controls		The bypass valve of inching type shall be used for the isolation purpose. Control valve shall

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				applications only.	are fully automated and highly dynamic controls.		be used for the auto controls. Bidder to follow the specification
279.	Vol. II, Section 4.12	1.1.5(v)	8 of 16	For fuel gas applications the valve leakage class shall be minimum class VI.	Bidder clarify that leakage class VI may not be feasible for valves with metal seating.		Bidder to follow the specification requirement
280.	Vol. II, Section 4.12	1.1.18	13 of 16	The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters. The Positioners/ E/P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters.	TANGEDCO/FI shall clarify this clause specifies requirement of I/P converters under position transmitter.		Being a combined heading for the SMART positioned /position transmitter, the content is included here. This clause is also applicable for I to P converters used to operate the SADC dampers and for any other I to P converters used in the process.
281.	Vol. II, Section 4.12	2.4.0	1 of 13	The following Analyzers to be considered per unit on Flue gas path, a)Air pre heater inlet CO (Insitu) -3Nos b)Economizer outlet (or) Air pre heater inlet O2 (Insitu) - 3Nos c) Air pre heater outlet O2 (Insitu)- 2Nos	Flue gas analysers are considered as per bidder standard and proven practice. Three O2 analysers are considered at Eco outlet in each stream for combustion control.		Bidder to follow the specification requirement

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				d)ESP Outlet or each ID fan suction O2 (Insitu) - 2Nos e)High temperature locations Heater less O2 -3Nos			
282.	Vol. II, Section 4.12	2.6.0	1 of 13	O2 analyzers shall be direct insertion 'insitu' type with an accuracy of ± 1.0% of reading or better, repeatability of ± 0.5% of full scale, response time of better than 10 sec for 90%, Drift shall not be more than 0.1% O2 per week, auto and manual calibration having zirconium probe as sensing element,	Bidder clarify that response time of analyzer will be as per market availability.		Bidder to follow the specification requirement
283.	Vol. II, Section 4.12	2.6.0	2 of 13	**Carbon Monoxide Analyzer** CO analyzer shall be of infrared absorption technique 'insitu' type system with an accuracy of ± 2% of measured value or better, repeatability of ± 2% of full scale, response time of better than 5 sec for 90%, Drift shall not be more than 2% per month and having features like auto zero & span calibration, auto temperature compensation etc, IP 65 or equivalent degree of protection for enclosure.	Bidder clarify that response time of analyzer will be as per market availability.		Bidder to follow the specification requirement
284.	Vol. II, Section 4.21	1.3.0	2 of 8	Impulse pipes for high pressure applications shall be	Bidder clarify that as per bidder proven practice ,		Bidder to follow the specification

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				used with material and rating as same as that of the process line. Size and thickness of piping/tubing shall be suitable for the design pressure and temperature conditions as per ANSI16.11.	Bidder uses SS304H pipe for high pressure/temp. application and SS304 for other application. The IBR certification is not required for SS fittings		requirement
285.	Vol. II, Section 4.23	E- IV-1.	31 of 65	**Thermocouple:** Response time : a) Less than 2 to 6 seconds. . b) Less than 10 seconds for control.	Bidder clarify that the response time of thermocouple will be as per guidelines given in ASME PTC 19.3		Bidder to follow the specification requirement
286.	Vol. II, Section 4.23	E- IV-1.	31 of 65	**Thermocouple:** Wire gauge - 16 AWG	The cross section of metal temperature Thermocouples used for boiler Metal thermocouple will be K type with dia of 22 AWG, since the dia of thermocouple is less than 5mm to suit the application requirement		Noted
287.	Vol. II, Section 4.23	E- IV-2.	32 of 65	**Resistance Temperature Detector:** Response time :1 to 2 seconds. .	Bidder clarify that the response time of thermocouple will be as per guidelines given in ASME PTC 19.3		Bidder to follow the specification requirement
288.	Vol. II, Section 4.23	E- 16	54 of 65	Instrument Manifolds Technical Particulars 01. Type : a) Two valve manifold b) Five valve manifold 02 Mounting : Remote 2″ Pipe Mounting	For high pressure applications In main steam & HRH line , bidder recommend use of fabricated manifold instead of single block due to leakage problem in high		Bidder to follow the specification requirement

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				03. Construction : Single block (bar stock) 04. Material : Forged body and bonnet AISI 316 stainless steel 05. Ports : 1/2 " NPT (F) 06. Rating : 420 Kg/Sq. cm at ambient	pressure applications.		
289.	Vol.-II, Section 4, Sub-section-4.2 & Vol.-II, Section 4, Sub-section-4.5	1.1.6 & 1.4.0	3 to 8 of 19 & 3 to 5 of 11	DCS Remote I/O based Control Systems have been specified for : -coal handling system -ash handling system -desalination/WTP -sea water intake -effluent and sewage treatment plant -mill reject handling system -fuel oil system -water and waste water treatment plants (DM Plant, condensate polishing, chlorination plant, etc.)	Bidder proposes to offer the PLC based controls system for below mentioned offsite packages instead of having DCS remote I/Os/DCS as per package vendor standard & proven practice. Offsite packages are: 1. Coal handling system 2. Ash handling system 3. Water intake system, DM plant, pretreatment plant, ETP plant, Chlorination system, 4. Condensate polishing plant 5. Condenser tube cleaning system 6. condenser vacuum system 7. Compressed air system 8. Mill reject system 9. Fire protection system etc. Moreover these systems		Not acceptable. As per the specification, the BOP system shall be of the similar hardware family of plant DCS. Bidder to follow the specification requirement

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					does not need the high end microprocessor based control system as compared to DCS. Also the approved package vendors have proven control system integrated to their process. Please confirm if it is acceptable.		
290.	Vol.-II, Section 4, Sub-section-4.2	1.1.0	1 of 19	The following I&C systems shall be supplied, installed, commissioned and tested for successful and satisfactory operation of the proposed thermal power project. The proposed system shall be in successful trouble free operation for at least 3 years as on bid date opening in plant capacity of 500MW or more having pulverized coal facility	Owner is requested to modify this clause as " The following I&C systems shall be supplied, installed, commissioned and tested for successful and satisfactory operation of the proposed thermal power project. The proposed system shall be in successful trouble free operation for at least 1 year as on bid date opening in plant capacity of 500MW or more having pulverized coal facility".		Bidder to follow the specification requirement
291.	Vol.-II, Section 4, Sub-section-4.2 & Vol.-II, Section 4, Sub-section-4.5	1.1.1 & 1.1.2 & 1.3.0 & 1.4.0	1 of 19	In which case Two (2) no 24" LED type /keyboard operator stations and One (1) no. 24" LED type/keyboard Engineering work station with dedicated printers for SG integral controls of each unit	As per the plant control system configuration drawing no. 00-1115112-I-351, sheet 1 of 4, note no. 5, we understand that 2 nos. of OWS and 1 no. EWS for SG and TG systems		Confirmed that 2 nos. of OWS and 1 no. EWS for SG control system and 2 nos. of OWS and 1no. EWS for TG control systems

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				shall be provided at Central control room connected to the proprietary control system. & In which case Two (2) no 24" LED type /keyboard operator stations and One (1) no. 24" LED type/keyboard Engineering work station with dedicated printers for TG integral controls of each unit shall be provided at Central control room connected to the proprietary control system	shall be provided only if the SG and TG control systems are not of same family as of plant DCS. Please confirm whether bidder's understanding is correct.		shall be provided only if the SG and TG systems are not of same family as of plant DCS as per specification.
292.	Vol.-II, Section 4, Sub-section-4.2	1.1.6. s)	3 of 19	Plant wide office LAN comprising of 450 users at various location of plant and installation of 300 PCs with 21" LED display units, keyboard/ mouse etc., in the network.	The details of the said clause number are not specified in the control configuration drawing, we understand the PCs, LAN are independent of the plant DCS network. Please confirm the understanding.		Noted
293.	Vol.-II, Section 4, Sub-section-4.2 & Vol.-II, Section 4, Sub-section-4.5	1.1.11 & 1.4.0 d)	5 of 19 & 3 of 11	Instrument and service air compressors and driers shall be controlled and monitored from the Central control room & local control room, through the DCS Remote I/Os, Redundant processor, power supply, communication module, redundant communication link all hardware, software and other	Bidder proposes to provide proprietary microprocessor based control system for IA/SA which shall further be hardwired interfaced/connected with plant DCS for control and monitoring. Please confirm if it is acceptable.		Confirmed. As per the clause the operator station shall be provided.

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				interfaces envisaged to control and monitor it. Remote operation is envisaged from the Central control room. & Compressed air system- Proprietary microprocessor based control system/DCS.			
294.	Vol.-II, Section 4, Sub-section-4.2 & Vol.-II, Section 4, Sub-section-4.5	1.1.12 & 1.4.0 d)	6 of 19 & 4 of 11	AC and ventilation system shall be controlled and monitored from the AC and ventilation system local control room, through the DCS remote I/Os, Redundant Processor, power supply, communication module, redundant communication link ,all hardware, software, other interfaces, cables and field sensors/instruments/erection hardware envisaged to control and monitor it. & HVAC system- i) Controlled from PLC with soft link connectivity to plant DCS CCR. ii) Relay based Local Control panel/manufacture's skid mounted systems shall be provided.	Bidder propose to provide PLC / Relay based control system for HVAC control in-line to the Sub-section 4.5 specification. Please confirm if it is acceptable.		Bidder shall provide PLC based control system of same make and family of hardware of other BOPs for HVAC for HVAC
295.	Vol.-II, Section 4,	1.1.18&1.4.	7 of 19 &	Hydrogen generation system	Hydrogen generation plant		Bidder shall provide

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	Sub-section-4.2&Vol.-II, Section 4, Sub-section-4.5	0 d)	4 of 11	shall be controlled and monitored from the Hydrogen generation system local control room, through the DCS remote I/Os, Redundant Processor, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors/instruments/erection hardware envisaged to control and monitor it.&Hydrogen Generation plant-Controlledfrom PLC with soft link connectivity to plant DCS	shall be provided with PLC / Relay based control system as per OEM standard practice as specified in the plant control system configuration drawing.		PLC based control system of same make and family of hardware of other BOPs for Hydrogen generation plant
296.	Vol.-II, Section 4, Sub-section-4.2 & Vol.-II, Section 4, Sub-section-4.5	1.1.20 & 1.4.0 d)	7 of 19 & 4 of 11	Electro chlorination system shall be controlled and monitored from the Electro chlorination system local control room, through the DCS remote I/Os, Redundant Processor, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors / instruments / erection hardware envisaged to control and monitor it. & Electro Chlorination system-	Electro Chlorination system shall be provided with PLC based control system as specified in the plant control system configuration drawing.		Bidder shall provide PLC based control system of same make and family of hardware of other BOPs for ECP

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				Controlled from PLC with soft link connectivity to plant DCS			
297.	Vol.-II, Section 4, Sub-section-4.2	1.1.22	8 of 19	Operation of all the sump pumps will be controlled from the DCS. Sump pump shall be connected functionally with the RIO located at different areas of the plant.	Sumps pumps are generally provided with local starter cum control panel for local operation. Hardwired interface for monitoring in the DCS shall be envisaged. Please confirm.		Bidder to follow the specification requirement
298.	Vol.-II, Section 4, Sub-section-4.2	1.1.37 & 2.15	10 of 19 & 16 of 19	For automatic refresh features for viewing Web based Plant information extending option for additional 25 viewers shall be provided. & For automatic refresh features for viewing Web based Plant information extending option for additional 50 viewers shall be provided.	Owner is requested to clarify the number of additional viewers for web based plant information system at owner's corporate office.		Cl 2.15 shall be referred and the additional viewers for web based plant information system shall be fifty (50).
299.	Vol.-II, Section 4, Sub-section-4.6	2.8.1	14 of 34	Interrogation voltage for digital cards shall not be grouped and provided for each individual channels.	Interrogation wiring arrangement for digital cards shall be as per the standard design of the DCS supplier. Owner is requested to kindly consider the same as this application shall be totally vendor/DCS OEM dependent requirement.		The specification requirement shall be specified to the vendor/ DCS OEM which is to be followed
300.	Vol.-II, Section 4,	2.0.0	1 of 1	PLC based systems of same	Make/model of the PLC for		Bidder to note that

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	Sub-section-4.7			make and same family of hardware shall be provided for all PLCs offered in the plant.	systems like hydrogen generation system etc. shall be as per the OEM standard proven design.		the supply of PLC is limited as it is envisaged only for the few BOP packages. Skid mounted PLCs will be the other additional one (if any).In view of this, bidder to provide PLC of same make and same family of hardware as detailed in the specification.
301.	Vol.-II, Section 4, Sub-section-4.11	1.4.0	4 of 5	Signals used for HW Annunciation shall not be multiplied/ diode auctioneered, it shall be thru control system's digital output only.	However as per the clause no. 1.1.0 c), at page number 1 of 5 of same sub-section, it is mentioned that the HW annunciation system shall be driven by Digital output channels or diode auctioning of input signals. Owner to please confirm that the diode auctioning of input signals is acceptable for hardwired annunciation signals from DCS.		Requirement shall be as per Cl 1.4.0
302.	Vol.-II, Section 4,	1.1.2 g)	1 of 19	Temperature transmitters of	Temperature transmitters		Bidder to follow the

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	Sub-section-4.12			SMART type are to be provided for all temperature measurements that are used in any CLCS.	may not be provided wherever OEM standard practice in general does not allow for using temperature transmitters. In such cases temperature elements (RTD/TC) shall be wired to control system without using transmitters.		specification requirement
303.	Vol.-II, Section 4, Sub-section-4.18	4.3.0	4 of 13	It is the sole responsibility of the Vendor to obtain the necessary approval. Owner has no liability towards the same.	1) We understand that Location for installation of AAQMS (four Nos. AAQMS stations) shall be informed by purchaser. 2) Statutory clearance for AAQMS shall be obtained by owner.		1) Confirmed 2) Approval from Central & State regulatory agencies like, MOEF, Central & State Pollution Control Boards (PCBs) etc. or of US EPA for the system supplied shall be obtained by the bidder.
304.	Vol.-II, Section 4, Sub-section-4.21	1.1.0	1 of 8	Panels and control desk shall be freestanding type and fabricated preferably from 2.5 mm thick cold rolled steel sheet.	Panels and control desk shall be freestanding type and fabricated preferably from 2.0 mm thick cold rolled steel sheet. Owner to please consider the same.		Bidder to follow the specification requirement

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305.	Vol. II, Section 2 SUB-SECTION - 2.2	3.1.0	Page : 3 of 27	Turbine preservation system consisting of adequate numbers of air driers including, fans, motors, filters, heater drying wheel, connecting piping's, valves, fittings etc. for preservation against corrosion of turbine during idle periods shall be provided. Write-up on the recommended system to be furnished. Bidder to elaborate the alternate preservation procedure recommended for turbine corrosion protection during long outage of plant in his bid.	Turbine preservation system is not provided as a standard design practice of OEM.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification.
306.	Vol. II, Section 2 SUB-SECTION - 2.2	5.1.0	Page : 16 of 27	Turbine preservation system consisting of adequate numbers of air driers including, fans, motors, filters, heater drying wheel, connecting pipings, valves, fittings etc. for preservation against corrosion of turbine during idle periods shall be provided. Write-up on the recommended system to be furnished.			
307.	Vol. II, Section 2 SUB-SECTION - 2.2	5.1.0	Page : 12 of 27	c) Local temperature indicators in each bearing lube oil drains along with RTDs for remote indication and annunciation.	Thermocouples are provided on each bearing oil drain line for temperature measurement.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification.

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308.	Vol. II, Section 2 SUB-SECTION - 2.2	5.1.0	Page : 13 of 27	Each valve shall be provided with two sets of limit switches for both open and close position with two changeover contacts.	One set of limit switches is provided as per bidder's standard practice.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification.
309.	Vol. II, Section 2 SUB-SECTION - 2.2	5.1.0	Page : 15 of 27	**Gland sealing system Steam turbine and BFP turbine** Suitable arrangement shall be provided to bypass gland steam condenser (designed to operate under vacuum condition also) alongwith desuperheating arrangement, if required, for the bypass to prevent unit tripping when gland steam condenser is not in operation The exhaust shall be discharged above the TG hall roof level. The gland steam condenser shall be provided with bypass on water side also.	Since stainless tubes are used in gland steam condenser, no tube leakage is envisaged. Hence, gland steam bypass is not provided as per the bidder's practice.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification.
310.	Vol. II, Section 2 SUB-SECTION - 2.2	5.1.0	Page : 16 of 27	Necessary equipment shall be provided for forced cooling of turbine during emergency condition for quick access.	Forced Cooling system is not provided as a standard design practice of OEM.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification.
311.	Vol. II, Section 2 SUB-SECTION - 2.2	5.4.0	Page : 19 of 27	A differential pressure gauge and differential pressure switches with alarm shall be provided on both filters.	A common differential Pressure Transmitter is provided across the inlet and outlet of oil filter.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification.

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312.	Vol. II, Section 1.0 General Technical Specification	7.1.0	Page : 38 of 191	The life span to be considered for the design of equipment and component selection shall be at least 40 years.	The life span to be considered for the design of equipment and component selection will be 25 years.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification
313.	Vol. II, Section 1.0 General Technical Specification	7.3.0	Page : 42 of 191	ii) The steam flow through steam turbine under valves wide open (VWO) condition shall correspond to 105% of steam flow corresponding to MCR output.	Bidder will follow Vol. II, Section 2 2.2 Steam Turbine & Aux. System, ANNEX 2.2.1 VWO definition. i.e. VWO = 105% of TMCR load	Please refer to our Statement of clarification sought explanation	Bidder shall follow Vol. II, Section 2 2.2 Steam Turbine & Aux. System, ANNEX 2.2.1
314.	Vol. II, Section 2 2.2 Steam Turbine & Aux. System	ANNEX 2.2.1	Page : 27 of 27	Maximum generation during valve wide (VWO) condition (with continuous operation capability): MW: Minimum 5% over TMCR output			
315.	Vol. II, Section 1.0 General Technical Specification	7.3.0	Page : 42 of 191	iii) The unit shall be designed for constant pressure and sliding pressure operation. The unit shall be designed to operate at constant pressure from zero to 40% rated load, sliding pressure mode from 40% to rated load.	As per Vol. II, Section 1.0 General Technical Specification, clause no. 7.3.0, the unit will be designed to operate at constant pressure from zero to 40% rated load, sliding pressure mode from 40% to rated load. Also, from rated load to 105% of rated load it will be constant pressure mode.	Please refer to our Statement of clarification sought explanation	Noted.
316.	Vol. II, Section 2 2.2 Steam Turbine & Aux. System	4.0.0	Page : 7 of 27	During sliding pressure mode, throttle pressure shall slide from 100% to 40% of rated pressure corresponding to 30% load.			
317.	Vol. II, Section 1.0 General Technical Specification	7.5.0	Page : 43 of 191	(b) Noise level for the continuously operating equipment shall not be more than 85 dBA at a distance of 1	Procedure of noise measurement will be in accordance with ASME PTC-36 or ISO 3746. Noise level	Please refer to our Statement of clarification sought explanation	Bidder to follow specification

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				metre and at a height of 1.5 metre from any equipment.	except for back ground noise will not exceed 90 dB(A) at 1.0 meters horizontal distance from the equipment, and at 1.5 meters above operating floor and the floor on which the equipment is mounted during normal running of the equipment.		
318.	Vol. II, Section 1.0 General Technical Specification	11.5.1	Page : 66 of 191	The measurement shall be carried out with a calibrated integrated sound level meter meeting the requirement of IEC 651 or BS 5969 or IS 9779. Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/machine and at a height of 1.5 m above the floor level in elevation. A minimum of 6 points around each equipment shall be covered for measurement. Additional measurement points shall be considered based on the applicable standards and the size of the equipment. The measurement shall be done with slow response on the A-weighing scale. The average of A-weighted sound pressure level measurements expressed in decibels to a reference of 0.0002 micro bar shall not exceed 85 dBA.			

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
319.	Vol. II, Section 1.0 General Technical Specification	11.11.5.1	Page : 76 of 191	Sound pressure shall be measured all around the equipment at a distance of 1.0 m horizontally from the nearest surface of any equipment/ machine and at a height of 1.5 m above the floor level in elevation.....Corrections for background noise shall be considered in line with the applicable standards.			
320.	Vol. II, Section 1.0 General Technical Specification	11.7.0	Page : 67 of 191	Test Uncertainties The guaranteed performance parameters shall be without any tolerance values and all margins required for instrument inaccuracies and other uncertainties shall be deemed to have been included in the guaranteed figures.	Measurement uncertainty shall be considered as a test tolerance. Measurement uncertainty will be calculated based on ASME PTC-6 report-1985 "guidance for evaluation of measurement uncertainty in performance tests of steam turbine".	Please refer to our Statement of clarification sought explanation	Bidder to follow specification
321.	Vol. II, Section 1.0 General Technical Specification	11.10.0	Page : 67 of 191	All the instruments shall be calibrated by a certified body before and after the tests Instruments need to be calibrated before and after the test to identify the drift which is to be used for applying corrections to the calibration which is estimated based on the average of the pretest and post-test calibrations.	Calibration of special test instrument used for PG Test will be carried out only prior to the commencement of test.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
322.	Vol. II, Section 1.0 General Technical Specification	11.11.2.1	Page : 68 of 191	vii) Test Instrumentation, Flow Measurement and their Calibration All instruments required for performance testing shall be of the type and accuracy required by the code and prior to the test, the Contractor shall get these instruments calibrated in an independent test Institute approved by the Owner.	The calibration of flow nozzle will be carried out institute , where actual flow calibration facility is available.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification
323.	Vol. II, Section 1.0 General Technical Specification	11.11.2.1	Page : 69 of 191	Preliminary test reports shall be submitted to the Owner after completing each test run.	Test report for final PG test will be submitted to customer.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification
324.	Vol. II, Section 1.0General Technical Specification	11.11.3.1	Page : 70 of 191	Gross Turbine Cycle Heat RateMinimum Gross Turbine cycle heat rate at 100% TMCR after subtracting excitation power and power of TG integral auxiliaries with following conditions:1. Cycle make-up : 0% makeup2. Cooling water inlet temperature of 33 deg.C3. TDBFP's in operation.....Pg - Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 693MW, and 660MW respectively for 105%, and 100% TMCR unit load:	Bidder understand that Minimum Gross Turbine cycle heat rate at 100% TMCR is to be guaranteed under Category-I – (Performance Guarantees Under Penalty). Thus, Pg - Unit output after deducting the power consumption by auxiliaries as listed below and the same shall be 660MW i.e. 100% TMCR unit loadTest will not be carried out for (i), (iii) and (iv)	Please refer to our Statement of clarification sought explanation	Bidder shall follow Schedule-1 and 2 of Vol-II, Section-6 and Vol-II, Section-1, Clause No. 11.11.5.3.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
325.	Vol. II, Section 1.0 General Technical Specification	11.11.6	Page : 93 of 191	6. During Performance/ Acceptance test, following tests shall be carried out for T.G. set with test grade instruments as per ASME code.(i) Guarantee Turbine Cycle Heat rate test at 693MW (105% rated load) corresponding to the heat balance diagram specified in tender specification (ii) Guarantee Turbine Cycle Heat rate test at 660MW corresponding to the heat balance diagram specified in tender specification (iii) Guarantee Output test of 693 MW (105% rated load) corresponding to the heat balance diagram specified in tender specification (iv) Maximum continuous output corresponding to both strings of HP heaters out of operation, under rated steam conditions at a condenser pressure of 77 mm Hg (abs) and 1% makeup.			
326.	Vol. II, Section 1.0 General Technical Specification	11.11.5.5	Page : 87 of 191	Unit Start-Up Time (From Light-Up to Synchronization) (Minutes) a) Cold start-up : >72 hours b) Warm start-up : 10-72	Unit Start-Up Time will be as per following (From Light-Up to Synchronization) (Minutes) a) Cold start-up : >72	Please refer to our Statement of clarification sought explanation	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				hours c) Hot start-up : <10 hours **d) Very hot start-up : <1.5 hours**	hours b) Warm start-up : 10-72 hours c) Hot start-up : <10 hours		
327.	Vol. II, Section 1.0 General Technical Specification	11.11.6	Page : 92 of 191	Such test shall be binding on the parties to the contract to determine compliance with the guaranteed heat balance conditions at 693 MW (105% TMCR) MW and 660 MW (100% TMCR) unit outputs corresponding to the conditions stipulated in the specification.	As per bidder's understanding and as per Vol. II, Section 1.0, General Technical Specification, Clause 11.11.3.3, Gross continuous TG power output at 100% TMCR after subtracting excitation power is under guarantee. Please confirm	Please refer to our Statement of clarification sought explanation	noted.
328.	Vol. II, Section 1.0 General Technical Specification	11.11.6	Page : 93 of 191	Ageing allowance will be given during evaluation of PG test results and hence guaranteed heat rates shall be increased by the amount calculated as per the formula given in Cl. No. 3.07, Sub-Section-3 of ASME-PTC-6 Report 1985 (Reaffirmed 1991). Period of ageing shall be considered from the date of successful completion of initial operation to the date of conductance of PG test, In calculating the above factor any period(s) during which the turbine has not been in operation at a stretch for more than a week shall not be considered.	Period of ageing shall be considered from the date of first steam admission into steam turbine as per ASME PTC 6.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
329.	Vol. II, Section 1.0 General Technical Specification	14.0.0	Page : 100 of 191	TOOLS, TACKLES & EQUIPMENT The following tools and appliances shall be supplied under this Contract for use by the Owner: a) two sets of special tools and gauges required for the maintenance of the Plant b) One set of special lifting and handling tackles / appliances required for the maintenance of the Plant. The tools, tackles and appliances supplied in general, shall not be used for erection purposes by the Contractor and shall be handed over in brand new condition. Damaged tools, tackles, and appliances shall be replaced before handing over.	New special tools & tackles will be supplied by Bidder. However during Erection & commissioning activities these supplied special tools and tackles will be used by the bidder & same will be handed over to customer. In case, any special tool and tackle is damaged, same shall be replaced with new one.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification
330.	Vol. II, Section 1.0 General Technical Specification	19.2.1	Page : 108 of 191	• Experience list for supply and installation plants of similar capacity supercritical Units and performance certificate of the plants indicating the availability and plant load factor from the date of COD.	Experience list for supply and installation plants of similar capacity supercritical Units will be provided.	Please refer to our Statement of clarification sought explanation	Bidder to follow specification
331.	Vol. II, Section 2 SUB-SECTION - 2.2	3.1.0	Page : 2 of 27	• Explosion diaphragms for outer casing.	Bidder understand that explosion diaphragms is pressure relief bursting	Please refer to our Statement of clarification sought	Bidder understanding is inline with

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
332.	Vol. II, Section 2 SUB-SECTION - 2.2	5.1.0	Page : 10 of 27	Pressure relief bursting diaphragms shall be provided for LP casing(s) to limit the exhaust hood pressure within a safe margin from design pressure.	diaphragms for LP casing. Please confirm.	explanation	requirement.
333.	Vol. II, Section 2 SUB-SECTION - 2.2	4.0.0	Page : 6 of 27	Contractor shall indicate the turbine over pressurization (under VWO) possible and ensure corresponding continuous output of TG set as per IEC 45. Turbine shall be capable of accepting variation in steam temperature and pressure as per IEC 45 in case continuous over pressure operation is possible.	Turbine not designed for over pressure operation. Turbine inlet pressure and temperature variation is as per IEC-45	Please refer to our Statement of clarification sought explanation	Bidder shall confirm for the continuous operation of TG set during VWO condition.
334.	Vol. II, Section 2 SUB-SECTION - 2.2	4.0.0	Page : 7 of 27	While operating under all the above conditions the variation in steam temperature and pressure shall be limited to the extent stipulated in latest IEC-45.			
335.	Vol. II, Section 2 2.2 Steam Turbine & Aux. System	ANNEX 2.2.1	Page : 27 of 27	Design & operational requirement including variations in rated steam As per IEC 45			
336.	Vol. II, Section 2 SUB-SECTION - 2.2	4.0.0	Page : 7 of 27	Over speed during full load loss shall be limited to 8% of the rated speed.	As per clause Vol. II, Section 2 SUB-SECTION - 2.2, 4.0.0,	Please refer to our Statement of clarification sought	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
337.	Vol. II, Section 2 SUB-SECTI ON- 2.2	4.0.0	Page : 7 of 27	ii) Over speed during full load loss shall be limited to maximum of 120% of the rated speed	Over speed during full load loss will be limited to 8% of the rated speed.	explanation	
338.	Vol-II Section 4 4.2 Scope of Supply & Services	1.1.6	2 of 18	x) Marshalling and interposing relay cabinets	No separate Marshalling cabinet & relays cabinet will be provided for bidder's supplied TCS/TPS. For the termination of cables from the field the relays are places in the system cabinet only as per OEM standard practice.	OEM Standard and proven practice.	Bidder to follow specification.
339.	Volume - II, Section - 4 4.9 TG Instrumentation & Controls	1.6.0	7 of 22	The turbine Protection system shall meet al applicable safety standard requirements including those stipulated in VDE 0116 Section 8.7.	The Turbine Protective Functions will be part of Turbine Protection System (TPS), which is micro-processor based triple redundant including all protective / trip functions. It is not yet confirming to SIL 3 with certification from authorized agency. In order to realize the proven and reliable turbine control system and turbine protection system , they will be configured by our standard practice established by our long experience.	OEM Standard and proven practice.	Bidder to follow specification other than SIL 3 condition.
340.	Volume - II, Sect ion - 4	8.0.0	24 of 34	d) Loop execution time for protection and governing	Loop execution time is 50msec	OEM Standard and proven practice.	Bidder to follow specification.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
	4.6 Specification for DCS			controls -maximum 20 mSec p) Speed of communication Bus - 1GBps			
341.	Volume - II, Section - 4 4.9 TG Instrumentation & Controls	1.4.0	6 of 22	Automatic Turbine Testing The ATT function shall include but not limited to the following i) Opening and closing of emergency stop & control valves, reheat stop and interceptor vales ii) Over speed trip iii) Low Vacuum trip iv) Thrust bearing trip v) Electrical Remote Trip vi) Lub Oil Trip vii) Vibration Trip channel viii) Axial Shift Channel	i) On line testing of emergency stop & control valves, reheat stop and interceptor vales - included in offer ii) Over speed trip - Over Speed trip test from TCS iii) Low Vacuum trip - Will not be provided iv)thrust bearing trip - Will not be provided v) Electrical Remote Trip - Will not be provided vi) Lub Oil Trip-Local Test Valve for pressure switches of Condenser vacuum Low shall be opened by Operator vii) Vibration Trip channel-Will not be provided viii) Axial Shift Channel-Will not be provided	OEM Standard and proven practice.	Bidder to follow specification.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
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Mechanical -Fuel oil system								
342.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	4.2.0 & 4.7.0	3 of 19 & 5 of 19		*The HFO unloading facility shall be designed to enable to unload 10 road tankers simultaneously and discharge to onsite storage tanks within one hour period * The HSD road tanker unloading facility shall be designed to enable to unload 5 road tankers simultaneously and discharge to onsite storage tanks within one hour period.	Please provide the capacity of road tanker (Both HFO & HSD). It is to check the adequacy of pump capacity to unload the complete oil from tanker within ONE (1) hour as specified in specification	Capacity of road tanker (Both HFO & HSD) shall be considered as 20 kL.
343.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	4.2.0	3 of 19		The HFO unloading facility shall be designed to enable to unload 10 road tankers simultaneously and discharge to onsite storage tanks within one hour period		
344.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	4.3.0	3 of 19		HFO Storage tanks: The maximum storage temperature for the tank shall be at least 50°C.	Please specify the following for calculation of steam requirement of floor coil heater *Initial temperature of oil * Heating time to be considered to heat the oil from initial temperature to final temperature	Criteria as follows: Initial temperature is ambient temperature and final temperature of 50 deg C is to be reached within 72 hours.
345.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	4.7.0	5 of 19		HSD Unloading Pumps * Configuration shall be Two (2) nos - (1W+1S) each with a capacity of 100 Cum /hr.	Please read this in conjunction with below query	Configuration shall be Two (2) nos - (1W+1S) each with a capacity of 100 Cum /hr.
346.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	ANNEX 2.9.1	13 of 19		II. HSD UNLOADING PUMPS 3. Rated capacity (m3/hr) ----- 50(each)	There is contradiction in capacity of pump between two clauses. Please confirm the correct capacity	

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
						Pre Bid Reply		
347.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	4.11.0	7 of 19		Steam and Condensate System: Condensate from storage tank heating and suction heaters shall be drained through steam traps to a header which shall lead to condensate flash tank. Condensate from truck unloading area shall be collected through the condensate drain header and led to the condensate flash tank of suitable capacity before discharging the same to oily water separator sump.	Please read this in conjunction with below query	Follow 00-1115112-M-005_FLOW DIAGRAM FOR FUEL OIL UNLOADING AND STORAGE SYSTEM (Sheet 3 of 3).
348.	VOLUME - II	SECTION - 7/ TENDER DRAWINGS	-	-		DRAWING No: 00-1115112-M-005_FLOW DIAGRAM FOR FUEL OIL UNLOADINF AND STORAGE SYSTEM (Sheet 3 of 3)	There is contradiction in condensate recovery system between two documents. We are envisaged that scheme mentioned in this flow diagram to be considered as final. Please confirm	
349.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	4.10.0	6 of 19		Oily Water separator System: The oily water mixture from Oily water collection sump shall be led to the oily water separator sumps through non clog vertical centrifugal pumps suitable capacity. Configuration shall be 1W + 1S. The waste water from oily water separator sump shall be transferred to Waste Water Treatment System for further treatment	Since the specification is not particular about the type of OWS, We have considered OWS as API conventional baffle type (Not parallel plate type). Please confirm	Noted.
350.	VOLUME - II	SECTION - 7/ TENDER DRAWINGS	-	-		DRAWING No: 00-1115112-G-001_PLOT PLAN	Location of auxiliary boiler & Day oil tank(including capacity) is not mentioned. Please	To be finalized during detailed engineering stage.

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							confirm the location.	
351.	VOLUME - II	SECTION - 7/ TENDER DRAWINGS	-	-		DRAWING No: 00-1115112-M-005_FLOW DIAGRAM FOR FUEL OIL UNLOADINF AND STORAGE SYSTEM (Sheet 1 of 3) & (Sheet 2 of 3)	In flow diagram(both HFO & HSD), It is mentioned that spare connection to be provided in the forwarding pump's suction header for future purpose. Do we need to provide the space provision also in the Fuel oil pump house for forwarding pumps/HFO heater/HFO cooler of future unit? Please confirm	Space provision for future pump house shall be provided in the fuel oil area.
352.	VOLUME - II	SECTION - 4/SUB-SECTION 4.10	4.1.0	9 of 29		The HFO pumps shall be controlled by VFD.	Please confirm the requirement of VFD.If VFD is required, Specify the particular HFO pump (Unloading or forwarding pump)	HFO forwarding pump shall be provided with VFD.
353.	VOLUME - II	SECTION - 5	5.2.16	24 of 38		FUEL OIL HANDLING SYSTEM: Monorails shall be provided for handling the pumps	We are providing monorail with hand operated type hoist for handling of pumps. Please confirm	Criteria for hoists shall be as per specification. Refer section volume II Section no.2 sub section 2.19.0. Bidder to follow specification.
354.	VOLUME - II	SECTION - 5	5.2.16	24 of 38		FUEL OIL HANDLING SYSTEM	Since the specification is not particular about the location of various pumps & equipments in fuel oil	Noted.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
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						Pre Bid Reply		
							area. We are considering the following locations. Please confirm the same. Inside the FO pump house: * Unloading pumps (both HFO & HSD) * Forwarding pumps (both HFO& HSD) * DO tank transfer pump (HSD) for aux. boiler * HFO heater & coolers * Drain oil tank Outside the FO pump house * Oil-water collection sump & transfer pumps * Oil-water separator * Flash tank * Yard condensate collection tank & lancing pumps * Cooling tower & pumps Near to auxiliary boiler * DO tank * Aux. boiler pressurising pumps	
355.	VOLUME - II	SECTION - 7/ TENDER DRAWINGS	-	-		DRAWING No: 00-1115112-M-005_FLOW DIAGRAM FOR FUEL OIL UNLOADINF AND STORAGE SYSTEM (Sheet 1 of 3)	As per FD, PHE, CT & Related pumps are showen for HFO return oil piping. Since HFO system operating occationally (30% BMCR) , Hence we are not recomending this type of system for HFO return	Bidder to follow specification.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
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							oil. Please confirm.	
356.	VOLUME - II	SECTION - 2/ SUB-SECTION 2.9	ANNEX 2.9.1	15 of 19		V. HSD STORAGE TANKS 9. Insulation : Yes	we are not envisaging insulation for HSD tank. Please confirm	Refer Vol II sec 2.9 clause VI 8, wherein "insulation for HSD Tank - not applicable".
357.	Drawing	Plot Plan-00-1115112-G-001 Rev0				Plot Plan	Ash pond shown in the plot plan is only for stage-I (2 x 660 MW) or it is common for both stage- I & Stage-II. Please confirm. What is the height of the ash pond we should consider while designing the system.	Ash pond shown in the plot plan is only for stage-I (2 x 660 MW) Refer Vol II sec 1.0 page 21 of 191 clause 2.5.0 wherein " For ash pond, the required area of the land will be about 120acres considering the bund height of 25m for both fly and bottom ash above finished ground level". Refer Vol II sec 5.0 Ash Pond section 5.10.3 page 2 of 6 clause 5.10.3.1 wherein " Contractor shall construct the starter bund upto 5 m. Bidder to follow specification.
358.	General						Tangenco is requested to furnish topographical survey and contour drawing of complete area. Topographical survey, plot plan and	Plot Plan has been provided.

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							contour drawing may please be provided in AutoCAD format for complete plant including ash pond area.	
Compressed Air System								
359.	II	Section - 2 / 2.16 / Compressed air system	3.0.0	1 of 9		Instrument air & Service air compressor	Kindly provide the instrument air & servise air compressor capacity & pressure to be maintined at header. Since this is required to select the compressor & maintain all the bidders in same platform.	Refer Vol II sec 2.16 clause 4.0.0 page 2 of 9,"design require-ments for air compressor is specified." Bidder to follow specification. The discharge pressure at the header shall not be less than 8.0 Kg/cm2 (g) at compressor outlet.
360.		Plot plan (Drg no. 00-1115112-G-001)				Instrument air & Service air compressor	In the layout point no 14, refers to Compressor house. Kindly confirm that this location is only for instrument air & service air compressors.	Noted . The Compressors required for instrument air & service air for BTG only.
361.	II	Section - 2 / 2.16 / Compressed air system	4.0.0	2 of 9		Compressor capacity	The each compressor capacity shall be 40 Nm^3/min instead of 40 Nm^3/h. Since the given capacity is very less for this size of power plant. Please clarify	Refer Vol II sec 2.16 clause 4.0.0 page 2 of 9, wherein " design requirements for air compressor is specified." Bidder to follow specification.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
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								Bidder referred compressor capacity of 40 Nm3/h is for air consumed per station for service air requirement. Refer Vol II sec 2.16 clause 4.0.0 page 2 of 9
362.	II	Section - 2 / 2.16 / Compressed air system	3.0.0	1 of 9		Instrument air & service air receiver	Three numbers of instrument air receiver & three numbers of service air receiver quantity was mentioned in the tender specification, Whereas in the tender drawing (00-1115-12-M-006/ R0) five air receiver shown for instrument air & two air receiver shown for service air. Kindly clarify how many air receivers to be considered.	Three numbers of instrument air receiver & three numbers of service air receiver quantity was mentioned in the tender specification is for the receiver to located near the compressor house. Tender drawing (00-1115-12-M-006/ R0) five air receiver shown for instrument air. as follows: 3nos. near the compressor house. 1no. near the unit I Boiler area. 1no. near the unit-II boiler area. Regarding the service air receiver, 3 nos. shall be provided near the compressor house.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
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						Pre Bid Reply		
								For receiver capacity, refer Refer Vol II sec 2.16.1 clause 5.0.0 page 8 of 9,
363.		Plot plan (Drg no. 00-1115112-G-001)				Pipe rack	We presumed that pipe rack routing shown in the plot plan is tentative only. Bidder's are allowed to modify the routing for optimised path. Examble : Fuel oil area & boiler are located nearby. To bring the fuel oil piping to boiler, there is no shortest pipe rack routing.	The plot plan provided by the owner along with this tender specification is indicative only . It is the intent of the owner to provide extensions in future for four more units of each having capacity of 660 MW in adjacent land. Hence bidder has to prepare the Plot plan to accommodate future units as above and same shall be submitted along with the bid.
364.	II	Section - 2 / 2.20 / Piping, Valves & Fittings	5.00.00	8 of 31		50% extra space for the routing of future pipes for stage –II shall be provided in the pedestals and pipe rack.	Kindly mention in the plot plan that, which are the pipe racks / Pedestals required 50% extra space for future pipes. Since bidder is not aware of that, future pipe routings and also its very difficult to consider all the racks with 50% extra space.	
365.	II	Section - 2 / 2.20 / Piping, Valves & Fittings	5.00.00	8 of 31		Suitable Walkways of 750mm width for maintaining pipes and cables shall be provided on the pipe rack	Since this is not a continuous or normal walkway on pipe rack. During the maintenance time only access required. Hence we are considering min 500 mm clear walk way on the pipe rack.	Bidder to follow specification.
366.	II	Section - 2	5.00.00	8 of 31		Pipe rack minimum ground	It was given that,	Refer Vol II sec 5.3.8

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		/ 2.20 / Piping, Valves & Fittings				clearance on non road areas.	minimum ground clearance of 8.0 m shall be considered for road crossing. Bidder is considering the pipe rack minimum ground clearance of 3.0 M in non road areas. Since it was not mentioned in tender. Kindly confirm.	(Civil specification)
367.	II	Section - 2 / 2.20 / Piping, Valves & Fittings	5.00.00	8 of 31		Pipe pedestal	It was understood that pipes can be supported from pedestals also. Kindly provide the minimum pipe size which can be considered in pipe pedestals.	No constraint on minimum pipe size
368.		Plot plan (Drg no. 00-1115112-G-001)				Pipe rack & Condensate storage tank	In the plot plan pipe rack & CST (Item no. 48) are interfering. The CST need to be relocate with out interference.	Noted.
369.	II	Section - 2 / 2.22 / Workshop, Lab, RWB & Stores	2.1.0	1 of 34		Workshop equipments	Kindly provide the sizes of each machines / equipment and their capacity which are comes in work shop.	Refer Vol - II, Section 5 - Civil sec 2.22 page 5 of 11 for headroom clearance.
370.	II	Section 3 / Detailed Technical Specification - Electrical	2.0.0 (i)	255 of 353		Passenger Elevator	It was mentioned that passenger elevator for other buildings of height 15M & above. Kindly specify the requirement of elevator in other buildings.	Bidder to follow specification.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
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371.	II	Section - 2 / 2.14 / PWT, WW& Chemical Treatment Systems	3.2.8	10 of 34		Service & Potable water	Kindly confirm that, service & potable water lines can be routed on ground (pipe sleeper) or trench wherever pipe rack is not provided.	Service & potable water lines can be routed on pipe sleeper.
HVAC								
372.	Vol -II	SECTION 2-17 HVAC	2.1.1	1 OF 20		Independent water cooled chiller shall be provided for TG building and service building air conditioned areas.	Please provide location of chiller buildings for TG and service building.	Location shall be near to the control building. However actual location shall be finalized during detailed engineering.
373.	Vol -II	SECTION 2-17 HVAC	2.1.3	2 OF 20		For areas having AC load more than 5 TR or equal to 5 TR, water cooled package units shall be provided.	It is requested to note that for cooling loads above including 5 TR upto 22 TR Air cooled package Air conditioners are available, can we select air cooler package air conditioners for this TR range.	Bidder to follow specification.
374.	Vol -II	SECTION 2-17 HVAC	3.1.0	3 OF 20		Inside design conditions to be maintained in air conditioned area.	Please note that Relative Humidity as mentioned in inside design condition cannot be maintained in areas with split air conditioners.	TANGEDCO Noted.
375.	Vol -II	SECTION 2-17 HVAC	3.1.0	4 OF 20		Bidder shall adopt the Thoothukudi metrological data (no of years shall be min og 20 yrs) …….	Please provide Thoothukudi metrological data for arriving at cooling loads for HVAC systems for bidding purpose.	As per volume II section 2.17/Clause-3.1.0 Bidder shall collect the actual data from the meteorological

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								department pertaining to site location and design for plant accordingly.
376.	Vol -II	SECTION 2-17 HVAC	3.2.0	4 OF 20		Supply and exhaust ventilation system TG Hall Exhaust air system Roof exhaust fans	For exhaust air system of TG Hall, roof exhaust fans are mentioned, we assume that these are roof extractors with no driven motors. Please clarify.	Bidder to follow specification clause no. 4.16.0 page 12 of 20.
377.	Vol -II	SECTION 2-17 HVAC	Annex 2.17.1, f	19 OF 20		Split air conditioners	Is R 22 refrigerant acceptable for split air conditioners.	Bidder to follow specification.
CHP								
378.	Vol.II section 2.0	2.10.0 By pass system	3.0.0	3 of 15		Bypass chute will be provided to bypass screen and crusher.	We suppose there is no Bypass arrangement as the same is not shown in flow diagram and the same is not clearly mentioned in the specification.	Bypass chute will be provided to bypass screen and crusher.
379.	Vol.II section 2.0	2.10.1 Belt conveyors	7	8 of 9		Length of feed point :6m (min.) Skirt board shall be designed in such a way avoiding spillage if the conveyor is having multiple feeding points. Skirt board shall be extended minimum 3m ahead of the feeding zone . (applicable to multiple feeding also). Skirt board shall not be provided in the idler transition zone. Minimum 500mm shall be maintained behind the feeding zone.	In specified data sheet the skirt board length is mentioned as 6m (min) and in subsequent para it is mentioned as 3m (min) ahead from feeding zone. Please confirm which length to consider.	Both the clauses are not contradicting. Minimum length of the skirt board shall be 6m. Skirt board shall be extended minimum 3m ahead of the feeding zone. Bidder shall follow specification.

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380.	Vol.II section 2.0	2.10.0 Data sheet / Skirt board Length	12	4 of 15		Bidder shall provide sheds either in two stock piles or in four stock piles. If provided for two stock piles, the covered shed shall be 270m. Ifprovided for all four stock piles , the covered shed shall be 140m. Stacker cum, reclaimer shall move inside the covered shed.	We understand that the dimension for covered stockpile indicated (140 and 270 m) is the length and the balance stock pile to be covered with wind barrier. Please confirm.	Refer Vol II sec 2 sub section 2.10 clause 4.0.0 14.0 page 4 of 15, wherein " Bidder shall provide sheds either in two stock piles or in four stock piles. If provided for two stock piles, the covered shed length shall be 270m. If provided for all four stock piles, the covered shed length shall be 140m." Wind barrier shall be provided for the area of the stockpile without the covered shed.
381.	Vol.II section 2.0	2.10.0 Scope of supply / Stacker reclaimer	6.3.3.14	1 of 15 12 of 15		Unidirectional stacker cum reclaimer with rails and all it's accessories / Reversible Stacker / Reclaimer	we understand the same to be read as stacker reclaimer and not reversible SCR. Please confirm.	Confirmed
382.	General	2.10.1 Belt conveyors	v	2 of 9		Coal Handling system / Angle of wrap	Angle of wrap is mentioned as 210 deg. For belt feeders/short conveyors we are considering 180 deg. Wrap angle . Please confirm	For belt feeders, wrap angle of minimum 180 deg shall be followed.
383.	Vol.II section 2.0	2.10.3 SCREENS	7.3	1 of 2 2 of 2		Screens shall be Vibrating Grizzly screens and shall be provided with bars. Perforated deck liner	For screens, it is mentioned as screens shall be provided with bars but in the data sheet it is	Perforated deck liner as per Data sheet shall be provided for screens.

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							mentioned as perforated plates. Please confirm which type of deck to follow.	
384.	Vol.II section 2.0	2.10.4 STACKER CUM RECLAIMER data sheet	2	2 of 4		STACKER CUM RECLAIMER Number required are 4. No	Please confirm the stacker reclaimer qty. we propose 2 nos. stacker reclaimer for four stock piles.	Bidder to follow specification.
Water System								
385.	Vol. - II	Section 2-13 Planr CW -RO	Specific data sheet Annex 2.13.1	Page 18 of 21		Basin depth :The basin shall be complete with 7 minutes storage capacity (from normal water level to low water level)	Since There is no Maximum water level mentioned in data sheet. So Normal water level in Cooling tower will match the FGL in Cooling tower area with free board of 300mm from FGL. Please confirm.	Bidder to note the following: 1. A minimum of 300 mm free board shall be provided in the basin as per Vol-II sec 2.13 clause 5.1.0 page 5 of 21. This freeboard shall be provided above the Maximum water level (MWL). 2. MWL shall be minimum 200mm above the Normal water level (NWL). 3. The basin shall have 7 minutes storage capacity from NWL to low water level (LWL) as per Vol-II sec 2.13 clause 5.1.0 page 5 of 21. 4. The basin invert level shall be minimum 300mm
386.	Vol. - II	Section 2-13 Planr CW -RO	5.1.0	6 of 21		The basin shall be 7min storage capacity (from normal water level to low water level).A minimum of 300 mm free board..... Maximum, minimum and normal operating water levels in the basin shall be clearly indicated in the data sheets		

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								below the LWL. Accordingly bidder shall size the cooling tower basin accordingly.
387.	Vol. - II	Section 2-13 Planr CW -RO	Specific data sheet Annex 2.13.1	Page 18 of 22		Design relative humidity :75%	Design point for cooling tower shall be for RH :75% . Please confirm.	Bidder to follow specification.
388.	Vol. - II	Section 2-13 Planr CW -RO	Specific data sheet Annex 2.13.1	Page 18 of 24		Drift eliminator	Please confirm the percentage of drift loss across the drift eliminator.	Percentage of drift loss shall be less than 0.005%.
389.	Vol. - II	Flow diagram cooling water system	00-1115112-M-003 rev-00			Unit-1 Initial fill line from ACW pumps For Unit -II, Initials fill line from CW blow down pumps	We propose ACW Booster pumps located in TG building taking tap off for suction/ discharge from CW conduit. The initial filling of CW header of Unit-I & unit-II will be done with CW blow down pumps. Please confirm.	Bidder to follow specification.
390.	Vol. - II	Section 2-13 Planr CW -RO	5.3.2	8 of 21		CFD Model shall be conducted for Concrete volute pump.	Pump CFD Model test will be carried out by the manufacture if offered pump model has not done model test earlier. Please confirm.	Bidder to follow specification.
391.	Vol. - II	Section 2-13 Planr CW -RO	Specific data sheet Annex 2.13.1	Page 20 of 25		Delivery rate: Suitable to supply cooling water to condenser +10% Margin.	Since the capacity of circulating water is higher. We request to consider the 5% margin on the delivery rate as against	Bidder to follow specification.

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							10%..	
392.	Vol. - II	Section - 2.14 WTP RO	4.0.0	8 of 31		The HDPE pipes shall be of suitable diameter with rating of SDR 26 or better, PE 100 material. The intake pipes shall be provided with man holes at every 100 m distance.	It is not advisable to have many joints/cuts in the HDPE pipe as this will weaken its strength and increase stress concentration. Thus the recommended spacing for manholes is 300m.	Refer Vol. - II, Section 2.0 Page 5 of 34 clause no: 3.1.6 wherein "the intake pipes shall be provided with man holes at every 200 m distance in the off shore". Bidder to follow specification.
393.	Vol. - II	Section - 2.14 WTP RO	ANNEX – 2.14.1	23 of 34		Minimum capacity of the plant shall be 16 MLD. Nett Capacity Of each stream 5 MLD each.	There is contradiction between the net capacity of RO stream to total capacity of RO stream (3X50%). Please confirm the Net capacity of RO stream for 3X50% configuration.	Refer Vol II sec 2 sub section 2.14 page 23 of 34, wherein "Minimum capacity of the plant shall be 16 MLD. Number of stream shall be 3 x 50%."with each stream of 8 MLD capacity.
394.	Vol. - II	Section - 2.14 WTP RO	ANNEX – 2.14.1	25 of 34		Provision of suction line from Overhead water tank with isolation valve for Colony Transfer Pumps (2 x100 %) with necessary provision of electrics	We suggest providing separate colony potable water pumps (by Owner) in Desalination water pump house instead of taking tap off from potable over head tank.	Bidder to follow specification.
395.	Vol. - II	Section - 2.14 WTP RO	ANNEX – 2.14.1	26 of 34		BWRO outlet TDS is <20ppm.	Since BWRO outlet TDS is <20ppm, We suggest the Degasser with mixed bed vessel. SAC, SBA ion-exchanger are not required. Hence We are considering DM plant with BWRO+Degasser+MB	Bidder to follow specification.

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							only. Please confirm	
396.	Vol. - II	Section - 2.14 WTP RO	3.1.5	5 of 34		"from the shore, outfall pipe shall be routed on coal conveyor deck for which space will be provided"	The MOC sea water outfall piping on top of conveyor deck will be HDPE only. Please confirm.	Bidder to follow specification.
397.	Vol. - II	Section - 2.14 WTP RO	3.2.1	Page 7 of 34		Lime along with carbon dioxide dosing shall be considered at SWRO outlet to achieve the pH and LSI requirements	Please confirm the number of storage days required for Lime & CO2 for desalination plant & the location of storage.	One month storage shall be considered in PT chemical storage building.
398.	Vol. - II	Sea water inatke system	10-11151112-M-012 rev-00			Two number of lines are shown for sea water intake line.	We are considering the Two lines of 2X50% line from sea water intake location to plant. Each line will be sized for 15000 cu.m/hr capacity. Please confirm.	Velocity Restriction of 1m/sec does not apply to seawater intake lines. Specification calls for two pipes of OD 2000 (vol-II sec 2.14 annex 2.14.1).
399.	Volume -II, section-1	Cl 2.1.0(a)		page 11 of 191		"Terminal point at stage-II intake channel after desilting basin." Intake channel shall be divided into two (one for present 2 x 660 MW & another for future 2 x 660 MW)	But on page 6 of 191, Clause 1.1.0, future expansion written is 4 x 660 MW. Please confirm future expansion is 2 x 660 MW or 4 X 660 MW.	Future expansion is 4 x 660 MW as per Vol -II section 1 GTS Clause 1.1.0. However intake and outfall system is designed for 4 x 660MW. Refer clause no: 2.0.0 limits of supply/terminal point. Bidder to follow specification.
Fire System								

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400.	II	Section 2.0 / sub section 2.15 Fire Protection System	2.0.0	1 of 33		One (1) no of diesel engine driven vertical turbine pump of capacity 410 m3/hr for supplying fire water to the coal stockpile area ring main header.	1.The same pump shall start automatically based on the header pressure will drop. Please confirm. 2.Pump head shall match with as per TAC requirement. Please confirm.	Noted. In addition provision shall also be given to start the pump manually operation during emergency.
401.	II	Section 2.0 / sub section 2.15 Fire Protection System	3.0.0	3 of 33		Design Requirements	Hydrant and MVW spray system pump (3 W+2S) capacity & head as 410 m3/hr and 105 MWC. Please confirm.	Bidder to follow as per TAC and Specification requirements
402.	II	Section 2.0 / sub section 2.15 Fire Protection System	3.0.0	3 of 33		Design Requirements	HVW spray system pump (1 W+1S) capacity & head as 410 m3/hr and 105 MWC. Please confirm.	Bidder to follow as per TAC and Specification requirements
403.	II	Section 2.0 / sub section 2.15 Fire Protection System	3.0.0	3 of 33		Design Requirements	Jockey pump (1 W+1S) capacity & head as 55 m3/hr and 105 MWC. Please confirm.	Bidder to follow as per TAC and Specification requirements
404.	II	Section 2.0 / sub section 2.15 Fire Protection System	3.0.0	3 of 33		Design Requirements	Booster pumps (1 W+1S) capacity & head as 171 m3/hr and 45 MWC. Please confirm.	Capacity is noted. However head shall be finalized during detailed engineering.
405.	II	Section 2.0 / sub section 2.15 Fire Protection System	4.0.0	12 of 33		Construction requirements	All buried pipes shall be minimum 4 mm thick (in two layers each of 2mm thick) coated and wrapped as per IS: 10221 / IS 15337. Please confirm.	Noted.
406.	II	Section 2.0 /	Annex	25 of 34		Fire water storage tank	As per TAC, Fire water	Bidder to follow

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		sub section 2.14 PWT,WW & Chemical Treatment System	2.14.1				requirement for Hydrant & Spray system as 4920 m3. Please confirm including the same requirement for 13000 m3 capacity of Desalinated water cum fire water storage tank.	specification.
407.	II	Section 2.0 / sub section 2.15 Fire Protection System	4.0.0	12 of 33		Fire water pipes shall be of Carbon steel confirming to IS: 1239 (medium grade) and IS: 3589 (6.35 mm thik)	Mismatching for both pipe specification. Please confirm which one to follow.	Bidder to follow:IS: 1239 (Part-I) - Heavy class ERW MS black pipes for sizes 150 NB and below. IS: 3589 Grade 410 (wall thickness min - 6.35 mm) ERW MS black pipes for sizes above 150 NB .
408.	II		Annex 2.15.1	18 of 33		IS: 1239 (Part-I) - Heavy class ERW MS black pipes for sizes 150 NB and below. IS: 3589 Grade 410 (wall thickness min - 6.35 mm) ERW MS black pipes for sizes above 150 NB .		
409.	II	Section 2.0 / sub section 2.15 Fire Protection System	2.0.0 & Annex 2.15.1	2 of 33 & 19 of 33		Foam system piping	From Foam tank piping to foam concentrate piping MOC shall be SS. After foam concentrate piping MOC shall be GI. Please confirm.	TANGEDCO Noted.
Ash Handling System								
410.	II	Section 2.0 / 2.11.0				Ash Pond	Weather bidder shall consider Garlanding pipe for Ash Pond? If yes Please clarify on the length of garlanding required for the ash slurry pipe on the dyke, since the dyke perimeter is very large	Ash pond garlanding is required as per Flow Drg No.: 00-1115112-M-010. Bidder shall refer Plot Plan (Drg. No.: 00-1115112 -G-001) regarding garlanding pipe length.

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								Bidder to follow specification.
411.	II	Section 2.0 / 2.11.0				Ash Pond	Please inform the Static lift from Plant area to Ash pond ground level and Max. Height of dyke to design the BA & FA slurry pump head calculation.	Refer Vol II sec 1.0 page 21 of 191 clause 2.5.0 wherein "For ash pond, the required area of the land will be about 120 acres considering the bund height of 25m for both fly and bottom ash above finished ground level".
412.	II	Section 2.0 / 2.11.4		1 of 1		Buffer Hopper	Buffer hopper has been specified to be provided with 10 mm thick Alloy CI Liner. Please note that Liners in 10 mm thick Alloy CI cannot be manufactured. Hence please confirm that Liners of 10 mm thick SAIL Hard / TISCRAL can be provided.	Specification calls for minimum requirement. Bidder to follow specification.
413.	II	Section 2.0 / 2.11.0	2.4.0	4 of 13		Fly ash removal in slurry mode from ash silos to ash dyke.	please clarify the Design criteria for FA jet pump and FA slurry pump. We presumed that 50 % of the fly ash generated from each unit shall be disposed through FA slurry mode during emergency. Please confirm	Refer Vol II sec 2.0 Sub section 2.11.0 clause 3.0.0 wherein "fly ash generation for each unit is mentioned in terms of percentage". Operating time of Fly ash silo to ash slurry pump and ash slurry sump to ash pond (4W+4S)- 8h in a shift i.e. continuous basis. FA jet pump and FA

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								slurry pump shall be designed accordingly.
414.	II	Section 2.0 / 2.11.0	2.3.0	4 of 13		The ash unloading rate	Please specify the ash unloading rate from fly ash silo for open trucks & Closed tankers.	Bidder to follow specification. Refer Annex 2.11.10.1
415.	II	Section 2.0 / 2.11.15	2.3.0	1 of 2		Bottom ash slurry/ECO ash slurry/ fly ash slurry discharge pipes / Ash disposal pipe to ash dyke	slurry pipe shall be MSERW as per IS:3589 Gr FE 410 with 20 mm basalt lining or Cast iron pipes. Please confirm.	Bidder to follow specification.
416.	II	Section 6.0	SCHEDULE – 2	30 of 302		GUARANTEED AUXILIARY POWER CONSUMPTION	since Fuel oil system & Fire protection system are running occasionally, STP and AC & Ventilation system operation based on seasonal changes, request you to not to consider for Aux Power evaluation.	Bidder to follow specification.
417.	II	AHP flow diagram00-1115112-M-008 Rev 0				Flow drawing of Bottom ash Handling system: Tube settler	as per FD, Tube settler are envisaged. However tender spec doesn't calls for tube settler. Please confirm that This Tube setter is not required and not to consider by Bidder.	Flow diagram is part of the tender specification. Bidder to follow specification.
418.	II	Section 1.0				General	Capacities of the BOP systems shall be sized for 2 X 660 MW (stage -I) only. Please confirm	Bidder to follow specification.
419.	II	Section 1.0	7.1.0	38 of 191		The life span to be considered for the design of equipment and component selection shall be at least 40 years.	please note that this shall be subjected to manufactures standards. Please confirm.	Bidder to follow specification.

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420.	VOL-II	Section 5-civil	5.2.3.4	6 of 38		All internal plant roads and approach road from the state Highways to the main plant (Double lane roads) shall be of 7.5 m wide with 2.5 m wide shoulders on both sides of the road. Single lane roads shall be of 4.0 m wide with 1.0 m wide shoulders on both sides of the road. Patrol road along boundary wall shall be single lane road	We understand that the double lane road shall be 12.5m wide (7.5m wide with 2.5m wide shoulders on both side) and for single lane road shall be of 6m(4m wide with 1m wide shoulders on both side). Please confirm.	1.Approach road from the state Highways to the main plant (Double lane roads) shall be of 7.5 m wide **for each lane with 1 mtr median** with 2.5 m wide shoulders on both sides of the road.(21 Mtrs in total). 2.For other internal roads follow specification.
421.	VOL-II	Section 5-civil	5.4.14	12 of 12		Allowable bearing capacity of soil / pile capacity may be allowed to increase by 25% under seismic / wind load condition except for chimney, NDCT and other wind prominent structures, where increase in bearing capacity / pile capacity shall not be considered	We request the client to allow 25% increase in allowable bearing capacity for structures other than NDCT and Chimney. Please confirm.	Bidder to meet specification requirements.
422.	VOL-II	Section 5-civil	5.5.4	6 of 37		The following minimum thickness shall be followed b. Ground floor slab(non - suspended) plant buildings c. Water retaining slab walls l. Pile caps	We propose the minimum thickness of the structural elements shall be as per design requirement. Please confirm.	Bidder to meet specification requirements.
423.						Plot plan	We request the client to provide the contour map and plot plan in auto cad format	Provided now along with pre-bid clarifications
424.						Intake and out fall	We request the client to provide the longitudinal section of pipe routing for intake and outfall.	Bidder shall refer the specification for the inputs regarding sea water intake and outfall system.

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							We also presume that the right of way and statutory permissions for pipe corridor will be arranged by owner.	As per clause 1.1/Section-1 /Volume-II –All statutory and local approvals required for the work to be executed including payment of fees up to handing over of the plant is in the contactor's scope
425.	Vol-III Attachment s		4.4	137		Geotechnical report	We propose open foundations for lightly loaded structures in balance of plant area meeting the design requirements. Please confirm.	Open foundations can be provided, if meeting design requirements.
426.						General	Please indicate the lead for disposal of excess / unserviceable earth.	Clause 5.2.3.1 says "Area for disposal of unsuitable materials resulting from excavation will be identified by the Owner inside the project boundary at the time of execution."
427.	VOL-II	Section 5-civil	5.7.1.4	6 of 13		Sewage system	We request the owner to mention the capacity or number of users to design the sewage treatment plant.	Refer Volume II, Sub-Section 2.14 Plant Water Treatment, Waste Water & Chemical Treatment Systems Page 34 of 34.
428.						General	Demolition/breaking/clearing / rerouting of any existing structures over	Clause 5.2.3.1 says "Any structure or services existing at the

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							ground and underground are excluded from bidders scope. Please confirm	site shall be removed / rerouted with the permission of the OWNER."
429.	**II**	1.0 GTS	1.2.0/Electrical/ S.No.24	8 of 191		Dry type LV service transformers	Service transformers located in power house building shall be Dry type and service transformers located in other buildings shall be Oil type only. Kindly confirm.	Bidder to follow specification
430.	II	3.0	3.2.0	6 of 353		The Contractor shall establish 'KKS Codification' system, to provide consistent numbering throughout the Power project	We understand that KKS code is already specified by Owner in the Main plant SLD. We will follow the same KKS code for equipments. Kindly confirm.	KKS code indicated in the SLD is for guidance only. Bidder shall evolve detailed KKS coding system.
431.	II	3.0	3.5.0	6 of 353		Electrical equipment such as motors, push button stations, lighting fixtures, junction boxes located in areas such as fuel oil handling areas, hydrogen gas handling area, hydrogen generation plant, coal dust areas etc. shall be provided with flameproof type enclosures as per relevant standards.	We understand that coal dust areas is wrongly mentioned in flame proof area. All electrical equipments in coal handling system are not flame proof type and provided with dust protection enclosure. Kindly confirm.	Bidder to follow specification
432.	II	3.0	4.10.0 4.11.0 4.12.0	9 of 353		Feeder requirements for Owner's system	We understand that for owner's system only required number of feeders are considered in corresponding switchgear/PMCC. Further all electrical components such as cables, cabling	Confirmed. However, space provision shall be made in the cable trays for routing the cables of these feeders in future.

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							accessories, cable tray, supports, earthing are excluded from bidder scope. Kindly confirm.	
433.	II	3.0	5.6.0	12 of 353		All BTG related Switchgear rooms shall have Air Conditioned operator room and have direct access from TG Building Lifts.	We understand that switchgear rooms where BTG process loads are fed shall have air conditioned operator room. Kindly confirm.	The switchgear rooms located in BTG area shall have air conditioned operator room and shall have direct access from TG Building Lifts
434.	II	3.0	5.10.0	12 of 353		Cable spreader room shall be provided for all the electrical room and control rooms and control equipment rooms for the various buildings and areas:	We understand that Cable spreader room shall be provided for panels/switchgears located at elevated floors. cable trench shall be provided for switchgear/panels located at Ground floor. Kindly confirm.	Bidder to follow specification
435.	II	3.0	5.10.0	12 of 353		In electrical rooms of other buildings, cable trenches with less than 1.0 Mtr depth from the finished floor of respective building can be considered, adequately protecting from water ingress from outdoor trenches.	Cable trench depth will be based on cable tray requirement only. Kindly confirm.	Bidder to follow specification
436.	II	3.0	5.13.0	12 of 353		The Cable trays shall be of vertical formation.	Vertical cable tray shall be provided for coal handling system only. For all other areas, horizontal cable tray shall be provided. Kindly confirm.	As per clause 4.8.0 of Section 3.29 of Volume-II, Cable trays shall be laid in vertical formation in boiler, mill and ESP areas

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437.	II	3.0	4.2.7	160 of 353		The design of the LV Switchgear shall include all devices required for remote control & monitoring from DCS. It shall be monitored from the EMS system also.	Only breaker panels required for non process loads will be monitored from EMS system. Kindly confirm.	Confirmed for LV Switchgear. For other requirements of EMS, Bidder to follow specification
438.	II	3.0	5.6.1	168 of 353		Intelligent control unit	Kindly specify/clarify the requirement of Intelligent control unit.	Bidder shall consider intelligent MCC.
439.	II	3.0	2.0.0	214 of 353		Battery	We propose Ni-Cd battery of suitable rating. Kindly confirm.	Bidder to follow specification
440.	II	3.0	4.9.7	286 of 353		In pump houses, water treatment plant, compressor house, coal crushers, mill bay, coal transfer towers, ash handling plant, fuel oil pump house, H2 plant, GIS building, Switchyard, etc., minimum one welding receptacle shall be provided at each elevation at each enclosed area.	We understand that 1 No of receptacle shall be provided for enclosed areas only. Kindly confirm.	Bidder to follow specification
441.	II	3.0	4.9.8	287 of 353		Each receptacle panel shall be provided with one earth leakage circuit breaker rated 30 mA in outgoing circuits	We understand that outgoing circuits of Welding receptacle panel shall be provided for interior area and panel shall be provided wherever No of 1 ph receptacles are more than 3 nos. Kindly confirm.	Bidder to follow specification

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442.	II	3.0	4.9.9	287 of 353		Receptacles located in Conveyor galleries shall be flame proof type.	We will provide normal receptacles in conveyor galleries, as is the normal process in various power plants. Kindly confirm.	Bidder to follow specification
443.	II	3.0	5.1.20/ S.No.20	287 of 353		Street Lighting	We understand that street lighting cable shall be directly buried along the road. Kindly confirm.	Bidder to follow specification.
444.	II	3.0	4.1.3	304 of 353		FRP cable trays also shall be provided for the following areas •Water Treatment Plant •Coal Handling Plant •Sea Water intake system •Interplant cable trays	We understand that GI cable trays are acceptable for other areas (ie other than those mentioned in this clause). Kindly confirm.	Bidder to follow specification
445.	II	3.0	4.13.0	9 of 353		In 415 V system of Ash water recovery pump house, additional load of 500 kVA for future use shall be considered while sizing the transformer and 2 nos. 1000 Amp feeders shall be provided in PCC.	Client to furnish the load corresponding to the 1000A feeders to be considered in AHP PCC.	It is already indicated as 500 kVA

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446.	II	3.0	5.30.10	15 of 353		All electrical buildings shall have two floor construction with the following rooms , which are further detailed in the Civil section: • Electrical room • Battery room • Air conditioned Control room • Cable spreader room • Air conditioned Maintenance engineers room (5 metreX5metre) • Store cum tool room in ground floor • Toilet (Men & Women) • Pantry Room • AHU Room • The required furniture's such as Chairs, Tables, Almirahs shall be provided.	We understand that the clause is generally defined only for the main plant area ie., for TG building, ESP. However for BOP areas, the electrical rooms will be provided with battery rooms and control /RIO rooms, AHU rooms as per system and layout requirements. Also the following rooms will not be applicable for BOP area electrical rooms: • Air conditioned Maintenance engineers room (5 metreX5metre) • Store cum tool room in ground floor • Pantry Room Please confirm our understanding	Bidder to follow specification
447.	II	3.0	20.14.0 2.017.0	59 of 353 60 of 253		d) Ethernet switch fault tolerant ring architecture for each bay f) Dual redundant communication between intelligent electronic devices (IEDs) and Ethernet switches. The connection from each IED to the switch shall be by a dual fiber optic link.	As per SAS architecture drawing no: 10-1115112-E-217 Rev.0 , for each bay ,we have envisaged redundant connection to the bay level Ethernet switch from each BCU. However the numerical relays of that bay shall have a single connection to the bay Ethernet switch. Please confirm.	Drawing is indicative. Bidder to follow specification.

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448.	II	3.0	20.14.0	59 of 353		Dual redundant bi-directional communication link & gateway for remote load dispatch centre (RLDC)	We understand that only communication link and gateway is to be provided for RLDC, remote control centre (two ports are to be provided). The gateway outgoing terminals are the terminal point for the interconnection for each of these cases. Please confirm.	Bidder to follow specification
449.	II	7.0	SAS Architecture Drawing	49, 50, 51 of 73		SAS architecture drawing no: 10-1115112-E-217 Rev.0 ,	We understand that only communication link and gateway is to be provided for Stage -II . The gateway outgoing terminals are the terminal point for the interconnection to Stage -II. Please confirm.	Bidder to follow specification
450.	II	3.0	20.25.00	61 of 353		BCU shall be located in relay panels of respective bays. A separate control switch (TNC) spring return type with pistol grip handle for each breaker shall be provided in the SAS pnels housing the BCU to facilitate manual operation. The BCU and other IEDs shall have redundant power supply modules.	We understand that per bay, one SAS panel is envisaged housing a BCU, protection relays and the TNC switch for the breaker control. Hence per bay two feeders for auxiliary supplies are required to be envisaged. Please confirm.	Bidder to follow specification

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451.	II	3.0	20.27.0 20.32.0	61,62 of 353		The server shall be capable of performing all functions of the entire GIS Switchyard including future requirements. Substation automation system shall be suitable for extension in future for additional bays.	The future requirements/ additional bays stated here includes the requirement of following GIS bays: one equipped spare bay two unequipped spare bays Please confirm our understanding	Bidder to follow specification
452.	II	3.0	4.2.0 4.13.0	99,100 of 353		The rating of transformers shall be between 630 kVA and 2500 kVA. Efficiency of the transformers shall be in the range of 98.25 to 98.75% at 0.8 PF at full load for various ratings between 500 kVA and 2500 kVA.	We understand that the rating of service transformers shall be as per system requirements. Hence a rating of 500KVA may also be provided as per system viability.	Bidder to follow specification
453.	Spec. No. SE/C/UP/EE/E/OT No. 01/2015-16	Vol. II, Section 4,4.14 Environment Monitoring System	5.6.0	Page : 12 of 13		Ambient Pressure sensor	Pl provide the specification of ambient pressure sensor	Ambient pressure sensor is integral part of the AAQMS system. The same shall be reviewed for approval on submission of vendor documents during vendor review stage
454.	Spec. No. SE/C/UP/EE/E/OT No. 01/ 2015-16	Vol. II, Section 4,4.14 Environment Monitoring System	4.5.0	Page : 4 of 13		Mercury Measurement sensor	Pl provide the specification of Mercury measurement sensor.	Mercury measurement is integral part of the AAQMS. The same shall be reviewed for approval on submission of vendor documents during vendor review stage

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455.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 4,4.19 C&I Lab Instrumen ts	3.0.0	Page : 2 of 30		Quantity Mismatch	We ambiguity in quantities mentioned between List of Instruments table and followed by specifications of instruments.Pl clarify which quantities shall be considered. Ex: Digital multi meter, Multi function instrument calibrator, mA calibrator, Sound level monitor, Portable analogue vibration meter etc..	There would have been typographical erros which shall be ignored. Summary table in Cl 3.0.0 shall be followed
456.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 4,4.19 C&I Lab Instrumen ts	80.0.0	Page : 23 of 30		PORTABLE FERRULE MAKER / LABEL PRINTER : 1 No. Portable label printer for printing various sizes of labels:	We shall consider various sizes i.e. 2mm to 6mm which are inline to the sizes of ferrule marker . Pl confirm	Confirmed
457.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 4,4.19 C&I Lab Instrumen ts	81.0.0	Page : 23 of 30		**TUBE BENDER / CUTTER:**2 Nos. hydraulic type impulse tube cutter (catering various sizes)	We shall consider various sizes i.e. (½", ¼" and 3/8") which are inline to the sizes of tube bender provided by customer . Pl confirm	TUBE BENDER / CUTTER up to 1 " shall be considered
458.	Spec. No. SE/C/UP /EE/E /OT No. 01/2015 -16	Vol. II, Section 4,4.19 C&I Lab Instrumen ts	32.0.0	Page : 14 of 30		**PORTABLE GAS ANALYZER:** Bidder shall supply one (1) no. Portable gas analyzer for determining the individual quantities of Flue Gas Ranges and accuracy shall be finalized during detail engineering All hardware and chemicals required for operation of these analyzers shall be furnished.	Pl provide the parameters which are to be measured in through portable flue gas analyzer?	The parameters coming the flue gas process of boiler to chimney are to be considered by the bidder.

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459.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 4,4.19 C&I Lab Instrumen ts	62.0.0	Page : 20 of 30		**STABILIZED POWER SUPPLY** – (4 NOS.) – 2.5KVA (1 NO) AND 5KVA (1 NO.)	We presume that 2 sets of 2.5KVA and 2 sets of 5KVA power supply, in total 4 no's stabilized power supply shall be considered. Pl confirm our understanding.	Confirmed
460.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 4,4.2 Scope of supply & services	1.1.6	Page : 3 of 19		**Furniture:** Details of furniture-bb)Control Room desk and furniture.	As per spec requirement, Industrial grade furniture as per OEM recommendations will be considered since detailed specification is not available.	Ergonomically designed, modular furniture required in control room for server, Operator console table, Chair, Printer Table, Office Furniture, etc. with suitable dimension according to Control Room size shall be supplied with the system. The model shall be approved by owner.
461.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 2.0, 2.15 Fire Protection System	3.0.0	Page : 10 of 33		**Fire Detection and Alarm System:** sensors quantity	Quantity of sensors for FDAS shall be considered as per the applicable standards, since details are not provided. Pl confirm.	Bidder shall select the quantity of sensors as per guidelines mentioned in the specification. Refer Vol-II section 2.15 clause 3.0.0
462.	Spec. No. SE/C/UP /EE/E/O T No. 01/2015 -16	Vol. II, Section 2.0, 2.15 Fire Protection System	3.0.0	Page : 10 of 33		Fire Detection and Alarm System: fire detection sensors specification	Specification of sensors for FDAS shall be considered as per the bidder standards, since details are not provided. Pl confirm.	Noted.

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463.	Spec. No. SE/C/UP /EE/E/O T No.01/2 015-16	Vol. II, Section 3,3.21: PUBLIC ADDRESS SYSTEM	4.1.0	Page : 266 of 353		TECHNICAL REQUIREMENTS: Field handset stations shall be spread all over the plant.	We shall consider the Quantities in according to the architecture of PA system (10-1115112-E-220, R-0) provided, which are comprising of 5 zones with 50 no's handsets in each zone.Pl confirm.	Minimum requirements are shown in the drawing. If additional handset stations are required to spread all over the plant, the same shall be considered.
464.	Spec. No. SE/C/UP /EE/E/O T No.01/2 015-16	Vol. II, Section 2 ,2.13 Plant Cooling Water System	6.3.0	Page 9 of 21		Vibration monitoring system for all the CW pumps, ACW pumps and Blow down pumps shall be provided.	In BOP area ,we have consider the vibration monitoring system for the following pumps only : CW , AC & Blow down pumps. Pl confirm our under standing.	Not acceptable. Bidder to provide VMS for all the HT drives as covered in respective sections of C&I
465.	Spec. No. SE/C/UP /EE/E/O T No.01/2 015-16	VOLUME II SUB-SECTION - 2.10.2 CRUSHER	2.10.2	Page 1 of 2		**vibration monitoring system** for crusher bearings shall be provided.	In CHP area ,we have consider the vibration monitoring system for the following equipment only :Crushers. Pl confirm our under standing.	Not acceptable. Bidder to provide VMS for all the HT drives as covered in respective sections of C&I
466.	Spec. No. SE/C/UP /EE/E/O T No.01/2 015-16	Vol. II, Section 4, 4.2 Scope of supply & services	1.1.26	Page : 8 of 19		**General query for BOP DCS systems**	As per the specification requirement , we have considered server frof BOP areas at the central control room and this server shall be common for the systems in the BOP areas.Pl confirm	Bidder to understand that the BOP systems are controlled and monitored from the local control room with the DCS Remote I/IO unit & the dedicated controller for each of the respective BOP systems. Please understand the specification requirement completely for acquiring clarity on the control strategy

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467.	Spec. No. SE/C/UP /EE/E/O T No.01/2 015-16	General				**DCS RIO's for Common areas**	DCS RIO's for common area are not mentioned in the contract specifications, Pl clarify	Bidder to refer the following sections wherein the DCS RIOs requirement are specified 1. Sec 4.2 cl 1.0.0 2. Sec 4.5 cl 1.4.0. d 3. Drawings 00-1112140-I-351, Sheet 1 to 4 Further details regarding the RIOs shall be referred in the contract specifications covered elsewhere. Bidder to read the specification completely to understand the requirement in totality..
IST OF PRE-BID CLARIFICATIONS – BOILER								
468.	Start-Up Recirculation and Drain System	Vol-II / Sec-2	2.1	2 of 66	3.1.0	b) One motorized and One manual isolation valves at suction of start-up recirculation pumps and Motorized isolation, **electrohydraulic** operated control valves and Non return valves at discharge of the start-up recirculation pumps. e) **Mixing box** at pump suction, a non-return valve upstream of the Mixing box on the recirculation line from separator, along with necessary piping and valves.	We offer Super Critical unit, which is based on Benson Once-through Technology. Benson Startup recirculation system comprises of pneumatically open. recirculation valve which maintains min. recirculation with bump-less transfer philosophy. Hence Electro-hydraulic control valve and mixing box is not required/applicable.	Bidder shall provide the details along with bid

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						j) All level controls, **electro-hydraulically** operated fast acting valve with safety features, their isolating valves, bypass/ non-return, drain valves etc. for the start-up circuit.		
469.	Desuper heater system for superheaters and reheater	Vol-II / Sec-2	2.1	3 of 66	3.1.0	c) Two (2) Nos. electrically operated isolating valve downstream of each control valve	Bidder proposes to consider, Two (2) Nos. manual isolating valve downstream of each control valve for superheaters and reheater Attemperator control station	Bidder to follow specification.
470.	Desuper heater system for superheaters and reheater	Vol-II / Sec-2	2.1	3 of 66	3.1.0	f) Drain valve at after downstream of non-return valve to clear spray nozzle blockage.	Drain valve is provided at upstream of Non-return valve (NRV).	Bidder to follow specification.
471.	Superheaters and Reheater System	Vol-II / Sec-2	2.1	3 of 66	3.1.0	All startup vents shall be provided with two valves in series – one motorized isolating and other motorized regulating type.	Bidder proposes to utilize ERV valve as start up vent valve during initial lighting operation.	Bidder to follow specification.
472.	Safety valves / Pressure relief devices	Vol-II / Sec-2	2.1	22 of 66	5.7.0	Capacity of electormatic relief valves shall be 15% BMCR for super heater.	Capacity of electromatic relief valves shall be 10% BMCR for super heater located at seperator outlet but actuation pressure sensed from SH outlet (inline with ASME code). Venting from steam separator area saves	Bidder to follow specification.

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473.	Superheaters and Reheater System	Vol-II / Sec-2	2.1	3 of 66	3.1.0	All start-up vents, ..., first lowest and second lowest set pressure safety valves on the water separators shall be provided with silencers.	Bidder proposes to provide Silencer for lowest set pressure safety valve only.	Bidder to follow specification.
474.	Flue Gas System	Vol-II / Sec-2	2.1	5 of 66	3.5.0	Wear resistant plates in flue gas ducts at corners and direction changing areas (min 5 mm thick)	Duct & dampers are sized with optimum velocity considering erosion nature of ash. Moreover splitters are provided, wherever gas/air changes direction to minimize localized turbulence and erosion.	Bidder to follow specification.
475.	Steam Generator accessories	Vol-II / Sec-2	2.1	5 of 66	3.7.0	Electrically operated automatic sequential type intelligent soot blowing system for furnace, super heaters, ...	The soot blowers shall be fully automatic sequentially controlled with selective soot blowing with Boiler optimization logic.	Bidder to follow specification.
476.	Steam Generator accessories	Vol-II / Sec-2	2.1	6 of 66	3.7.0	Two(2) Numbers of 3000 kg capacity passenger-cum-goods lift for each Steam generator ...	Bidder proposes to consider 1088 Kgs. (equivalent to 16 person) for Passenger Elevator & 3000 kgs for passenger cum goods elevator.	Bidder to follow specification.
477.	Flue Gas and Air Ducts	Vol-II / Sec-2	2.1	15 of 66	4.21.0	Wear resistance plates made out of tougher material such as boron carbide, tungsten carbide, etc., shall be provided in flue gas ducts at corners and direction changing areas (min 5 mm thick)	Refer point 7 above	Bidder to follow specification.

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478.	Steam Generator Seperator/Mixing chamber /Header	Vol-II / Sec-2	2.1	18 of 66	5.3.0	Manhole shall be provided with forged steel cover.	Not applicable to bidder	Bidder to follow specification.
479.	FURNACE AND WATER WALL	Vol-II / Sec-2	2.1	18 of 66	5.4.0	Further, an additional tube thickness of 1.0 mm over and above the thickness of water wall.....	Higher thickness water wall tube (min 0.6 mm over and above the calculated thickness as per IBR) may be provided for entire water wall.	Bidder to follow specification.
480.	SUPERHEATER AND REHEATER	Vol-II / Sec-2	2.1	20 of 66	5.5.0	b) Balance of tubes in the bank shall be provided with additional thickness of minimum 1 mm as erosion allowance over and above the calculated thickness as per IBR.	Minimum tube thicknessa) Minimum tube thickness as per IBR or as required based on performance calculation which ever is higher. The leading tube of each bank in convective pass zone to have erosion shield.b) Minimum tube thickness as per IBR or as required based on performance calculation which ever is higher.	Bidder to follow specification.
481.	Coal Preparation and Firing System	Vol-II / Sec-2	2.1	24 of 66	5.10.5	c) Coal supply to the mills shall be from the individual coal bunkers having useful storage capacity of minimum 14 hours with the unit operation at 100% BMCR....	Bidder proposes to consider, Coal supply to the mills shall be from the individual coal bunkers having useful storage capacity of minimum 10 hours with the unit operation at 100% BMCR Worst Coal	Bidder to follow specification.

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482.	Coal Preparation and Firing System	Vol-II / Sec-2	2.1	24 of 66	5.10.5	d) Coal bunkers shall complete with lining, inertisation,.....	Bidder proposes to consider water quenching system as against steam inertisation.	Bidder to follow specification.
483.	Coal Feeder	Vol-II / Sec-2	2.1	26 of 66	5.10.7	The mass flow of the coal powder shall be adjustable with online orifice adjustment using micro wave based flow measurement.	Not applicable to gravimetric coal feeder. Hence not considered	Bidder to follow specification.
484.	Distribution of pulverized coal	Vol-II / Sec-2	2.1	28 of 66	5.10.10	Pulverized coal piping shall be ceramic lined with the thickness of not less than 15 mm...	Bidder proposes to consider Pulverized coal piping with ceramic lining of 12.7mm thickness	Bidder to follow specification.
485.	Regenerative Air heaters	Vol-II / Sec-2	2.1	33 of 66	5.14.0	Sacrificial hot end element to a height of 300 mm to 400 mm. or Equivalent subject to approval of owner	Space provision for future element addition is considered	Bidder to follow specification.
486.	Regenerative Air heaters	Vol-II / Sec-2	2.1	34 of 66	5.14.0	Sacrificing basket for APH shall be provided at hot end	Refer Point 21 above	Bidder to follow specification.
487.	Regenerative Air heaters	Vol-II / Sec-2	2.1	34 of 66	5.14.0	b) Bearings(Sump lubricated and forced cooled lub oil system)	Bidder proposes to consider sump oil lubrication	Bidder to follow specification.
488.	Dampers	Vol-II / Sec-2	2.1	37 of 66	5.15.2	Before and after each ID fan. : Guillotine gate type	Bidder proposes to consider Multi-louve damper at ID fan inlet.	Bidder to follow specification.
489.	FURNACE	Vol-II / Sec-2	Annex 2.1.1	53 of 66		Maximum Effective Projected Radiant Surface area - 2.1x10^5kcal/hr/m2 Maximum furnace cooling factor - 1.8x10^5kcal/hr/m2	Bidder considers Maximum furnace cooling factor - 2.1x10^5kcal/hr/m2	Bidder to follow specification.
490.	FURNACE	Vol-II / Sec-2	Annex 2.1.1	53 of 66		Loss due to Unburnt Carbon (%) - Guaranteed unburnt carbon loss for boiler efficiency shall not be more than 1%	There is contradiction in tender clauses. Request clarification.	As per 11.11.3.2, Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.).

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491.	Steam Generator Efficiency	Vol-II / Sec-1		72 of 191	11.11.3.2	Unburnt fuel at all guaranteed efficiency load i.e. 1.0% (min.)		shall be considered.
492.	Minimum stable load on the Steam Generator without oil support	Vol-II / Sec-1		78 of 191	8.00	It shall be guaranteed that oil support for flame stabilisation shall not be required beyond 30% of BMCR load	Bidder proposes to consider, No oil support beyond 40% BMCR load when firing any coal from the range	Bidder to follow specification.
493.	FURNACE	Vol-II / Sec-2	2.1	10 of 66	4.10.0	b) For FEGT, the furnace exit plane shall be defined as the plane above the furnace nose tip or the plane beyond which the transverse tube pitching is less than 600 mm whichever is positioned first in the flue gas path.	Bidder proposes to consider, for FEGT, the furnace exit plane shall be defined as plane beyond which the transverse tube pitching is less than 600 mm in the flue gas path.	Bidder to follow specification.
494.	FURNACE	Vol-II / Sec-2	Annex 2.1.1	54 of 66		Max. flue gas velocity before gas flow changes the direction - 10 m/s	Bidder proposes to consider 12m/s (The maximum localized velocity across the cross section shall not exceed 14m/s)	Bidder to follow specification.
495.	SUPER HEATERS AND REHEATERS	Vol-II / Sec-2	Annex 2.1.1	54 of 66		Maximum average flue gas velocity in sections/tube banks with transverse tube pitching 600mm or less and with 25% excess air at economiser outlet :- 10 (The maximum localized velocity across the cross section shall not exceed 12m/s)		

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496.	ECONOMIZER	Vol-II / Sec-2	Annex 2.1.1	54 of 66		Maximum average flue gas velocity through inter-tube space of the economiser banks (the gas velocity shall be calculated considering 25% excess air at economiser inlet):- 8m/s	Bidder proposes to consider 10m/s (The maximum localized velocity across the cross section shall not exceed 12m/s)	Bidder to follow specification.
497.	Pressure Parts Materials :	Vol-II / Sec-2	Annex 2.1.1	54 of 66		c) Upto & including 605 deg C - Alloy steel to ASME SA-335/213:P-91/T-91, T-92, or approved equivalent.	a) Upto & including 610 degree Celsius - Alloy steel ASME SA-335/213:P-92/T-92 or approved equivalent. b) Upto & above 610 degree Celsius-Austenitic stainless steel, Super 304H, TP347H or approved equivalent.	**Pressure Parts Materials** Above 605 deg C : Austenitic stainless steel, Super 304H, TP347H or equivalent shall be provided. Bidder shall meet the process parameters as per specification.
498.	STEAM COIL AIR PREHEATER(SCAPH)	Vol-II / Sec-2	Annex 2.1.1	54 of 66		Air temperature at the inlet of each air pre heater (throughout Steam Generator control range) - To keep average cold end metal temperature minimum 10 °C above the acid dew point for flue gases	Bidder proposes to consider, Air temperature at the inlet of each Air Preheater-To keep average metal temp. (Cold end) at least 76 oC with coal firing and 100 DegC with oil firing.	Bidder to follow specification.
499.	COAL MILLS	Vol-II / Sec-2	Annex 2.1.1	55 of 66		Number of Mills (N) corresponding to maximum 90% mill loading - N+1 : 100% BMCR with worst coalN+2 : 100% BMCR with design coal(preferred total Number of Mills 8 (Min))	Bidder proposes to consider total number of mill as 6 nos. with N+1 : 100% BMCR with design coal and worst coal with 90% mill loading.	Bidder to follow specification.

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500.	COAL MILLS	Vol-II / Sec-2	Annex 2.1.1	54 of 66		Maximum permissible mill loading for selection of mill capacity/type even during worn-out condition - 80% of guaranteed capacity	Maximum permissible mill loading for deciding mill capacity shall be 90% or the mill loading achievable corresponding to the near worn out conditions of mill grinding rolls/balls/tyres etc. whichever is less.	Bidder to follow specification.
501.	OIL BURNER	Vol-II / Sec-2	Annex 2.1.1	57 of 66		b)Atomisation Medium Air for HSD Steam for HFO	Bidder proposes to consider Atomisation Medium: Air/steam for HSD Steam for HFO	Bidder to follow specification.
502.	ELECTROSTATIC PRECIPITATOR	Vol-II / Sec-2	Annex 2.1.1	60 of 66		Inlet dust burden (gm/Nm3) Design Point -To be worked out by the Contractor (based on 90% of ash or actual Guarantee Point - To be worked out by the Contractor (based on 90% of ash or actual predicted whichever is…..	Bidder proposes to consider Inlet dust burden (gm/Nm3) Design Point -To be worked out by the Contractor (based on 85% of ash or actual Guarantee Point -To be worked out by the Contractor (based on 85% of ash or actual predicted whichever is…..	Bidder to follow specification.
503.	Coal Bunker outlet gate	Volume - II Section - 2	SUB-SECTION - 2.1	4 of 66	3.3.0 5.10.6	Clause 3.3.0 : Pneumatically operated sliding type shut off gate at each Coal bunker outlet gates with proper approach and Electrically operated (shut off gate at each coal feeder inlet) Clause 5.10.6. b) : Bunker shut off gate(s) and coal feeder inlet gate(s) shall be provided with the following features : Shut off gates/valves shall be motor	There is contradiction in tender clause 3.3.0 & 5.10.6 about coal bunker outlet valve in that case Bidder propose to follow only clause 5.10.6 for coal Bunker shut off gate. & For coal feeder inlet gate, Bidder propose manually operated gate with double rack and pinion drive	Bidder to comply with specification and shall be as per Cl. 5.10.6-b.

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						operated, with double rack and pinion drive arrangement and shall be of non-jamming type.	arrangement and shall be of non-jamming type. This general engineering practice for all PC fired boiler in India.	
504.	Flue Gas Ducts and Air Ducts	Volume - II Section - 2	SUB-SECTION - 2.1	14 of 66 35 of 66 59 of 66	4.21.0 5.15.1 'ANNEX 2.1.1	Minimum thickness of **7 mm** shall be provided for flue gas ducts before ESP	Minimum thickness of **6 mm** shall be provided for flue gas ducts before ESP	Bidder to follow specification.
505.	Drain Tank	Volume - II Section - 2	SUB-SECTION - 2.1	22 of 66	5.6.0	Selection of design conditions of drain tank shall be as per BS:806	Selection of design conditions of drain tank shall be as per BS:806 /IS:2825	Noted.
506.	Dampers	Volume - II Section - 2	SUB-SECTION - 2.1	37 of 66	5.15.2	Damper gas tightness for the guillotine dampers shall be guaranteed for a gas tightness efficiency of 100% with or without use of sealing air	Damper gas tightness for the guillotine dampers shall be guaranteed for a gas tightness efficiency of 100% with sealing air & 99.7% without use of sealing air	Bidder to follow specification.
507.	Soot Blowers	Volume - II Section - 2	SUB-SECTION - 2.1	41 of 66	5.18.0	The soot blowers shall be capable of selective operation in areas of ash deposition (SMART) type or equivalent	The soot blowers shall be fully automatic sequentially controlled with selective soot blowing with Boiler optimization logic.	Bidder to follow specification.
508.	PA Fan Sizing Criteria	Volume - II Section - 2	SUB-SECTION - 2.1	55 of 66	ANNEX 2.1.1	PA Fan Case A & Case B : Air Pre heater air in Leakage : 15% of primary air leakage in RAPH or Guaranteed value whichever is higher	PA Fan Case A & Case B : Given leakage rate is ok in case of Bi-Sector RAPH, Bidder is proposing trisector RAPH in that case air-in-leakage: Min. 6 % of flue gas flow entering APH, or actual proportion of guaranteed RAPH leakage	Bidder to follow specification.

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							whichever is higher	
509.	FD Fan Sizing Criteria	Volume - II Section - 2	SUB-SECTION - 2.1	58 of 66	ANNEX 2.1.1	FD Fan Case A & Case B : 10% of secondary air leakage or actual guaranteed value whichever is higher	FD Fan Case A & Case B : Given leakage rate is ok in case of Bi-Sector RAPH. , Bidder is proposing trisector RAPH in that case air-in-leakage: Min. 4 % of flue gas flow entering RAPH, or actual proportion of guaranteed RAPH leakage whichever is higher	Bidder to follow specification.
510.	ID Fan Sizing Criteria	Volume - II Section - 2	SUB-SECTION - 2.1	58 of 66	ANNEX 2.1.1	ID Fan Case A & Case B : 10% combined primary and secondary air leakages into flue gas side of RAPH or actual guaranteed values whichever is higher	ID Fan Case A & Case B : 8 % combined primary and secondary air leakages into flue gas side of RAPH or actual guaranteed values whichever is higher	Bidder to follow specification.
511.	FD Fan Sizing Criteria	Volume - II Section - 2	SUB-SECTION - 2.1	58 of 66	ANNEX 2.1.1	FD Fan Case A : Margin over 60% BMCR flow requirement. : 20% Margin over 60% BMCR pressure requirement : 44%	Bidder proposes FD Fan Case A :No Margin is required over 60% BMCR for Flow and Pressure	Bidder to follow specification.
512.	ID Fan Sizing Criteria	Volume - II Section - 2	SUB-SECTION - 2.1	58 of 66	ANNEX 2.1.1	ID Fan Case A : Margin over 60% BMCR flow requirement. : 20% Margin over 60% BMCR pressure requirement : 44%	Bidder proposes ID Fan Case A :No Margin is required over 60% BMCR for Flow and Pressure	Bidder to follow specification.

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513.	General technical Specification	Volume II Section-1.0	Annex 1.4	155 of 191	Mandatory Spares	Spares parts list of Middle speed Mills	Please define the term "Set" for mill spare parts.	Bidder to note that "set" is comprising of complete assembly as per description specified in the specification.
	LIST OF PRE-BID CLARIFICATIONS – MECHANICAL							
514.		II	7		Plot Plan		Please provide auto CAD version of tender plot plan	Already uploaded in the TANGEDCO website
515.	Design Requirements	II	2.8	2 of 9	4.0.0	auxiliaries to be considered a) to o)	c) Cw pump motor d) Access door scaffod doors, k), l) Ash compressor, m) SA, IA compressor. Are to be cooled by ACW system	Bidder to follow specification.
516.	DMCW P&ID	II	7		Zone I-5			
517.	Turbine oil system	II	2.2	3 of 27	3.2.0	2x100% AC MOP, 2x100% AOP,	OEM standard is as below: 2X100 % MOP (AC motor) EOP : 1x100% (DC motor) JOP : 2x100% (1 AC + 1DC)	Bidder to follow specification.
518.	Turbine oil system	II	2.2	4 of 27	3.2.1	2x100% JOP	According to OEM standard JOP is not required.	Bidder to follow specification.
519.	Main oil tank	II	2.2	19 of 27	5.4.0	Explosion proof vapor extractor motor.	Elec hazard classification (zone-II, IEC 60079) for vapor extractor motor does not calls for explosion proof.	Bidder to follow specification.
520.	Oil cooler	II	2.2	19 of 27	5.4.0	Shell and tube oil cooler	Bidder is offering PHE oil cooler.	Bidder to follow specification.

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521.	Central turbine lub oil storage and purification	II	2.2	21 of 27	5.4.0	Suitable arrangement shall be provided to evacuate the lube oil from main turbine lube oil tank, boiler feed pump turbine lube oil tank and clean oil tank and dirty oil tank of central lube oil storage and purification system to emergency oil pit during emergency condition such as fire accidents etc.	Bidder plant operation philosophy does not require such facility.	Bidder to follow specification.
522.	Steam bypass system	II	2.2	22 of 27	5.7.0	Each bypass station shall comprises a quick acting stop valve and a pressure control valve on steam line(operated by separate actuator), a desuperheater, a stop valve and a control valve on spray water injection line(operated by separate actuator),	Bypass valve shall be stop cum control valve.	Bidder to follow specification.
523.	Condenser	II	2.3	2 of 12	3.1.0 (h)	Design for installation of LP heater(s) in condenser neck. The drain cooler to be installed outside the condenser neck.	Drain cooler (if required) shall be integral part of LPH.	Noted and shall be as per OEM standard
524.	Tube side water box test pressure	II	2.3	11 of 12	Anexx 2.3.1	1.5 times of design pressure.	Bidder propose to follow HEI code requirement of test pressure i.e 1.3 times if design pressure.	Bidder to follow specification.
525.	Feed water heating system	II	2.4	5 of 11	5.1.0	Proper drainage of bled steam lines to be ensured. Each bleed lines shall have ordinary and power assisted NRVs and motorised isolation valves except for heaters mounted incondenser neck and extraction to heater from CRH line.	OEM suggest no requirement of ordinary NRV in Bled steam lines	Bidder to follow specification.

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526.	Feed control station	II	2.5	3 of 22	3.1.0	Feed regulating station for feed water flow control during unit startup and normal condition, consisting of the following for each unit: a) One pneumatically operated (0 to 30% BMCR capacity range) feed control valve. b) Two numbers of motor operated gate valves with motor operated integral bypass valve, one each on upstream and downstream of pneumatically operated feed control valve. c) One motor operated gate valve with motor operated integral bypass valve in parallel to the pneumatically operated feed control valve to bypass the feed control in the unit operation range of 30-100% BMCR.	OEM practice is as below: 1. One control valve (0 - 30%). With motorised isolation valve with intergral bypass valve. 2. 30 -100% motorised inching gate valve with integral bypass valve	Bidder to follow specification.
527.	Turbine exhaust pipe	II	2.5	10 of 22	5.1.0	Turbine exhaust pipe shall be separately piped to condenser of main TG unit in the downward direction.	OEM offering TDBFP, MDBFP location of ground floor in BC bay. So Steam exhaust duct is connected in condenser neck it means the BFPT exhaust would be upward.	Bidder to follow specification.

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528.	DEAERATOR	II	2.4	6 of 11	5.3.0	All water spray valves, splash plates, trays, vent condenser and other elements in contact with undeaerated water or noncondensable gases shall be of stainless steel SS-304.	We request owners to accept valve material as following A 351 CF8- body & disc A 276 Type 304 - spring Also, material of construction of all the elements in contact with undeaerated water or non-condensable gases is martensitic stainless steel conforming to SS-410, considering good weldability and similar thermal expansion coefficient as carbon steel and also has fairly good corrosion resistance suitable for the deaeartor application. ASTM A240 410 material has been extensively used by bidder and has provided very good reliability and life.	Bidder to follow specification.
529.	COAL HANDLING SYSTEM	Vol. II; SEC-1	2.0.0 LIMITS OF SUPPLY/ TERMINAL POINT (TP)	15 of 191	2.1.0; S.No.10	The terminal point for the Coal Handling Plant will the from the surge hopper outlet provided in the JNT-1. Four chutes with flanged connection shall be provided) Companion flange is in owner's scope.	M/s TANGEDCO/FITCHNER to indicate the C/C distance between the two streams of surge hopper and upstream two conveyors in client scope i.e EBCN-1A/1B to decide bidders circuit.	Same shall be furnished during detailed engineering. Bidder shall suitably design ICHP accordingly.

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530.	SYSTEM DESCRIPTION	VOL-II; SEC-2	2.10.0 Coal Handling System	3 of 15	3.0.0	Bypass chute will be provided to bypass screen and crusher.	Refer Flow Diagram; Drawing No - 00-1115112-M-007, Rev- 0; There are no by-pass chute for screen & crusher; Bidder shall follow as per Flow diagram. M/s TANGEDCO/ FICHTNER to confirm	Bypass chute will be provided to bypass screen and crusher.
531.	Flow Path Capacity Tests; iii)	VOL-II; SEC-2	2.10.0 Coal Handling System	7 of 15	6.3.2.1, S.No.-iii)	However, for purpose of measurement of guaranteed power consumption the coal shall be discharged into the last bunker of unit-1	Refer Vol. II, Section 6; Sl No 4.1 a); path has been defined upto last bunker of Unit - 2; Bidder follow the path as defined in this clause. M/s TANGEDCO/ FICHTNER to confirm	Bidder to follow volume-II section 6
532.	Functional Guarantees for Coal Handling System	VOL-II; SEC-2	2.10.0 Coal Handling System	6 of 15	6.2.0, S.No.- 1)	The capacity shall be achieved with specified maximum input size of coal even while handling damp & sticky run-of-mill / crushed coal during rainy season having 25 % moisture content & fines upto 40 % without any spillage / choking / over loading of equipment.	The technical parameters for conveyor, skirt, chute valley angle etc. shall be considered as per the specification to avoid spillage / chocking. M/s TANGEDCO/ FICHTNER to confirm	Bidder to follow specification.
533.	Functional Guarantees for Coal Handling System	VOL-II; SEC-2	2.10.0 Coal Handling System	6 of 15	6.2.0, S.No.- 6)	Vibration levels shall conform to the limits specified below and shall be measured as per BS 4675.	Bidder proposed Limits shall be as per VDI2056/BS4675 M/s TANGEDCO/FICHTNER to confirm	Noted.

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534.	DESIGN REQUIREMENTS	VOL-II; SEC-2	2.10.1 Belt Conveyors	2 of 9	2.0.0, S.No-iv	Idlers shall be three roll, 35 degrees troughing angle for carrying side and impact idler & two roll V type for return side for all belt conveyors.	Refer ANNEX – 2.10.1; SPECIFIED DESIGN DATA; 3.4 Self aligning carrying and return idlers Since V-return idlers provided, no self aligning return idlers required. M/s TANGEDCO/ FICHTNER to confirm	Bidder to follow specification.
535.	DESIGN REQUIREMENTS	VOL-II; SEC-2	2.10.1 Belt Conveyors	2 of 9	2.0.0, S.No-iv	Conveyor idlers, below the magnetic separators shall be of non-magnetic material (stainless steel).	ILMS provided at the discharge end of BCN-1A/1B and BCN-9A/9B; non-magnetic idler not envisaged. M/s TANGEDCO/ FICHTNER to confirm	As per Flow Diagram; Drawing No - 00-1115112-M-007, Rev- 0, suspended magnet shall be provided for yard conveyors and emergency reclaim conveyors. Bidder to follow specification.
536.	SPECIFIED DESIGN DATA	VOL-II; SEC-2	ANNEX – 2.10.4.1	2 of 4	2.0	Quantity of Stacker cum Reclaimer required - 4 Nos	Quantity of Stacker cum Reclaimer as per Flow Diagram; Drawing No - 00-1115112-M-007, Rev- 0; shall be two numbers. M/s TANGEDCO/FICHTNER to confirm	Quantity of Stacker cum Reclaimer as per Flow Diagram; Drawing No - 00-1115112-M-007, Rev- 0; shall be four numbers. Bidder to follow specification.

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537.	2.1 Steam Generator & Aux. System	Volume II Section-2.0	ANNEX 2.1.2	63 of 66	SPECIFICATION FOR AUXILIARY BOILER	Complete steam and water circuit includes feed control station comprising of 2x100%feed control valves and Saturated steam from evaporators section / drums shall pass to a convective superheater. Super heated steam shall be connected to aux steam header through a NRV and a motor operated isolating valve	As per auxiliary Boiler operation requirement 1x100% and 1x30% Feed control valve is sufficient	Bidder to follow specification.
538.	2.1 Steam Generator & Aux. System	Volume II Section-2.0	ANNEX 2.1.2	63 of 66	SPECIFICATION FOR AUXILIARY BOILER	One no. D.M. Water storage tank sized for half an hour make-up water requirement.....	As per vendor standards One no. D.M. Water storage tank sized for 10 minutes make-up water requirement.....	Bidder to follow specification.
539.	2.1 Steam Generator & Aux. System	Volume II Section-2.0	ANNEX 2.1.2	63 of 66	SPECIFICATION FOR AUXILIARY BOILER	The chimney shall be manufactured from CORTEN steel plate with insulation and cladding and shall be provided with access door	As per vendor standards One no. Carbon steel chimney of 35 m height shall be provided with access door	Bidder to follow specification.
540.	Fuel oil handling system	Volume - II/Section -2.0	2.9	5 of 19	4.7.0	Configuration shall be Two (2) nos - (1W+1S) each with a capacity of 100 Cum /hr.	Please clarify the capacity of Unloading pumps.	Configuration shall be Two (2) nos - (1W+1S) each with a capacity of 100 Cum /hr.
541.	Fuel oil handling system	Volume-II/ Section-2.0	2.9	13 of 19	Annexure-2.9.1	Rated capacity - 50(each)-m3/hr		
542.	Electrostatic Precipitator	Vol. II, Section 2	2.1 Steam Generator & Aux. System	41 of 66	5.17.0	Bidder shall perform model study i.e Physical scale modeling as well as CFD modeling.	For ensuring proper flow distribution & maximum particulate collection of flue gas, only Computerized Fluid Dynamic Analysis (CFD) shall be conducted for flow modeling and	Bidder to follow specification.

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							simulation. No physical scale modeling shall be conducted. Owner to review & confirm.	
543.	Electrostatic Precipitator	Vol. II, Section 2	2.1 Steam Generator & Aux. System	40of 66	5.17.0	The ESP minimum requirements are: ..... Pipes and condensate traps for steam trace	Bidder proposes to provide Panel type electrical heaters for hopper faces instead of steam trace type heaters, and pipes condensate traps are not applicable for proposed type of heaters	Noted.
544.	Water systems / CPU	Volume : II / Section 2	2.7	1 of 13	3.1.1	**Condensate Polishing Unit :** 3x50% capacity service vessels for each unit.	As per the industry practice, Toshiba proposed 3 x 33% Condensate polishing Vessels instead of 3 x 50%. 3 x 33% configuration is also acceptable by NTPC.	Bidder to follow specification.
545.	Water systems / CPU	Volume : II / Section 2	2.7	2 of 13	3.1.4	**Regeneration system :** Two nos. resin separation / regeneration vessels, one no. mixed resin vessel and one no. mixed resin storage vessel (to hold charge of one service vessel) shall be provided alongwith all internals, fittings and appurtenances for these vessels.	As per the industry practice, Toshiba proposed one number of mixed resin storage vessel instead of two at common regeneration facility. It is also acceptable by NTPC.	Bidder to follow specification.
546.	Water systems / CPU	Volume : II / Section 2	2.7	3 of 13	3.1.4	**Chemical dosing system / Hot Water Tank :** This tank shall be provided with burn out protection, pressure relief valve, level switches, temperature indicator etc.	Burn out protection (insulation) is not required for hot water tank as the temperature of the water inside the tank will be not exceed more than 50 Deg C. Hence, the burn out protection is not provided	Bidder to follow specification.

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							for Hot water tank and associated pipe lines and valves.	
547.	Water systems / Chemical feed system	Volume : II / Section 2	2.7	4 of 13	3.2.0	**Chemical Feed System / Bulk Ammonia storage tank :** Bulk storage tank will be common for both units for storage of concentratedaqueous ammonia as per the available market standards subject to approval of Owner. 2x100% capacity transfer pumps shall be provided for transfer of concentrated ammonia from bulk storage to the measuring tank. The ammonia transfer pumps shall be of centrifugal type.	Bulk ammonia storage tanks may not be required as the consumption of ammonia is minimum. Hence, Toshiba proposed to store the ammonia in carboys / drums / containers instead of Bulk ammonia storage tank and transfer pumps.	Bidder to follow specification.
548.	Water systems / CPU	Volume : II / Section 2	2.7	5 of 13	4.1.0	**Condensate Polishing Unit :** Influent suspended solids during normal operation is 50 ppb.	As per the industry practice, Toshiba proposed influent Suspended solids (crud) during normal operation will be of 25 ppb instead of 50 ppb. It is also acceptable by NTPC.	Bidder to follow specification.
549.	Water systems / CPU	Volume : II / Section 2	2.7	5 of 13	4.1.0	**Condensate Polishing Unit :** Influent pH during normal operation is 8 - 9.3 ppb.	As per the industry practice and Standard guidelines like EPRI, Toshiba proposed influent pH during normal operation will be of 8 - 8.5 instead of 8 - 9.3.	Bidder to follow specification.

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550.	Water systems / Plant cooling water system	Volume : II / Section 2	2.13	6 of 21	5.3.1	**Plant cooling water system :** The pump suction bell diameter shall be such as to limit the flow velocity at the maximum flow to within 1.5 m/sec.	As per the HIS guidelines, the suction bell velocity can be considered upto 2.1 m/sec for the selected ACW pumps & Blow down pumps design flow rate. Please note that suction bell velocity will be finalized during detailed engineering stage based on vendor selection.	Bidder to follow specification.
551.	Water systems / Plant cooling water system	Volume : II / Section 2	2.13	20 of 21	ANNEX 2.13.1	**Plant cooling water system :** Delivery rate of Condenser cooling water pumps : Suitable to supply cooling water to condenser +10% Margin.	10% margin on condenser cooling water flow to size the CW Pump is seems to be on higher side. 5% may be sufficient. Please check and confirm.	Bidder to follow specification.
552.	Water systems / PWT, WW& Chemical Treatment Systems	Volume : II / Section 2	2.14	8 of 34	3.2.1	**PWT, WW& Chemical Treatment Systems :** Turbidity analyzers at the outlet of clarifiers and at the common outlet of gravity filters.	As per the GTS & flow diagram of desalination plant, Gravity filters are not applicable. Please confirm.	Turbidity analyzers at the outlet of clarifiers and at the common outlet of Ultra Filteration module.
553.	Water systems / PWT, WW& Chemical Treatment Systems	Volume : II / Section 2	2.14	8 of 34	3.2.1	**PWT, WW& Chemical Treatment Systems :** SDI analyzer at each SWRO cartridge filter outlet	Toshiba proposed Common SDI analyzer at the outlet of cartridge filter instead of each.	Bidder to follow specification.

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554.	Water systems / PWT, WW& Chemical Treatment Systems	Volume : II / Section 2	2.14	8 of 34	3.2.1	**PWT, WW& Chemical Treatment Systems :** Lime along with carbon dioxide dosing shall be considered at SWRO outlet to achieve the pH and LSI requirements.	We understand that lime and CO2 dosing is applicable only for potable water requirement and not for complete SWRO Permeate water. Please confirm.	Bidder to follow specification.
555.	Water systems / PWT, WW& Chemical Treatment Systems	Volume : II / Section 2	2.14	23 of 34	ANNEX – 2.14.1	**PWT, WW& Chemical Treatment Systems :** Total Capacity of SWRO System : 16 MLD Number of stream : 3 x 50% Net capacity of each stream : 5 MLD	Number of streams , Capacity of each stream and total capacity of SWRO system are not matching. Please check.	Refer Vol II sec 2 sub section 2.14 page 23 of 34, wherein "Minimum capacity of the plant shall be 16 MLD. Number of stream shall be 3 x 50% with each stream of 8 MLD.
556.	Flow diagram for Cooling water system					Quantity of circulating water pumps are 2 Working +1 Standby for each unit. Total number of CW pumps are 4 Working + 2 Standby for both units.	We recommend to consider the CW Pumps configuration as follows : 4 Working + 1 common Standby for both the units with common header.	Bidder to follow specification.
557.	Flow diagram for Cooling water system					Quantity of ACW Pumps are 1 Working + 1 Standby for each unit. Total number of ACW pumps are 2 Working + 2 Standby for both units.	We recommend to consider the ACW Pumps configuration as follows : 2 Working + 1 common Standby for both the units with common header.	Bidder to follow specification.
558.	Flow diagram for Cooling water system					The location of Blow down pumps (3 x 50%) are in CW fore bay.	Provision of tapping from CW pump discharge for blow down instead of providing the dedicated pumps.	Bidder to follow specification.

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559.	Plant Components and Major Equipment	1		9	1.2.0 - Control & Instrumentation System-12	Performance analysis, Diagnosis and optimization (PADO)	Various BTG system performance calculations are already available in offered DCS. Nowadays many indian power developer and generation companies like NTPC is not opting for the PADO package for their latest projects of 660/800/1000 MW capacities. Bidder requests Owner to kindly review whether PADO package is required for this project.	Bidder to follow specification.
560.	Instrumentation and control	1		20	2.3.0-2	Provision shall be made available at the ICHS end for the following 1. DCS IOs for the interface of ECHS equipments 2. Time synchronization signal for extension to ECHS control system	1. Please provide the quantity of the DCS IO to be considered at ICHS end for the ECHS equipment, 2. Only one number of NTP protocol time synchronization signal will be provided.	1. Bidder to understand that this is an EPC contract and it is the bidder's responsibility for the design of I&C system/estimation of IOs based on the specification requirement. Further it is to be noted that the bill of quantity shall not be limited and it shall be provided on as required basis evolving during detail engineering. 2. Redundant ports shall be provided at the ICHS end.

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561.	Environmental Monitoring Station	1		118	20.3.5	Six (6) nos. of environmental monitoring stations shall be provided by the EPC Contractor in accordance with "Environmental Protection Design Stipulation for Thermal Power Projects"	In clause 1.1.33 of Section-4 it is indicated that "Ambient Air Quality Measurement AAQMS (4 lots) complete with all the analyzers, controller, dedicated PC at CCR with all the soft wares, calibration unit and other accessories. Interfaces to plant DCS shall be provided." Bidder requests Owner to kindly clarify the quantity of Environmental monitoring stations.	Minimum of Six (6) nos. of environmental monitoring stations shall be provided in accordance with "Environmental Protection Design Stipulation for Thermal Power Projects".
562.	SCOPE OF SUPPLY	4		1	1.1.0	The proposed system shall be in successful trouble free operation for at least 3 years as on bid date opening in plant capacity of 500MW or more having pulverized coal facility	i) Owner is requested to kindly reconsider the clause for 1 year of operation instead of 3 years of operation. Ii) Please clarify whether this clause is applicable only for the control system or all other C&I items. Reason being it is difficult to comply to this condition for other C&I items to be procured within India.	i) Bidder to follow the specification ii)It is applicable for the control system
563.	SCOPE OF SUPPLY	4		1	1.1.1	SG integral controls shall be provided with the state of Art microprocessor based control & protection system. SG integral controls shall include Burner Management System, Boiler Protection System, Soot	The SG DCS offered will have redundancy in CPUs, Communication and Power supply. Bidder requests Owner to kindly check whether I/Os shall be redundant for these SG	Bidder to follow the specification

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						blower system, Secondary Air Damper Controls & Gravimetric feeder controls. The System shall be completely redundant for CPUs, I/Os, Communication & Power supply.	integral control systems.	
564.	SCOPE OF SUPPLY	4		1	1.1.2	TG integral controls shall be provided with the state of Art microprocessor based control & protection system. TG integral shall include (Automatic turbine run up system, Electro hydraulic governing system, Turbine protection system, Turbine stress Evaluator, Turbo supervisory instrumentation and Automatic turbine testing system). The System shall be completely redundant for CPUs, I/Os, Communication & Power supply.	i) The TG DCS offered will have redundancy in CPUs, Communication and Power supply. Bidder requests Owner to kindly check whether I/Os shall be redundant for these SG integral control systems. Ii) The redundancy requirements indicated is not applicable for Turbo supervisory instrumentation system. Bidder requets Owner to kindly check the applicability of the clause for TSI system.	i) Bidder to follow the specification ii) It is applicable for the control system
565.	SCOPE OF SUPPLY	4		2	1.1.6-e	Two (2) l 24" LED type / Keyboard/ Mouse based Operator station for Unit supervisor	Please clarify whether two (02) operator station for unit supervisor is for the whole plant or per unit.	Two (02) operator station for unit supervisor per unit.
566.	SCOPE OF SUPPLY	4		2	1.1.6-i	Printers (1 lot) as per the plant control system configuration drawing No. 00-1115112-I-350 Rev 0.	Bidder proposes Laser printer in-lieu of Dot Matrix printers shown in the control system configuration drawing. Laser beam printer is of latest technology & also	Bidder to follow the specification

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							easier to maintain.	
567.	SCOPE OF SUPPLY	4		3	1.1.6-s	Plant wide office LAN comprising of 450 users at various location of plant and installation of 300 PCs with 21" LED display units, keyboard/ mouse etc., in the network.	Bidder understands that interface shall be provided to Owner's plant wide office LAN.	Bidder to understand the specification requirement completely wherein the MIS and plant wide office LAN is completely included in bidder's scope. Bidder to refer Sec 4.16 , and the users distribution is as follows 1. No. of licensed users : 300 2. MIS station : 50 3. LAN station : 150 The number of PCs provided by the bidder for MIS and Station LAN shall be 200 in line with the above.
568.	SCOPE OF SUPPLY	4		3	1.1.6-t	Management Information System comprising of 50 PC's with 24" LED display units, keyboard/ mouse, necessary software for viewing process related information and mimics, real time parameter trends, history values etc.,	Bidder understands that only MIS server is in Bidder's scope and the MIS network and user stations are in Owner's scope as indicated in the dwg. No.-00-1115112-I-351. Interface will be provided at Bidder's MIS server end for connection to Owner's ERP server.	Refer reply to S.No 9
569.	SCOPE OF SUPPLY	4		3	1.1.6-u	One (1) HART Management station with 24" LED type / Keyboard / Mouse and Laptop	The HART management system is only applicable for the Unit DCS as per the	Noted.

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						PC with application software for the whole plant.	clause 13.0.0 HART MANAGEMENT SYSTEM (HMS) of section-4.Hence HART management station will be applicable only for the unit DCS instead of whole plant.	
570.	SCOPE OF SUPPLY	4		3	1.1.6-dd	1 no. of Operating Station at CE's room, 1 no. of Operating Stations at Factory manager, and 1 no. of Operating Stations at Electrical System incharge room shall be provided, operation/ command shall not be executed from these three consoles to start/stop the equipments.	Since plant operating parameters can be made available in MIS network through MIS server, and no operation is envisaged from the operating stations to be located at CE, Factory Manager & Electrical In charge rooms; Bidder requests Owner to review whether operating stations will be required for CE/Factory Manager & Electrical Incharge rooms.	Bidder to follow specification.
571.	SCOPE OF SUPPLY	4		4	1.1.6	Operator station shall be provided at local control room for control and monitoring of each Wagon tippler system & stacker reclaimer locally in addition to remote operation from CHP local control room.	Bidder proposes that Wagon Tippler and Stacker Reclaimer systems will be controlled from respective PLC based control systems.	Bidder to follow specification.
572.	SCOPE OF SUPPLY	4		7	1.1.17	Fire protection system (fire water booster system) shall be controlled and monitored from the Fire protection system local control room, through the DCS remote I/Os, Redundant Processor, power supply, communication module,	Bidder proposes PLC based control system for Fire protection system. This control system can be interfaced with plant DCS through communication link for monitoring purpose.	Bidder to follow specification.

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						redundant communication link all hardware, software, other interfaces, cables and field sensors / instruments / erection hardware envisaged to control and monitor it		
573.	SCOPE OF SUPPLY	4		7	1.1.18	Hydrogen generation system shall be controlled and monitored from the Hydrogen generation system local control room, through the DCS remote I/Os, Redundant Processor, power supply, communication module, redundant communication link all hardware, software, other interfaces, cables and field sensors/instruments/erection hardware envisaged to control and monitor it	In table of cl. No.- 1.4.0-d of sec-4.5 Plant control philosophy it is indicated that hydrogen generation plant will be Controlled from PLC with soft link connectivity to plant DCS. Bidder requests Owner to kindly clarify.	Bidder shall provide PLC based control system for Hydrogen generation plant.
574.	SCOPE OF SUPPLY	4		8	1.1.23	Redundant bidirectional Interface through suitable protocol with required hardware and software shall be envisaged for the following: 1. Switchyard SCADA and DCS. 2. EMS and DCS.	Bidder proposes that bi-directional interface is not required for the following reasons: 1. Switchyard SCADA does not require any process data from the DCS, 2. DCS does not require any data from EMS.	Bidder to follow specification.
575.	SCOPE OF SUPPLY	4		8	1.1.24	Unit DCS Operator station shall also be extended to each of the following locations provided with the access to monitor the main plant operations1. ESP control room2. Turbine 0 m floor3. HT	Since plant operation from these areas are not necessary and plant parameters could be made available through Owner's MIS, Bidder requests Owner to kindly review the	Bidder to follow specification.

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						switchgear room4. "A" Elevation boiler5. Switchyard control room6. Express laboratory (SWAS/chemical room)	requirements of the DCS operator stations in the areas.	
576.	SCOPE OF SUPPLY	4		9	1.1.29	User Interface bidirectional Connectivity with other system like ERP & PADO.	Since DCS does not require any information from the ERP & PADO systems, Bidder requests owner to kindly review the requirement of bidirectional connectivity.	Bidder to follow specification for PADO system. Whereas ERP is not envisaged in the EPC contract. But interface to ERP shall be available in the bidder's system.
577.	SCOPE OF SUPPLY	4		9	1.1.34	Necessary interfaces shall be provided to plant DCS for maintenance management system.	The interface between VMAS and plant DCS for the purpose of maintenance management system is not clear. Bidder requests Owner to kindly elaborate the requirement of maintenance management system.	Interface of VMAS with the DCS shall be provided
578.	SCOPE OF SUPPLY	4		9	1.1.35	Vibration monitoring system for all the HT drives and driven equipments for BOP auxiliaries such as CHP, AHP, Compressed air system, Desalination pumps etc shall be provided and interfaced with the plant VMAS. Necessary interfaces shall be provided to plant DCS for maintenance management system.	The purpose of interfacing VMS of BOP auxiliaries to plant VMAS is not clear. Bidder requests Owner to kindly elaborate. Also, the purpose and details of maintenance management system is not clear.	VMAS is a centralized analysis station for the BTG and BOP HT drives. Interface of VMAS with the DCS shall be provided Bidder to follow the above specification requirement

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579.	SCOPE OF SUPPLY	4		10	1.1.38	Four number (4) nos. of 40" LED TVs connected to DCS so as to visualize Annunciation windows/alarm messages in enlarged versions and for viewing process mimics.	Please clarify whether these 4 nos. of 40 inch LED TVs are required apart from the Large Video Screens?	Clarified that 4 nos. of 40 inch LED TVs are required apart from the Large Video Screens
580.	SCOPE OF WORK & SERVICES	4		11	2.5.0	The Owner reserves the right of selecting the manufacturer / model of control & instrumentation items in the interest of standardization wherever necessary and the Bidder shall agree to supply equipment of particular make if so desired by the client without any cost implication.	Bidder requests Owner to provide the list of approved vendors and the makes and manufacturers of C&I system/ equipment, which shall be followed for the project. There will be price implications for the supply of equipment of particular make.	Bidder to follow the specification
581.	SCOPE OF WORK & SERVICES	4		16	2.15.0	WAN with necessary hardware and software. Bidder shall provide two nos. work stations with A4 laser printer (B/W) each along with necessary software & internet connection at Owner's Corporate office for remote monitoring.	We understand Owner will provide the necessary telecommunication facility between the Plant DCS and Owner's corporate office. Terminal points will be at: 1. Gateway at Plant DCS panel in CER of TG Building, 2. Bidder supplied Workstations located at Owner's Corporate office. Please confirm.	Establishing the communication including all necessary software & internet connection for remote monitoring is included in bidder's scope.
582.	SCOPE OF WORK & SERVICES	4		16	2.15.0	For automatic refresh features for viewing Web based Plant information extending option for additional 50 viewers shall be provided.	The requirement for automatic refresh features for viewing Web based Plant information extending option for additional 50	Provision for extending additional 50 viewers in the WAN for viewing plant information shall be provided.

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							viewers is not clear. Kindly elaborate.	
583.	SCOPE OF WORK & SERVICES	4		16	2.17.0	Enterprise resource planning	We understand Bidder will only provide an interface for Owner's Enterprise Resource planning system. Please confirm.	Confirmed
584.	CODES AND STANDARDS	4.4		1	1.3.0	Flow Measurement a) Instruments and apparatus for flow measurement (Flow nozzle assembly)- ASME PTC 19.5 (1972) Interim supplement, Part-II, BS 1042. b) Instruments and apparatus for flow measurement (Orifice plate)- ISO 5167 Part – 1 / BS 1042.	The BS 1042 is not in use. Bidder will follow ISO 5167 for flow measurements.	Bidder to follow specification. However these shall be clarified during post bid/ detail design stage.
585.	Plant control philosophy	4.5		3	1.4.0-d	Control and monitoring system for various balance of plant systems/equipments shall be specified in the below table:-	Bidder proposes PLC based control systems for the BOP packages like AHP, CHP, Water treatment system, Plant water system etc. instead of DCS based control systems since the BOP controls are mostly OLCS and sequential in nature. No complex type of logics, algorithms and calculations are involved. Hence Owner is requested to kindly review the requirement of DCS systems for BOP system controls.	Bidder to follow specification.
586.	Specification for DCS	4.6		12	2.5.4	SER system shall be capable of presenting/acquiring 1024	Bidder understand the requirement of SER is 1024	The requirement of SER is 1024 events for

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						events with a resolution of one milli second.	points for two units.	only one Unit.
587.	GENERAL I/O REQUIREMENTS AND SPARE CAPACITY	4.6		29	12.0.0-v	20% spare fully wired I/O channels shall be provided in each I/O module.	Future use or expansion in the order of 20% is not envisaged for standard designs of similar capacity plants. 10% spare I/O channels in each I/O module is generally envisaged. Bidder requests Owner to kindly review the spare I/O channels.	Bidder to follow the specification
588.	GENERAL I/O REQUIREMENTS AND SPARE CAPACITY	4.6		29	12.0.0-vi	Electrical I/Os required as per Energy Distribution Management System (EDMS), Energy Management System (EMS) and any other electrical system shall also be considered/included by bidder in respective package I/O list.	The requirements of Energy Distribution Management System (EDMS), Energy Management System (EMS) are not clear. Kindly provide the technical details.	Bidder to refer Electrical section for the details regarding the EDMS, EMS etc
589.	General	Vol. II, Section 3	3.1	8 of 353	4.2.0	Auxiliary power supply is envisaged at 11 kV, 6.6 kV & 415 V level.	Bidder proposes Auxiliary power supply at 11 kV, 3.3 kV & 415 V level as followed in most of the 660MW projects in India also by NTPC and other IPPs.	Bidder to follow specification.
590.	General	Vol. II, Section 3	3.1	9 of 353	4.9.0	To feed external coal handling system 2 Nos. each 25 MVA rated feeders shall be provided at 33 kV switchgear located, at Sea water intake electrical room near plant boundary.	Client is requested to confirm that the 33 kv switch gear at sea water intake pump house shall be provided by the owner.	Bidder to refer Volume-II, Section-3, Section 3.8 High voltage (HV) switchgear. Bidder to follow specification.

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591.	General	Vol. II, Section 3	3.1	9 of 353	4.14	LT emergency supply : 415 V (±10%), 3 phase, 4 wire, solidly earthed	Bidder proposes for 415 LT emergency supply, 3 phase, 3 wire shall be accepted by client.	Bidder to follow specification.
592.	General	Vol. II, Section 3	3.1	10 of 353	4.14.0	Voltage levels shall be considered as follows: Above 200 kW & up to 2000 kW: 6.6 kV, 3 phase, 50 Hz Above 2000 kW : 11 kV, 3 phase, 50 Hz	Bidder proposes Voltage shall be considered as follows as followed in most of the 660MW projects in India also by NTPC and other IPPs: Above 200 kW & up to 1500 kW:3.3 kV, 3 phase, 50 Hz Above 1500 kW : 11 kV, 3 phase, 50 Hz	Bidder to follow specification.
593.	General	Vol. II, Section 3	3.1	10 of 353	4.17.0	The three phase symmetrical short circuit ratings of the switchgear and equipment at different voltage levels shall be not less than the following values: a) 400 kV 63 kA for 1 second c) 11 kV 50 kA for 3 second	Bidder proposes that the three phase symmetrical short circuit ratings of the switchgear and equipment at different voltage levels shall be not less than the following values: a) 400 kV 50 kA for 1 second c) 11 kV 40 kA for 3 second or as calculated during detailed engg.	Bidder to follow specification.
594.	General	Vol. II, Section 3	3.1	10 of 353	4.17	Symmetrical Short time withstand current for 415V shall be 65/50kA for 1 Sec.	For 415 volts, Bidder envisages Symmetrical Short time withstand current as 50 kA for 1 sec.	Bidder to follow specification.
595.	General	Vol. II, Section 3	3.1	11 of 353	4.27.0	System study shall be carried out using authenticated validated software of latest version. The system study shall include the following for	a) Bidder do not envisages following studies (shall be the scope of the owner) • System study during	Bidder to follow specification.

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						the entire project including power evacuation system: • Load flow study • Short circuit study during steady state and transient condition. • Voltage drop study during steady state and transient condition. • System study during Islanding / Grid disturbance. • Insulation co-ordination study. • Motor acceleration study • Relay setting coordination study. • Power System Stability (PSS) studies.	Islanding / Grid disturbance. • Insulation co-ordination study. b) Bidder proposes the PSS study scope shall be limited to single machine infinite bus with grid inputs from owner	
596.	General	Vol. II, Section 3	3.1	12of 353	5.6.0	All BTG related SWGR rooms shall have Air Conditioned operator room and have direct access from TG building lifts.	As the plant control is from DCS bidder do not envisages Air Conditioned operator room for this proposal in Electrical SWGR rooms. Client is requested to revisit the requirement.	Bidder to follow specification.
597.	General	Vol. II, Section 3	3.1	12 of 353	5.7.0	Overhead lines from Switchyard shall be tied to a separate gantry structure positioned near respective transformers to facilitate tap off connection to GT and ST etc.	Bidder proposes A row column support also as the alternative arrangement for Overhead line connection from Switchyard Gantry for tap off to GT and ST. Client is requested to confirm the bidder's proposal.	Bidder to follow specification.

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598.	General	Vol. II, Section 3	3.1	13 of 353	5.10.0	Cable spreader room shall be provided for all the electrical rooms and control rooms and control equipment rooms for various buildings and areas: • Main plant turbine building • Central control building • Switchyard control building • ESP control building • Ash handling plant • Coal handling plant • CW water Pump House • Water treatment plant • RO & DM Plant • Out fall sea water pump house • Fuel Oil Pump House	Except main plant building and central control building , bidder do not envisage requirement of cable spreader room for other Bop Buildings as this can be done with cable trench as followed in most of the 660M plants also by NTPC and other IPPs. Client is requested to revisit the tender specification.	Bidder to follow specification.
599.	General	Vol. II, Section 3	3.1	13 of 353	5.12.0	Cables shall not be routed in the coal conveyor gallery. A separate cable gallery shall be provided with walkway along the conveyor gallery	Bidder proposes cable route along the coal conveyor gallery also be accepted by Clinet as followed in most of the 660MW plants .	Bidder to follow specification.
600.	General	Vol. II, Section 3	3.1	13 of 353	5.15.0	All the LV service transformers shall be dry type, located indoor	Bidder proposes only BTG area transformers shall be dry type and BOP area service transformers shall be accepted as oil type as followed in most of the plants .	Bidder to follow specification.

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601.	General	Vol. II, Section 3	3.1	15 of 353	5.30.0	All electrical buildings shall have two floor construction Electrical room • Battery room • Air-conditioned Control room • Cable spreader room • Air-conditioned Maintenance engineers room (5 metreX5metre) • Store cum tool room in ground floor • Toilet (Men & Women) • Pantry Room • AHU Room • The required furniture's such as Chairs, Tables, Almirahs shall be provided.	Bidder proposes electrical building with Single floor Construction with cable trench shall also be accepted by client as followed in most of the 660MW plants in India also accepted by NTPC and other IPPs.	Bidder to follow specification.
602.	General	Vol. II, Section 3	3.1	15of 353	5.31.0	In each electrical room of main plant building, operator cubicle with fan and furniture shall be provided	As the plant control is from DCS do not envisages operator cubicle with fan and furniture for this proposal in Electrical SWGR rooms. Client is requested to revisit the requirement.	In each electrical room of main plant building, operator cubicle with A/C and furniture shall be provided.
603.	POWER TRANSFORMERS & BUS REACTOR	Volume-II/Section 3	3.4	73 of 353	3.2.0	The transformer shall be capable of operating without injurious heating at rated output at any tap position, provided the voltage corresponding to that tap does not vary by more than ±10% of rated voltage.	We understand that the same shall not be applicable for GT, as in case of GT this range shall be limited to +/- 5%. Please confirm our understanding.	Bidder to follow specification.

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604.	POWER TRANSFORMERS & BUS REACTOR	Volume-II/Section 3	3.4	74 of 353	3.16.0	Transformer tank shall be dispatched filled with oil or pure dry inert Nitrogen gas. In case the tank is filled with inert gas the temperature and pressure at the time of gas filling shall be marked on a tag.	Please note that the dispatching of transformer shall be as per transformer manufacturer's standard practice. Customer is requested to accept the same.	Bidder to follow specification.
605.	POWER TRANSFORMERS & BUS REACTOR	Volume-II/Section 3	3.4	74 of 353	3.19.0-a)	Generator transformer shall be used to connect to EHV network to evacuate power. The transformer shall be adequately sized for the stringent operating condition. It shall be rated to evacuate full power of the generator with valve wide open condition at 95% operating voltage, when unit/station auxiliaries are not powered directly by generating source. Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator.	Please note that Generator will never operate beyond VWO condition. Hence GT shall be sized to evacuate all of the generated power under VWO (105% of TMCR) condition. No further margin is considered. Customer is requested to accept the same.	Generator Transformer Rating shall be 3X275MVA (Single phase) as per specification Vol-II, Section-3, DTS-Electrical, page 91 0f 353. The last sentence of referred clause ''Accordingly, GT shall be sized for 110% of maximum continuous rating MVA of generator.'' is deleted.
606.	POWER TRANSFORMERS & BUS REACTOR	Volume-II/Section 3	3.4	76 of 353	4.1.0-b)	The tank shall be of bell type with bolted joint at about 500 mm above the bottom of tank.	Please note that alternatively conventional type tank may also be accepted. Customer is requested to accept the same.	Bidder to follow specification.

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607.	Bus Duct	Vol. II, Section 3	3.6	109 of 353	4.5.0	For steam turbine generator, IPBD shall be sized to evacuate whole generated power at valve wide open (VWO) condition continuously, without exceeding the specified temperature limits. A design margin of 10% shall be considered further.	Please note that Generator will never operate beyond VWO condition. Hence IPB shall be sized to evacuate all of the generated power under VWO (105% of TMCR) condition. No further margin is considered. Customer is requested to accept the same.	Bidder to follow specification.
608.	Bus Duct	Vol. II, Section 3	3.6	109 of 353	4.7.0	SPBD and NSPBD busduct of transformers shall be rated to carry name plate power rating of the associated transformers continuously, without exceeding the specified temperature limits. A design margin of 10% shall be considered further.	10% margin on transformer MVA rating shall be considered for the selection of name plate rating of transformer. Hence, considering 10% margin again shall lead to a duplication of margin. The continuous rating of 11/6.6kV SPBD and 415V NSPBD shall be based on the rated LV winding current of the transformer. Please confirm.	Bidder to follow specification.
609.	Bus Duct	Vol. II, Section 3	3.6	114 of 353	4.22.4	Seal-off bushings shall be dry non-hygroscopic, porcelain/epoxy type.	Bidder proposes to provide epoxy type seal-off bushing. Please confirm.	Bidder to follow specification.
610.	Bus Duct	Vol. II, Section 3	3.6	118 of 353	6.3.0	Short circuit rating and duration- 65 kA/1 sec 50 kA/1 sec	For 415 volts, Bidder envisages short circuit rating and duration as 50 kA for 1 sec.	Bidder to follow specification.

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611.	HT Switchgear	Vol. II, Section 3	3.8	135of 353	4.8 (i)	To feed external coal handling system, 33 kV supply is envisaged, which shall be derived from 11 kV Station switchgear through 11/34.5 kV transformer, 33 kV VCB isolation panels shall be located in the power house building and 33 kV switchgear locating at Electrical room of sea water intake pump house for further routing to external coal handling system.	Bidder proposes to provide outdoor type 33 kV VCB Isolation panel for feeding external coal handling system.	Bidder to follow specification.
612.	HT Switchgear	Vol. II, Section 3	3.8	138 of 353	5.2.1	The main buses and connections shall be of high conductivity Copper / Aluminum alloy sized for specified current ratings with maximum temperature limited to 90°C and 105°C for silver plated joints. The busbars shall be designed for specified short circuit rating.	Bidder proposes temperature rise limits shall be as per IEC 62271.	Bidder to follow specification.
613.	Battery	Vol. II, Section 3	3.14	215 of 353	4.2	220 V Unit battery for main plant : Lead acid Plante type.	Bidder requests that 220 V Ni-Cd Battery shall also be acceptable.	Bidder to follow specification.
614.	Battery	Vol. II, Section 3	3.14	215 of 353	4.2	The duty cycle imposed on the 220 V battery shall be for duration of two hours.	Bidder proposes the duty cycle to be for one hour.Client is requested to accept the requirement.	Bidder to follow specification.
615.	LV Switchgear	Vol. II, Section 3	3.10'	160 of 353	4.2.3	Symmetrical Short time withstand current for 415V shall be 65/50kA for 1 Sec.	For 415 volts, bidder envisages Symmetrical Short time withstand current as 50 kA for 1 sec.	Bidder to follow specification.

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616.	LV Switchgear	Vol. II, Section 3	3.10'	160 of 353	4.2.3	The continuous current rating of the incomers/tie feeders/main bus bars of PCC shall be based on the name plate rating of the upstream transformer with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.	10% margin on transformer MVA rating shall be considered for the selection of name plate rating of transformer. Hence, considering 10% margin again shall lead to a duplication of margin. The continuous current rating of incomers/main bus bars of PCC shall be based on the rated LV winding current of the transformer. Please confirm.	Bidder to follow specification.
617.	DG Set	Vol. II, Section 3	3.18	241 of 353	4.2.0	Diesel Generator shall be rated for "Prime duty". Generator shall be rated of 415 V, 3 phase, 4 wire supply.	Bidder envisages Generator shall be rated of 415 V, 3 phase, 3 wire supply. Neutral of Diesel Generator will be ungrounded. Please confirm	Bidder to follow specification.
618.	CABLE TRAYS, SUPPORTS & ACCESSORIES	Vol. II, Section 3	3.25	304 of 353	4.1.3	FRP cable trays also shall be provided for the following areas. a) WTP b) CHP c) Sea water intake system d) Interplant cable trays	Bidder proposes GI trays in CHP & for interplant cable laying as followed in almost all 660MW plants located in India . Client is requested to confirm?	Bidder to follow specification.
619.	CABLE TRAYS, SUPPORTS & ACCESSORIES	Vol. II, Section 3	3.25	304 of 353	4.1.4	Separate cable tray for Fibre optic cables	Bidder proposes conduit route shall be accepted by client for the signal cables.	Bidder to follow specification.

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620.	CABLE TRAYS, SUPPORTS & ACCESSORIES	Vol. II, Section 3	3.25	305 of 353	4.2.10	Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval of 1500mm for outdoor and 2000mm for indoor locations. Vertical running cable trays shall be bolted to main support channel by suitable bracket/clamps on both side rails at interval of 1500mm.	Bidder proposes that as per normal practice followed by leading consultancy firms both Horizontal and vertical trays can be supported at 2000mm. Client is requested to confirm?	Bidder to follow specification.
621.	EARTHING & LIGHTNING PROTECTION SYSTEM	Vol. II, Section 3	3.28	315 of 353	4.1.8	Earth mat and all earthing conductors for GIS building shall be of copper	Bidder proposes alternative MS rod also as the underground mesh material for earthing.	Bidder to follow specification.
622.	FIRE STOP SYSTEM	Vol. II, Section 3	3.27	310 of 353	2.0.0	All floor openings and wall openings (cable penetrations) in the electrical rooms/cable spreader rooms	Bidder proposes fire stop material only applicable in the main plant building only.	Bidder shall provide fire stop material For complete plan in line with technical specification
623.	FIRE STOP SYSTEM	Vol. II, Section 3	3.27	310 of 353	2.0.0	All floor openings and wall openings (cable penetrations) in the Aux plant buildings	Bidder proposes fire stop material only applicable in the main plant building only.	Bidder shall provide fire stop material For complete plan in line with technical specification
624.	MAIN SLD FOR AUXILIARY POWER DISTRIBUTION	10-1112140-E-201 -				ESP Power supply	we understands that ESP is designed with 4 passes. The electrical SLD scheme will change incase the passes increases more than 4.	Bidder to follow specification.

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1.	Vol.II	2.0	4.0.0 (14)	4/15	Barricade shall be provided around coal yard to avoid flying of coal dust.	Please elaborate the scope to be considered for barricading around coal yard and also it may obstruct dozer movement. Pl clarify.	Refer Vol. - II, Section 2.0 sub section 2.10.0 Page 4 of 15 cause no:14 for Barricading (Wind Barrier). Refer Vol II sec 2 sub section 2.10 clause 4.0.0/Page 4 of 15, wherein " Bidder shall provide sheds either in two stock piles or in four stock piles. If provided for two stock piles, the covered shed shall be 270m. If provided for all four stock piles , the covered shed shall be 140m." Wind barrier shall be provided for the area of the stockpile without the covered shed. Necessary openings for dozer shall be provided in the retaining wall.
2.	Vol.II	2.0	Sub section 2.11.4	1/2	Galavanic anode material…	Provision for fixing the Galvanic Anode material as per Customer's requirement shall be provided. The sacrificial anode (Zn, Al, In) shall have to be provided and replaced as and when required by the Customer. Please confirm.	Noted and this will be reviewed during detailed Engineering.

Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
	Tender Volume / Section	Clause No.	Page No.			
				Pre Bid Reply		
3.	General			PREN > 38	Please confirm the formula considered for arriving PREN no. 1) PREN: 1x%Cr + 3.3x%Mo + 16x%N Or 2) PREN: 1x%Cr + 3.3x%Mo + 30x%N	Bidder to consider the following formula for arriving PREN number: PREN= % Cr + 3.3 (%Mo) + 16 (%N)
4.	Vol-II / Section-1.0 (General Technical Specification)/ Page 98 to 99 of 191/Cl. 13.0.0			Spare Parts, Wear and Tear Parts.	Bidder observes that the quantity of Mandatory spares specified is either in terms of Nos, Set or in Percentage (%). TANGEDCO is requested to clarify the Definition of "Set" and Percentage (%) to be followed by bidders while submitting the offer.	Bidder to note that "set" comprises of complete assembly as per description specified in the specification. "%" of each type & size as specified in the specification.
5.	Vol-II / Section-1.0 (General Technical Specification)/ page 129 to 178 of 191		Annexure-1.4	Mandatory spares		
WATER SYSTEM						
6.	(i) II/ 1.0/- (ii) II/2.0/ 2.13	11.5.2 ANN.2.13.1	67 of 191 18 of 21	The plant performance guarantees to be provided during Performance Test shall be based on the following condition. Relative humidity - 65%. Design relative humidity for Cooling Tower: 75% As per volume II section 1.0 clause no.5.2.0 Bidder shall collect the actual data for a period of 20 years from the meteorological department pertaining to Thoothukudi location and design for plant accordingly. Design condition shall be subjected to owner's approval. Adverse condition of the above two shall be taken for the design condition without any commercial implication.	The two Clauses specified are contradicting each other. We understand that RH of 65 % is to be considered for Design purpose of NDCT since the guarantees of the plant are also at 65 % RH. Please confirm as design RH has considerable effect on design of NDCT.	Design relative humidity for Cooling Tower: 75% As per volume II section 1.0 clause no.5.2.0 Bidder shall collect the actual data for a period of 20 years from the meteorological department pertaining to Thoothukudi location and design for plant accordingly. Design condition shall be subjected to owner's approval. Adverse condition of the above two shall be taken for the design

Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
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						condition without any commercial implication.
7.	II/2.0/2.14	ANN. 2.14.1	25 of 34	Potable water overhead tank: 75 m3	We understand that this tank of 75 m3 is same as the Twin Compartment Service & Potable water tank for Plant (RCC Overhead tank) mentioned at Page 23 of 32 of the same ANNEXURE. Please confirm.	Refer page 25 of 34 /Sec-II/Vol-2 Service water tank :500 m3 Potable water tank: 75 m3
POWER CYCLE						
8.	II/2.0/2.2 II/2.0/2.1 II/7.0/-	Clause 4.1.0 & 5.21.1 and Tender drawing DWG NO. 10-1112140-M-002	8 of 27 48 of 66	Attemperating water for the HP Bypass valves shall be taken from feed water pump discharge and for LP Bypass shall be taken from Condensate Extraction Pump discharge. Spray water system shall include spray water control valves, Non-return valve and isolating valves. The spray water for de-superheating station shall be supplied from boiler feed pump discharge or inter stage tap-off. The system is provided with pressure and temperature control valves to meet the requirements of auxiliary steam system. Please refer to Flow diagram for steam, feed water & condensate system DWG NO. 10-1112140-M-002 wherein spray water for HP Bypass and APRDS system is indicated from HPH 8 Outlet. However, as per clause 4.1.0 & 5.21.1 section II, Spray for HP bypass and APRDS is taken from feed water pump discharge	As per Bidder's practice, Spray water for HP Bypass spray is taken from feed water pump discharge. Spray for APRDS is taken from CEP discharge and only one control valve shall be provided to match the process parameters. Please Confirm.	Bidder shall consider spray water for HP bypass from feed pump discharge. Spray for APRDS shall be from CEP line during full load operation only. During startup, the spray water for APRDS shall be from Feed pump discharge shall be considered. Bidder shall follow specification for other technical requirements.
9.	II/7.0	Tender drawing DWG NO.		Feed Control Station shown at downstream of HP heaters.	Feed Control station shall be located before HP heaters as per IBR. Please Confirm.	Bidder clarification noted as per specification Vol-II, Section-2.4, pg 4 of

Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
	Tender Volume / Section	Clause No.	Page No.			
				Pre Bid Reply		
		10-1112140-M-002				11. Cl: 4.5.2
WEIGH BRIDGE						
10.	II / 2.0 / 2.22	3.4.1 S. No. 14.1	20 of 34	Accuracy required ± 0.05%	Accuracy of load cell is ± 0.05% of rated output and accuracy of electronic weigh system is ± 0.1% of rated output (Full Scale) as per IS 9281. Kindly confirm acceptance.	Bidder to follow the specification
11.	II / 5.0/5.2	5.2.25.3	27 of 38	Chemical / Hazardous Storage building – this building shall be of RCC…….shall be designed for truck traffic	please clarify which building is this?	Building for SWRODM , STP, ETP , Chemical / Hazardous Storage building. Any other buildings involved Chemical / Hazardous handling as per the specification shall also be considered
12.	II/7.0/-	Dwrg No. 00-1115112-M-005, Sh 1 of 3		Auxiliary Steam header for road tanker heating and condensate return header to collect condensate from road tanker heating is shown.	Customer to please note that as per RTI no BPCL/RTI/2014-15/03546 dated 09.04.2015 raised with BPCL, no road tankers are provided with heating coils. HFO is brought to site in heated condition and are thereby unloaded by gravity flow & pumping. In view of above, no steam hoses, condensate hoses and steam & condensate headers nearby road tankers unloading area are required and the same is not being considered by us. Steam shall be provided only for HFO tanks heating and suction heaters mounted on HFO tanks. Please confirm the same. A copy of RTI attached for reference.	This shall be finalised during detailed engineering.

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Sl. No.	Enquiry Specification			As per Technical Specifications	Bidders' Comments/Clarifications	TANGEDCO's Reply
	Tender Volume / Section	Clause No.	Page No.			
				Pre Bid Reply		
13.	II /2.0/ 2.12	6.0.0	4 of 13	Total storage capacity for each unit to store mill rejects for 24 effective running hours at worst coal	Since specification calls for providing 2 nos. bunker for each unit, we have envisaged each bunker with 12hrs storage capacity to achieve cumulative storage of 24hrs for one unit. Kindly confirm acceptance.	Bidder to follow the specification
14.	II/5.0/5.5	5.5.2.2 Foundations and Underground Structures	2 of 37	No foundation shall rest on filled up soil. Minimum depth of foundation shall be at least 1.5m below virgin soil.	Please inform the depth of filling done by TANGEDCO at proposed site.	Depth of filling done by Owner is available in Attachment # 2 and 3 of tender specification Vol-III
15.	II/5.0/5.1	5.1.2	5 of 17	Anti-termite treatment for all buildings	Anti-termite treatment shall be provided to all vulnerable areas susceptible to termite attack only. Please confirm.	As mentioned in Clause 5.3.13, "Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible….. as directed by the owner."
16.	II/5.0/5.3	5.3.13	8 of 11	Pre-constructional anti termite Civil-treatment shall be given to all vulnerable areas susceptible to termite Attack		
17.	II/5.0/5.10.1	5.10.1.6.2	17 of 32	The staircase shall be supported by a structural steel framework independently of the wind shield.	At internal platform levels, staircase shall be supported by steel framework of internal platforms and for other landings locations shall be supported by shell. Please confirm.	Confirmed
18.	II/3.0/ 3.10 2.0.0	159 of 353		415 V, AC intelligent Power control centers (PCC) for units, station, auxiliary plant and non plant buildings. b) 415 V, AC intelligent Motor control centers (MCC) for units, station, auxiliary plant and non plant buildings.	The details of intelligent Power Control Centre and Intelligent motor control centre is not mentioned in the specification. Please clarify what features are desired in intelligent PCC / MCC.	Intelligent PCC / MCC shall be provided as per ANNEXURE 2

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Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
Mechanical-Ash Handling plant							
19.	Vol-II, Sec-2, 2.11	2.1.0	3 of 13	From Economiser hoppers, coarse ash will flow to the scraper chain conveyor (above the maintained water level) by means of an adequately sized sloping pipe Fly ash from Economizer hoppers are also conveyed to bottom ash hopper using flushing apparatus and same shall be handled as a part of this system	Please clarify the discharge of Economizer hoppers in to the bottom ash handling system.	Discrepancy noted in different parts of specification.	From Economiser hoppers, coarse ash will flow to the scraper chain conveyor (above the maintained water level) by means of an adequately sized sloping pipe shall be considered
20.	Vol-II, Sec-2, 2.11	2.5.0 (c)	5 of 13	Recovery water system shall be sized considering excess rainfall.	As per industrial practice Recovery system is not designed considering rainfall. If system is designed considering the same, please provided the followings: a) Intensity of Rainfall. b) Retention time of rain water.	This will save installation cost, pumping (auxiliary) power.	Vol-II, Sec-2, 2.11 2.5.0 c wherein " Whenever ashes are disposed in dry mode and excess water during rainfall, clear water shall be taken to sea water outfall." Rain fall data please refer page 28 of 191/Sec-I/GTS/Vol-II

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Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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21.	Vol. II, Section 1.0 ANNEX - 1.4 MANDATORY SPARES	GENERAL Quantity of Spares	129 of 191	We understand that the quantity of spares mentioned in the list is common for two units. Please confirm.	Clarification		Noted
22.	Section-2/Subsection-2.4/Volume-II	3.2.1	8 of 34	Turbidity analyzers at the outlet of clarifiers and at the common outlet of gravity filters.	The turbidity analyzers are envisaged at the outlet of the PSF. Owner to confirm.	The tender does not specify requirement of any gravity filter.	Turbidity analyzers at the outlet of clarifiers and at the common outlet of Ultra Filtration module.
23.	Section-2/Subsection-2.4/Volume-II	3.2.8	10 of 34	Service and potable water system consisting of Service Water Pumps for pumping water to the main plant Service Water Overhead Tank, Plant Potable Water Pumps for pumping water to the Potable Water Overhead Tank. Further Distribution of service and potable water in the various location shall be by gravity.	We have considered Service water and Potable water distribution network with piping and valves. For potable water 1 cum plastic tanks shall be provided on the roof of all the critical buildings. Owner to confirm.	As per the tender requirement Service water overhead tank and potable water overhead tank are required. Piping networks for both Potable water and Service water shall simplify the system and reduce the construction cost and construction time.	Bidder to follow specification
24.	Section-2/Subsection-2.4/Volume-II	Annex-2.14.1	25 of 34	Service water and potable water tanks- Overhead- Twin Compartment. Service water = 500 cum and Potable water = 75 cum.	We would like to offer service water tank with 100 m3 capacity of each unit i.e. total 200 m3 capacity of both units. Further, service water tank & potable service water tank will be of MS construction as per IS 800	Please clarify Bidder understanding	Bidder to follow specification.
25.	Section-2/Subsection-2.14/Volume-II	3.3.1	12 of 34	Sizing Criteria for Electro chlorination system For sea water intake system – 1 ppm continuous dosing at	For sea water intake system - 1 ppm continuous dosing at forebay and 3 ppm shock	Tender specification does not specify the design criteria	Noted.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
				forebay & 3 ppm shock dosing at velocity cap	dosing at velocity cap **once in a shift for 30 minutes** has been considered.		
26.	Vol-II, Sec-1,	1.2.0 (32)	7 of 191	Solar PV Plants on Roof Tops. The Solar Photo Voltaic (PV) installation on Rooftop of various buildings in the SG Package of Thermal Power Plant shall be carried out preferably on shadow free area in such a way that the generation is maximized on each building Rooftop suitable for installation of Solar PV power plants. The final solar plant capacity shall be as per detailed approved engineering design of each of the buildings	Please furnish list of buildings for which Solar PV plants on roof tops shall be considered.	Clarification is sought to bring all Bidders at par.	Refer enclosed Annexure-1-solar roof top
27.	Vol-II, Sec-5, ' Vol-II, Sec-1,	5.2.25.5 6.2.3	28 of 38 35 of 191	Maintenance Office cum Stores with provision for tool room of adequate area shall be provided in the following areas. This can be either independent building or can be part of Pump House / MCC / Other buildings nearby. Minimum size shall be 5.0 m x 15.0 m. - Mill Area – (may be accommodated in ground floor of Bunker Bay or Power House Building) - Boiler Area All BOP pump house shall have a tool room with racks and maintenance room of each (5 X 5 meters) in addition to control room.	We have consider 5 MX5 M space for tool room and maintenance room for the pump houses mentioned in clause 5.2.25.5. Please confirm.	Clarification is sought to bring all Bidders at par.	Bidder to follow Vol-II section 5 clause 5.2.25.5 completely. For any other pump houses not listed in above section, Vol-II section 1 clause 6.2.3 shall be applicable.

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Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
28.	Vol. II, Section 1.0 GTS Vol. - II, Section 2.0	11.5.2 ANNEX 2.13.1	67 of 191 18 of 21	11.5.2 Contract Specific Site Reference Conditions The plant performance guarantees to be provided during Performance Test shall be based on the following condition. a) Ambient conditions: • Altitude - Finished Ground Level (FGL) refer clause 6.0.0 • Ambient dry bulb temperature - 32.0°C. **• Relative humidity - 65%.** Cooling Tower Datasheet **Design Relative Humidity : 75 % As per volume II section 1.0 clause no.5.2.0** Bidder shall collect the actual data for a period of 20 years from the meteorological department pertaining to Thoothukudi location and design for plant accordingly. Design condition shall be subjected to owner's approval. Adverse condition of the above two shall be taken for the design condition without any commercial implication.	Discrepancy observed in design relative humidity of NDCT & Plant performance guarantee basis. Owner is requested to confirm Relative Humidity to be considered for NDCT design.	Clarification to bring all Bidders at par.	There is no discrepancy in the specification. Vol. II, Section 1.0 GTS Clause 11.5.2 deals with boiler performance guarantee. Vol. - II, Section 2.0 ANNEX 2.13.1 deals with cooling tower requirement. Bidder to follow specification.

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				Pre Bid Reply			
29.	Vol. II, Section 2	5.10.8Coal mills	27 of 66	The flap of power operated mill discharge valves shall be totally out of coal path during operation of the mill.	Bidder proposes to use pneumatic operated Knife Gate valve at mill outlet.	Bidder standard practice	Bidder shall ensure that pneumatic operated Knife Gate valve at mill outlet shall be totally out of coal path during operation of the mill.
30.	Vol. II, Section 2	5.11.1 Burner Design	29 of 66	• Each burner shall be provided with its own igniter and flame scanner.	Specific igniter for each coal burner is not envisaged. However during start-up, adjacent oil burner which is located between two coal burners will act as a igniter for coal burner.	Bidder standard design	Bidder to follow specification.
31.	Sec. 2.0 / Chapter 2.10.0 / Vol. II	4.0.0	4 of 15	All equipment drives shall be capable of starting on full load. However two stream operations shall be considered for designing coal handling system. All electrical system, water requirement shall be designed accordingly.	Owner is requested to clarify the criteria for Electrical transformer sizing. Single stream operation or simultaneous operation of both stream needs to be considered for each transformer sizing.	Clarification for requirement	All electrical system, water requirement shall be designed for two streams operation as per specification.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
32.	Sec. 2.0 / Chapter 2.10.0 / Vol. II	4.0.0	4 of 15	All equipment drives shall be capable of starting on full load. However two stream operations shall be considered for designing coal handling system. All electrical system, water requirement shall be designed accordingly. Separate pumps (1W+1S) shall be provided for the Dry fog system.	Bidder understands that 1 No. dust suppression pump (with 100 % capacity) shall fulfill the water requirement of single conveying stream. For stand-by conveying stream, standby pump of dust suppression shall be working. Please confirm our understanding is correct.	Clarification for requirement	Separate pumps (1W+1S) shall be provided for the Dry fog system. Working pump shall take care both conveyors as per the requirement.
33.	Sec. 2.0 / Chapter 2.10.0 / Vol. II	6.3.2.3	8 of 15	The guaranteed power consumption as total sum of all the equipment as specified shall be measured during capacity test of the identified Flow Paths for both the streams separately	We understand that guaranteed power consumption shall be based on Rated capacity of system. Not as per design capacity. Please confirm.	Clarification for requirement.	Bidder to follow specification.
34.	Vol. II, Section 1.0	11.11.3.4 (4) 11.11.5.8	74 of 191 87 of 191	Coal Handling System – Maximum of the mentioned flow path in the specification: 0.6 (Duty Factor) Power consumption of all equipment shall be guaranteed. Vibration and noise level of all the equipment at the rated duty point shall be demonstrated at site	As per clause no 11.11.3.4 (4) , power consumption for equipment of only guaranteed flow path shall be guaranteed. Power consumption of other equipment shall be demonstrated at site. Please confirm.	As there is a discrepancy in different parts of specification.	Bidder to follow volume II section 6.0 Clause 4.1 a, Maximum of Blending option 1 and blending option 2 shall be considered for auxiliary power consumption. Power consumption of other which is not part of guaranteed path shall be

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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							guaranteed separately as per specification.
35.	Volume II/ Section - I	2.1.0	12 of 191	d) Sludge disposal from desilting basin at Sea.	Bidder request owner to provide the following detail: 1) terminal point where the sludge from desilting basin has to be disposed in sea . 2) Also provide information regarding piping system design to be considered for the disposal. 3) If the pipe can be routed on the support structure of intake/outfall point.	owner to provide more data/information.	Refer Vol II section 2.14 Annex 2.14.1 page 17 of 34. Same route as the intake/ outfall shall be followed.
36.	Volume II/ Section - I	7.1.0	38 of 191	The auxiliary systems and plant facilities shall be designed for serving the whole power plant with adequate redundancy. Secondary system component shall be designed generally for 100% redundancy in order to achieve high reliability and availability of the power plant.	The specification clause no 7.1.0 is generic about 100% redundancy of secondary system component ,However for auxiliaries for which redundancy is clearly specified elsewhere in the tender specification ,those shall be followed for the redundancy/stand by equipment.	clarification	Bidder shall consider all redundancies requirement as per specification.
37.	Vol. II, Section 2.12 Mill Reject Handling System		13 of 13	Note: All equipment shall be suitable for seawater application.	Mill reject system equipment will not come to contact with sea water. Hence bidder understand that this 'Note' is not applicable for this system. Please confirm.	Clarification.	Noted.
Fuel oil handling system							

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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38.	Vol-II, Sec-2, 2.9	4.2.0	3 of 19 5 of 19	A margin of 10 % shall be added to the calculated head requirement. A margin of 10% shall be added to the calculated head requirement.	10% margin of friction drop of Piping & valves will be considered while selecting pump head. Please confirm.	Clarification	Noted.
39.	Vol-II, Sec-2, 2.9	4.4.0	4 of 19	The heaters shall be sized considering inlet temperature as 30° C and the design shall conform to TEMA/ ASME SEC-VIII	HFO Heaters shall be sized considered inlet temperature as 50 Deg C. Please confirm	Inlet oil to HFO heaters shall be sucked by HFO pressuring pumps from HFO storage tank which will be maintained at 50 Deg C.	Noted for Heavy Fuel Oil Tank Suction coil Heaters.
40.	Vol-II, Sec-2, 2.9	4.7.0	7 of 19	Auxiliary steam after pressure reduction / PRDS shall be available for Steam heating / tracing for Heavy Fuel oil unloading, storage system and HFO heaters along with drain oil system shall be provided to maintain the oil temperature and viscosity.		As there is a discrepancy in different parts of specification.	
41.	Vol-II, Sec-2, 2.9	4.10.0	6 of 19	Drain oil pump shall be vertical positive displacement, twin screw, steam jacketed type pumps shall be provided to transfer the drained oil to heavy fuel oil storage tanks. Configuration shall be 1W + 1S.	Bidder has considered single screw pump for drain oil pumps. Please confirm.		Noted.
42.	Vol-II, Sec-2, 2.9	Annexure 2.9.1	17 of 19	Datasheet of Drain oil pumps Vertical , non clog, single screw pumps	Bidder has considered heater with u tube bundle as mentioned in datasheet. Please confirm.	As there is a discrepancy in different parts of specification.	Noted.
43.	Vol-II, Sec-2, 2.9	5.12.0 (b)	9 of 19	The heat exchanger shall be shell/straight tube single pass type having oil flow through the tubes			

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44.	Section 3.1/ Volume II	5.24	14	Transformer Oil Filter Plant shall be housed in a Building.	Bidder proposes Mobile Transformer oil filtration plant because the transformer yard is wide spreader and there are few other transformers which are located at various places within plant area. Our proposal may please be accepted.	Ease of maintenance.	Bidder to follow specification
45.	Section 3.10/ Volume II	4.2.8	160	The power control centers and motor control centers shall be intelligent type.	Brief specification with component requirement of intelligent MCC may please be provided.	Information not available in tender document.	Intelligent PCC/MCC shall be provided as per Annexure 2
46.	Section 3.10/ Volume II	7.12.0 4.3.4	179 161	Relay and timers	As intelligent control units are specified for ACB, may please reconfirm requirement of relay.	Clarification	Intelligent PCC/MCC shall be provided as per Annexure 2.
47.	Section 3.18/ Volume II	4.16.0	243	-	We propose not to provide DG PCC 1/2 and directly connect each DG to Emergency MCC. This is to avoid chain of breakers in series so that during emergency conditions, dependency on control gears is reduced and DG can be put quickly in service. We further propose, a NC breaker as incomer to Emergency PMCC. NO	Difficulties experienced in past projects.	Bidder to follow specification

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				Pre Bid Reply			
					breaker will be housed in AMF. Cable till AMF will be kept charged always. On operation of U/V on Emergency MCC, DG and Standby DG will receive start command and upon building up of voltage AMF CB will be closed automatically. Like DG PCC 1/2, we will provide a PCC for Standby DG. May please accept our proposal.		
48.	Vol II /Section -I/ GTS	1.2.0	7 of 191	32. Solar PV Plants on Roof Tops. The Solar Photo Voltaic (PV) installation on Rooftop of various buildings in the SG Package of Thermal Power Plant shall be carried out preferably	Owner to please clarify whether solar PV plant is in bidder's scope or not. If it is to be considered by the bidder, kindly furnish the technical specification for the same.	Missing information	Bidder shall refer Annex – I Roof top Solar PV enclosed as attachment.
49.	I / 5, II / 6	4.0, 4.0	101 of 146, 5 of 302	SCHEDULE - 1 FUNCTIONAL GUARANTEES Total Auxiliary power consumption for the plant (1320 MW) including balance of plant at 100% TMCR condition after subtracting excitation power and power of TG integral auxiliaries with following	Bidder understand that since tender ask for separate guarantee & evaluation of Transformer losses, it will not be considered in guarantee quoted in Sr.no.4.0 of Schedule-1, "Total Auxiliary Power consumption for the plant". Owner may please confirm	Clarification.	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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	I / 5, II / 6	5.0, 5.0	102 of 146, 5 of 302	conditions: 1. Cycle make-up : 0% makeup 2. Cooling water inlet temperature of 33 deg.C 3. TDBFP's in operation 4. Generator power factor of 0.85 .....kW Transformer losses (at rated capacity of transformers) Loss figures should be inclusive of Tolerances	bidder's understanding.		
50.	I / 5, II / 6	5.1 (a, b, c, d), 5.1 (a, b, c, d)	133 of 146, 31 of 302	SCHEDULE – 2 GUARANTEED AUXILIARY POWER CONSUMPTION Total auxiliary power consumption of the following Electrical Systems at 100% TMCR a) Generator Transformer losses b) Unit Transformer losses c) Station Transformer losses d) Losses in all other transformers	Bidder understand that the referred list to be deleted from "SCHEDULE-2 GUARANTEED AUXILIARY POWER CONSUMPTION" as it is already covered at Sr.no.5.0 "SCHEDULE - 1 FUNCTIONAL GUARANTEES" Owner may please confirm bidder's understanding.	Mismatch / Clarification.	Bidder to follow specification
51.	I / 5	5.0	102 of 146	Transformer losses (at rated capacity of transformers) Loss figures should be inclusive of Tolerances **Generator Transformer**	Bidder understands that the transformer losses will be evaluated based on factory test report. Please confirm.	Clarification.	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
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				a) Iron Losses.....kW b) Copper Losses.....kW c) Cooler Pump / Fan Losses.....kW **Unit Auxiliary Transformer** a) Iron Losses.....kW b) Copper Losses.....kW c) Cooler Pump / Fan Losses.....kW **Station Transformer** a) Iron Losses.....kW b) Copper Losses.....kW c) Cooler Pump / Fan Losses.....kW **Standby maintenance Transformers** a) Iron Losses.....kW b) Copper Losses.....kW c) Cooler Pump / Fan Losses.....Kw			
52.	II / 1	11.11.3.4	73 of 191	**Total Auxiliary Power Consumption** The unit auxiliary power consumption shall be calculated using the following relationship. ... . While guaranteeing the auxiliary power consumption the bidder shall necessarily include all continuously operating unit auxiliaries. The auxiliaries to	List of auxiliaries are already specified at Vol-I, Sec-5, page no.130 of 146 "SCHEDULE – 15A GUARANTEED AUXILIARY POWER CONSUMPTION Complete list of auxiliary power consumption at input ... ... condition:" of price schedules. Bidder is considering list of auxiliaries as per above list	Clarification.	Bidder to follow specification

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
				be considered shall include but not be limited to the following: UNIT AUXILIARIES (TO BE CONSIDERED FOR CALCULATING PU)	and hence ignored list provided at clause no.11.11.3.4, page no.73 of 191, Vol-II, Sec-5.		
53.	II / 1	11.11.3.4	73 of 191	**Total Auxiliary Power Consumption** The unit auxiliary power consumption shall be calculated using the following relationship. Pa = Pu+TL Pa = Guaranteed Auxiliary Power Consumption. Pu = Power consumed by the auxiliaries of the unit under test. TL = Losses of the transformers supplied by bidder based on **works test reports.**	Both the clause contradict. As per clause no.11.11.3.4, the term TL represents "Losses of the transformers supplied by bidder based on **works test reports**." WHERE AS As per clause no.11.11.3.4 (5), losses at **100% TMCR rated load** has been asked. Bidder understand that losses of transformer at 100% TMCR to be quoted under "**Total Auxiliary Power Consumption**". This is in line with Vol-I, Sec-5, page no.130 of 146 "SCHEDULE – 15A GUARANTEED AUXILIARY POWER CONSUMPTION Complete list of auxiliary power consumption at input ... ... condition:" of price schedules. Please confirm.	Clarification.	Bidder to follow specification
54.	II / 1	11.11.3.4 (5)	75 of 191	Total auxiliary power consumption of the following Electrical Systems at **100 % TMCR** a) Generator Transformer losses (**at rated Load Condition**) b) Unit auxiliary transformer losses (**at rated load conditions**) c) Station transformer losses			

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
				(**at Unit rated load conditions**) d) Losses in all other transformers (**at rated load conditions**) e) Losses in Bus ducts (**at rated load conditions**) • Isolated Phase Bus Duct • Phase segregated busduct f) UPS power consumption (**at rated load condition**) g) DC System power consumption (**at rated load condition**) h) Any Other Items (Contractor to list any other continuously running equipment)			
55.	II / 1	11.11.3.4	73 of 191	**Total Auxiliary Power Consumption** The unit auxiliary power consumption shall be calculated using the following relationship. Pa = Pu+TL Pa = Guaranteed Auxiliary Power Consumption. Pu = Power consumed by the auxiliaries of the unit under test. TL = Losses of the transformers supplied by bidder based on **works test**	Both the clause contradict. As per clause no.11.11.3.4, Pa = Pu+TL, where TL represents only transformer losses. WHERE AS, items like Busducts, UPS, DC systems are indicated in referred clause no.11.11.3.4 (5) which are missing in formula indicated in clause no.11.11.3.4 Either formula need to be	Clarification.	Bidder to follow specification. It is self explanatorily.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
				reports.	updated OR the extra item indicated in clause no.11.11.3.4 (5) needs to be deleted. Bidder understand that list of auxiliaries mentioned at Vol-I, Sec-5, page no.130 of 146 "SCHEDULE – 15A GUARANTEED AUXILIARY POWER CONSUMPTION" of price schedules shall be followed. Please confirm.		
56.	II / 1	11.11.3.4 (5)	75 of 191	Total auxiliary power consumption of the following Electrical Systems at **100 % TMCR** a) Generator Transformer losses (**at rated Load Condition**) b) Unit auxiliary transformer losses (**at rated load conditions**) c) Station transformer losses (**at Unit rated load conditions**) d) Losses in all other transformers (**at rated load conditions**) e) Losses in Bus ducts (**at rated load conditions**) • Isolated Phase Bus Duct • Phase segregated busduct f) UPS power consumption (**at rated load condition**) g) DC System power consumption (**at rated load condition**) h) Any Other Items (Contractor to list any other continuously running equipment)			
57.	II / 1	11.11.3.5	75 of 191	Transformer Losses Transformer losses (at rated capacity transformers (**UAT, ST, GT & service transformer individually**) a. Iron loss b. Copper loss c. Cooler Pump / fan loss	Bidder reads the clause as follows: "Transformer losses (at rated capacity transformers **(GT, UT, ST and Standby Maintenance Transformer individually)**" The above is as per Sr. No. 5.0 of SCHEDULE - 15 "FUNCTIONAL	Clarification.	Bidder to follow specification. It is self explanatorily.

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
					GUARANTEES" Vol-I, Sec-5. Please confirm.		
58.	ANNEX - 1.4 MANDATORY SPARES		155 of 191	Mandatory Spares	Please confirm Mandatory Spares required for Pulveriser/Coal Mills. Also specify the definition of sets.	Clarification	Bidder to refer specification, Volume II Section 1 GTS, ANNEX - 1.4, pg 155 of 191 for the spare list for mills. Bidder to note that "set" is comprising of complete assembly as per description specified in the specification.
59.	ANNEX - 1.4 MANDATORY SPARES	154/191		Mandatory Spares	Please change the Quantity for Pressure part spare as below: Sl. No. 1 (Various spec tube of water wall system/ super heater /re heater/economizer etc.,) - 100 ~~160~~ M	Clarification	Bidder to follow specification.
60.	ANNEX - 1.4 MANDATORY SPARES	155/191		Mandatory Spares	Dampers - Quantity not specified	Clarification	Bidder to refer specification, Volume II Section 1 GTS, ANNEX - 1.4, pg

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
Pre Bid Reply							
							155 of 191 under Spares parts list for Boiler Pt. No. 16.
61.	ANNEX - 1.4 MANDATORY SPARES	134/191		Cooling water pumps 1) CWP	Bidder understands that item no. 2 to 4 are to be provided as mandatory spares for CWP. Please confirm.	Clarification	Noted
62.	ANNEX - 1.4 MANDATORY SPARES	_		GENERAL	Bidder understands that the items which falls under multiple category, spares partening to those items shall be consider for only one category which ever specified higher number of spares.	Clarification	Bidder to follow specification.
63.	Vol. II, Section 4.3	5.3.0	8 of 11	Flow nozzles will be used for main steam flow, feed-water flow and other criticalmeasurements where weld-in construction is required. Orifice plates will be used for other liquid flow measurements where flanged construction is acceptable.	As per bidder proven practice for supercritical boiler , the flow nozzles are used for boiler feed water applications. All other application such Aux steam /CCW etc., orifice plates are used. The accuracy of flow element will be as per market availability Main steam flow measurement is not applicable for super critical boilers.		Bidder to follow specification.
64.	Vol. II, Section 4.12	1.1.3(a)	4 of 16	a) Flow nozzles will be used for main steam flow, feed-water flow and other critical measurements where weld-in construction is required. Orifice plates will be used for other liquid flow measurements where flanged			

Sl. No.	Section / Part / Chapter / Volume	Clause No.	Page no.	Description	Statement of clarification sought	Reason for clarification	TANGEDCO 's Reply
				Pre Bid Reply			
				construction is acceptable. Accuracy of the measuring orifice plates, nozzles and annubar shall be minimum +-1%. Ultrasonic type flow meter shall be used for cooling water flow application with an accuracy of minimum +-0.4% of measured flow or better and haste alloy C wetted part material to be used if insertion type is provided.			
65.	Vol. II, Section 4.8	1.11.0	10 of 19	**Coal mass flow balancing system** On line fuel measurement facility for accurate measurement of coal mass flow rate/air fuel ratio in each pulverized fuel (PF) pipe for each pulverizer. The equipment shall comprise of sensors working on microwave technology.....	As this is not a proven system in the Indian power plant, the same is not considered by bidder. TANGECO/FI shall accept.		The system is envisaged based on the experience and the requirement. The system holds good and bidder to follow the specification

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
Pre Bid Reply								
66.	II	Section 2.0 / sub section 2.15 Fire Protection System	3.0.0	7 of 33		Fixed Foam System	Please clarify control valves purpose for foam system.	Foam system consists of the following, Foam tank, proportioners,, Foam makers with discharge outlet, piping, valves, fittings and other accessories as per specification. control valves meant for flow control of Foam & water ratio
67.		General					In general practice desalinated water is not used directly for fire fighting system. After RO permeate water only used for fire fighting system because of desalinated water is contain high TDS, sodium & chloride,due to corrosion will occur in pipe line with respective equipment. Please clarify.	LSI correction is provided at the SWRO permeate to avoid the corrosion in the downstream distribution network. Bidder to follow specification.
68.	VOL-II	Section 5-civil	5.10.3.1	2 of 6		Area and final design height of the bund shall be as per Mechanical specification. Contractor shall construct the starter bund upto 5 m	We presume that the height of starter bund upto 5m mentioned is inclusive of free board.	Noted
69.	VOL-II	Section 5-civil	5.10.2.9 (d)	6 of 12		For the load combination 0.9DL+1.5WL, uplift of the foundation, not exceeding a sector of 15 degrees is permitted, provided the	We presume that the sector angle for load combination 0.9D+1.5WL, uplift of the foundation, not exceeding a sector of 30	Confirmed

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
						Pre Bid Reply		
						foundation is a continuous annular raft foundation	degrees is permitted. Please confirm.	
70.	VOL-II	Section 1- General technical specification civil	6.1.2	30 of 191		Earthworks and Site grading	We understand that the client has formed the levels of site to cetain elevation in some locations as marked in the attachment 2 side graded level drawings and balance area is ungraded. The finished grade level is mention as RL+ 3.30m above MSL. Please confirm whether the balancing levels inside these blocks and also in ungraded areas are also to be graded to RL + 3.30m i. e .. an additional filling of 3.3-2.45 =0.95 is required in the graded areas.	Complete plant area (except ash pond shall be graded to FGL (RL 3.300m).
	VOL-II	Section 5- civil	5.1.4	7 of 17		Site levelling		
	Vol- III	Attachment 2				Site grading levels		

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
				Pre Bid Reply				
71.	VOL-II	Section 5-civil	5.2.3.8	7 of 38		Storm water diversion channels	We request the client to provide the details of peripheral channel along the western boundary of the project site.	Clause 5.2.3.8 says "Report titled "Design of Peripheral Channel to Pass the Runoff & Upstream Surplus in Udangudi Thermal Power Project Site" by Anna University, Chennai shall be referred to during the design of the channels." (refer No.4 of attachments /Vol-III of tender specification)
72.	II	3.0	20.23.0	61 of 353		The SAS shall support simultaneous communications with remote control centre as well as regional load dispatch centre (RLDC).	As per SAS architecture drawing no: 10-1115112-E-217 Rev.0 , we understand that the remote control centre referred in this clause means DCS control. Please confirm our understanding.	Bidder to follow specification.
73.	Spec. No. SE/C/UP/EE/E/OT No. 01/2015-16	Vol. II, Section 4,4.19 C&I Lab Instruments	General			Model & Make of the Instrument	We will consider the model & make of the instrument as bidder approved sources where ever the details are not available.	Bidder shall follow the instruments make which has been indicated in the specification. However for the instruments for which the make is not indicated in Technical Specification the same will be reviewed based on the credentials for approval and acceptance by TANGEDCO.

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
				Pre Bid Reply				
74.	Spec. No. SE/C/UP/EE/ E/OT No. 01/2015-15	Vol. II, Section 4,4.18 Plant Security & Surveillance System				Routers & Network switches	Pl provide the specification for Routers & Network switches specifications	Brief details of Routers and switches are covered elsewhere in the specification. However the same shall also be reviewed for approval on submission of vendor documents during vendor review stage
75.	Spec. No. SE/C/UP/EE/ E/OT No. 01/2015-16	Vol. II, Section 4,4.18 Plant Security & Surveillance System	5.0.0	Page : 19 of 19		**Patrol Guard System:** The system shall comprise of a selected number of proximity card readers located in various strategic locations of the Udangudi Supercritical Thermal Power Project including the perimeter	Pl provide the quantity of proximity card readers.	100 Locations.
76.	Spec. No. SE/C/UP/EE/ E/OT No. 01/2015-16	Vol. II, Section 4,4.18 Plant Security & Surveillance System	4.0.0	Page : 18 of 19		**SECURITY CARD ACCESS SYSTEM** :Access system cards shall be suitable for individual configuration of access privileges via access control software for controlling access to different locations. Biometric detection system is preferred.	Pl provide the quantity of Access cards.	1500 Cards.
77.	Steam Generator accessories	Vol-II / Sec-2	2.1	17 of 66	5.2.0	Clear cavity height of minimum 1.5 m shall be provided between two sections/ banks of the economiser for maintenance access.	Bidder proposes to consider Clear cavity height of minimum 1.0 m between two sections/ banks of the economiser for maintenance access.	Noted
78.	Steam Generator Seperator/Mixing	Vol-II / Sec-2	2.1	18 of 66	5.3.0	Minimum load with separator dry shall be 25% BMCR	Minimum load with separator dry shall be 30-40% BMCR	Noted

SL No.	Title	ENQUIRY SPECIFICATION				Specification Requirement	Clarification / Deviation	TANGEDCO's Reply
		Sec. / Part	Sub. Sec	Page	Clause			
						Pre Bid Reply		
	chamber/Header							
79.	SUPERHEATER AND REHEATER	Vol-II / Sec-2	2.1	19 of 66	5.5.0	e) Minimum clear spacing between any two sections of horizontal tube banks shall be 1500 mm.	Bidder proposes to consider Clear cavity height of minimum 1.0 m between any two horizontal sections/ banks for maintenance access.	Noted

ANNEXURE-1

TO PRE-BID CLARIFICATION

SOLAR ROOF TOP

1.1 The Solar Photo Voltaic (PV) installation shall be provided on Rooftop of the buildings in the Stage – I shall be connected to grid at 415 V switchgear located in respective buildings (such as Turbine Building, Service Building, Administrative Building, Switchyard control Building, etc.,) The exact locations shall be decided during Detailed Engineering. **The total capacity shall be not less than 750 kWp.**

1.2 Solar power from inverters shall be connected to 415 V grid supply through dry type indoor isolation transformer.

1.3 Metering shall be provided at each PV installation in respective 415 V switchgear, as per the "Central Electricity Authority (Installation and Operation of Meters) Amendment Regulations, 2013".

1.4 The plant should meet the Capacity Utilisation Factor (CUF) of not less than 19% as per the CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations 2012.

1.5 As per connectivity regulation for renewable energy plants notified by CEA, measurement of Total Harmonics Distortion, DC injection and Flicker at point of connection is to done annually. One set of necessary measuring instruments shall be provided for the same.

1.6 The system shall be provided with all necessary protections like Earthing, Lightning & Surge and Grid Islanding in accordance with the latest codes & standards and best industry practices. Protection shall comply as per CEA's "Technical standard for connectivity of the distributed generation resources", Regulation 2013.

1.7 Permanent staircase access to roof of all building having solar rooftop shall be provided.

1.8 Solar PV data shall be integrated into the plant network for monitoring through DCS HMI or EMS to monitor plant performance. Any hardware required for the same shall be included in the scope.

1.9 All data required for the project site relevant to solar PV plant shall be in bidder's scope.

1.10 The Performance Guarantee (PG) Test shall be carried out after successful commissioning of all solar rooftop locations. PG Test shall be carried out on any rooftop location by measuring Performance Ratio (PR) and comparing to the Guaranteed PR. Bidder to indicate the guaranteed valve in the bid.

1.11 The following items shall be provided as Mandatory spares.

a) Solar PV module -1% of total population
b) Inverter -1 Nos. of highest size of supplied capacity
c) DC cable -10% of total length
d) Inverter cooling fan - 5% of total population
e) Electronic cards & Communication cards of Inverter - 1 No of each type
f) DC side Surge Arrestor - 1 No
g) Energy Meter – 1 No

1.12 Solar PV modules used in plant(s) / system(s) must be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years. All the mechanical mounting system and structures along with Inverters of the Solar PV plant must be warranted against any manufacturing, design and installation defects for a minimum period of 5 years.

1.13 Design ambient temperature shall be considered as 50 deg C for all electrical equipment design.

1.14 The equipment and systems with proven design and have a service facility in India. The bidder shall get vendor approval from the owner

1.15 The plant instrumentation and control system should be designed to ensure high availability and reliability of the plant for safe and efficient operation of the plant.

1.16 The power plant has to operate in parallel with the grid system which is an infinite electrical system. Any faults not taken care will result in damage of SPV power plant, thus the Solar Power Plant has to protect its equipment against any possible fault or other disturbances from the Grid.

1.17 All the materials shall be as per standard SPV plant requirements and may adhere to the necessary safety standards and environmental requirements.

1.18 The plant and machinery including accessories and other materials should be new and complying with international standards, and approved either by the MNRE (or) by approved test centers in India/International test houses.

1.19 To ensure building safety, weight acting on any part of the roof shall not be more than 150kg/m2. This aspect has to be ensured by the detailed load calculations to be submitted by the contractor.

2.0 TECHNICAL SPECIFICATIONS

2.1 Solar PV system shall consist of following equipment / components.

a) Solar PV crystalline modules
b) Module Mounting Structures (MMS) and Civil Structures
c) String Monitoring Units
d) String Inverter
e) Transformers
f) Cables
g) Meter
h) Earthing and lightning protections
i) Conduits, pipes and accessories
j) Cleaning & water washing system
k) Energy metering system

Solar PV system: Suitable for saline and Dusty atmosphere

SOLAR PHOTO VOLTAIC (PV) MODULES

The Solar PV modules must conform to the latest edition of IEC 61215 / IS14286 for Crystalline Silicon Terrestrial PV Modules design qualification and type approval. In addition, the modules must conform to IEC 61730 Part-1 -requirements for construction & Part 2 -requirements for testing for safety qualification or Equivalent IS.

Each PV module used must have a Radio Frequency Identification Tag (RFID) capable of withstanding harsh environmental conditions carrying technical details of the Module. The capacity of each of the solar module shall not be less than 275 Wp and no negative tolerance from quoted power rating on solar module shall be allowed. Proven solar PV modules shall be offered. Solar PV modules shall be suitable for saline and Dusty atmosphere.

The module shall be tested as per IEC 61215 latest edition and manufactured in India and also type tested by any one of the accredited test laboratories under Ministry of New & Renewable Energy, Government of India. Also modules must qualify to IEC 61730 Part I and II for safety qualification testing. The type test certificate for solar module shall be submitted

Solar PV module array shall consist of high efficiency Solar Modules utilizing crystalline Silicon Solar PV cells. Power output Guarantee Certificate offered for the SPV Module shall not be less than 25 years.

The PV modules shall be supplied using a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions.
(i) Name of the manufacturer of PV Modules
(ii) Name of the Manufacturer of Solar cells
(iii) Month and year of the manufacture (separately for solar cells and module)
(iv) Country of origin (separately for solar cells and module)

(v) I-V curve for the module
(vi) Peak Wattage, Im, Vm and Fill Factor (FF) for the module
(vii) Unique Serial No and Model No of the module
(viii) Date and year of obtaining IEC PV module qualification certificate
(ix) Name of the test lab issuing IEC certificate

(x) Other relevant information on traceability of solar cells and module
The PV module shall perform satisfactorily in humidity conditions up to 100% with temperature between 10°C to 85°C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to that effect should be provided along with the supply of materials.

a. Raw materials(Solar cells) and technology employed in the module production processes shall have to be certified and a certificate giving details of major materials i.e. cells, Glass, back sheet, their makes and data sheets to be submitted for the modules at the time of supply of materials by the bidder.
b. The rated output power of any supplied module in single string shall have tolerance of +/- 3% to avoid array mismatch losses.
c. The peak-power point voltage of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
d. The front module surface shall consist of impact resistant, low-iron tempered glass for strength with anodized Aluminium frame.
e. Crystalline high power cells shall be used in the Solar Photovoltaic module. Solar module shall be laminated by lamination technology using stabilized polymer Ethyl Vinyl Acetate (EVA) and Tedlar / Polyester laminate.
f. The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation shall be compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/ material. The encapsulation arrangement shall ensure complete moisture proofing during life of the solar modules.
g. All materials used shall have a proven history of reliable, light weight and stable operation in external outdoor applications and shall have service life of more than 25 years.
h. Weatherproof DC rated MC 4 connector and a connecting cable coming out as a part of the module, making connections easier and secure, not allowing for any loose connections.
i. The module shall be resistant to water, abrasion, hail impact, humidity & other environmental factors for the worst situation during its service period.
j. The offered module shall have a Power warranty of 25 years with degradation of power generated not exceeding 20% of the minimum rated power over the 25 years period and not more than 10% after ten years period. Necessary certificate to this effect shall be furnished
k. The environment to be installed is highly polluted suitable precaution to be taken care in design stage.

MODULE MOUNTED STRUCTURES (MMS)

Solar PV Module shall be suitably inclined to receive maximum insolation at the site. However to accommodate more capacity and maximizing generation output, the angle inclination may be optimized to achieve the best performance requirements. Module Mounting Structures must be suitable to mount the Solar PV Modules on the roof top, at an angle of tilt with the horizontal in accordance with the latitude of the place of installation preferably with a Fixed Tilt angle. Type of mounting arrangement shall be selected depending on the load bearing capacity of roof and regional wind speed. For wind data, refer project information furnished elsewhere in the specification.

In case offered support structure is of MS type then, the frames and the complete leg assemblies of the array structures shall be Hot Dip Galvanized. Thickness of galvanization will be IS-4759 or relevant standard. In case offered support structure is of Aluminum Alloy necessary protection shall be provided anodization. The grade of anodic coating shall be AC25 as per IS:1868.

Module Mounting Structures shall be designed to withstand the extreme weather conditions in the area. The risk coefficient factor (K1) shall be taken as 1.0. The terrain factor (K2) and topography factor (K3) shall be as per IS 875.

The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels. Suitable clearance within the array shall be maintained for access for maintenance. The structure shall be designed to allow easy replacement of any module and shall be in line with site requirements. **The solar power plant shall be designed in such a way that the actual load of entire system acting on the roof top of the high rise building shall not exceed 150kg/sqm. Detailed calculations for ensuring this, has to be submitted by the contractor.**

All fasteners shall be of stainless steel of grade SS 304.

The module mounting structure shall be rested on the roof top floor and should not be grouted to the floor. No damage should occur to the weather proof tiles on the roof top floor during the erection of the structures. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. The module alignment & tilt angle shall be calculated to provide the maximum annual energy output..

The structures shall be designed for simple mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site.

The bidder shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, but not limited to, the following;

a. Determination of true south at the site;
b. Array tilt angle to the horizontal, with permitted tolerance;
c. Details with drawings for fixing the modules;
d. Details with drawings of fixing the junction/terminal boxes;
e. Interconnection details inside the junction/terminal boxes;

An appropriate Solar PV Module cleaning & water washing system complete GI pipes, valves, hose pipes, wipers, mops etc. shall be provided for regular cleaning and water washing of the rooftop Solar PV modules. Minimum two sets of Microfibre based cleaning tool is to be provided for each rooftop location.

The water required for cleaning shall be provided near the service tank at each building. It is contractor responsibility to distribute the same with necessary pipes and isolation valves. The drain from the system shall be connected to plant drain system

2.2 CABLES AND CONNECTIONS

a) The cables used in the system should be ISI marked PVC or XLPE insulated FRL Sarmoured Copper / aluminum conductor. Cables of various sizes as per load requirement for connecting all the modules / arrays to Junction Boxes and from Junction Boxes to DC distribution box and from DC distribution box to inverter.

b) Cables for use at the DC-side of PV system shall meet the requirements of TUV standard 2PfG 1169/08.2007 or other equivalent standard.

c) Suitable rigid conduits shall be provided for cables connecting Solar PV array with Inverter .All cable entry to and from Inverter must be able to prevent access of rodents, termites and other insects into the Inverter.

d) The permissible voltage drop from the Solar PV Module to the Inverter shall not be more than2% of peak power voltage of source

2.3 INVERTOR

Inverter of minimum 90% of Solar Field name plate capacity should be provided to convert DC power produced by Solar PV modules to AC power. The Inverter should be grid interactive and the output should be compatible with the grid frequency. Typical technical features of the Inverter shall be as follows:

a) String Inverter shall be three phase, transformer-less design with minimum euro efficiency of 98%.String Inverter may be selected in a way to keep string voltage within MPPT range under all temperature conditions from 10 deg to 50 deg ambient.

b) The Inverter shall be suitable for parallel operation with Total Harmonics Distortion of current less than 4% at 50% load. Inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

c) The Inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683 and IEC 600682(6,21,27,30,75,78).The Inverters should comply with IEC-61727 or IEC-62116 or equivalent standard for grid connectivity.

d) The protection class of electronics components of string inverter should be IP 65 (for outdoor) and balance of system of string inverter shall be IP 54 (indoor).In case combiner box is used, the enclosure shall be Flammability Fire Retardant, Halogen free and UV resistant with IP 55 class or better.

e) The solar string inverter should be capable of supplying reactive power to its full capacity when real power generation is not there (sleep mode / night hours) from the solar PV system, as per the technical specification. (Necessary catalogue/ documentary evidence meeting this requirement should be enclosed).

TECHNICALSPECIFICATION FOR STRING INVERTER:

Output voltage :3 phase,440Vac
Output Frequency :50 Hz
Dc link voltage range :up to 1000V
Operating temperatures Range :-25°C to +60°C
Inverter Max. efficiency :98% and above
Protection of Enclosure :IP65 for outdoor installation
Operating Power Factor : User settable during active power generation mode.
Total Harmonics Distortion (Voltage) : Less than 3% (certificate to be
Furnished at the time of supply of materials)
Other important features /protections required in the inverter are detailed below.
Mains (Grid) over/under voltage and frequency protection, Lightning and transient protection.
Fool proof protection against Islanding.
Continuous Maximum Power Point Tracking (MPPT) to ensure the highest yield from the installed PV capacity.
Array ground fault Monitoring
Automatic reconnection after recovery from the fault conditions and /or black 60
Type II DC surge protectors should be integrated inside the inverter.
All parameters should be accessible through an industry standard communication link.
A disconnection device should be present on the DC input side for additional protection.
The inverter shall be self-commuted and shall utilize a circuit topology and components suitable for meeting the specifications listed above at high conversion efficiency and with high reliability.

The inverter shall be capable of operating in parallel with the LT grid and shall be capable of interrupting line-to-line fault currents and line- to ground fault currents including multiple line and Grid faults.

The inverter shall include appropriate self protective and self diagnostic features to protect itself and the PV array from damage in the event of safe operating range due to internal or external causes. Faults due to malfunctioning within the inverter, including commutation failure, shall be cleared by the inverter protective devices and not by the existing site utility grid service circuit breaker.

Inverter shall provide full active power at unity power factor. full reactive power support if utility demands for it. Inverter should be able to handle both static and dynamic reactive power control. Inverter shall provide reactive power support to the grid at night when no PV power is available.

The internal copper wiring of the inverter shall have flame resistant insulation. Use of PVC is not acceptable. All conductors shall be made of standard copper.

The inverter shall withstand a high voltage test of 2000 V rms, between the input / output terminals and the cabinet (chassis).

Full protection against accidental open circuit and reverse polarity at the input shall be provided.

The inverter shall not produce Electromagnetic Interference (EMI) which may cause malfunctioning of electronic and electrical instruments including communication equipment, which are located within the facility in which the inverter is housed. Certificate to this effect to be furnished.

A communication device should be integrated in the inverter to enable the local and remote monitoring of the inverter parameters. Following parameters should be available for the monitoring: Status of the inverter, instantaneous AC voltage and current, Power factor, power output, DC voltage, current and DC power. Along with above parameters any alarms, faults, event logs should be available for monitoring.

The inverter shall go to shutdown/standby mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriate time delay

In sufficient Solar Power Input. When the power available from the PV array is insufficient to supply the losses of the inverter, the inverter shall go to a standby/shutdown mode. The inverter control shall prevent excessive cycling during night shut down or extended period of insufficient solar radiation.

Utility- Grid Over or Under Voltage. The inverter shall restart after an over or under voltage shutdown when the utility grid voltage has returned to within limits for minimum of two minutes.

Utility- Grid Over or Under Frequency. The inverter shall restart after an over or under frequency shutdown when the utility grid frequency has returned to within limits for minimum of two minutes.

Also the following operating modes are to be made available:

Operational or MPP tracking mode: Maximum power point tracker shall be integrated in the Inverter to maximize energy drawn from the array. The MPPT should be micro processor based to minimize power losses. The details of the working mechanism of MPPT shall be mentioned. The control system shall continuously adjust the voltage of the

generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold.

Electrical safety ,earthing and protection

Internal Faults: Inbuilt protection for internal faults including short circuits, over loads, single phasing, two phasing, excess temperature, commutation failure, over load and cooling fan failure (if fitted) is obligatory.

Over Voltage Protection : Over Voltage Protection against atmospheric lightning discharge to the PV array is required. Protection is to be provided against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.

Earth fault supervision: An integrated earth fault device shall have to be provided to detect earth fault on DC side and shall send message to the supervisory system.

DC reverse polarity protection.

The Inverter shall have the feature of built-in isolation to avoid transfer of surges from AC to DC and Vice versa.

2.4 INTEGRATION OF PV POWER WITH GRID:

a) The power from Solar PV would be fed to the Inverters which converts DC to AC and feeds it into the 415 V bus after synchronization. In case of grid failure, or low or high voltage, Solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the grid is energized / normalized, the Solar PV system shall again be automatically e synchronized and load requirement would be met to the extent of availability of power. Power evacuation shall be at3-phase 4-wire system

b) Isolation / Step up Transformer shall be converter duty, dry type of suitable voltage rating, 50 Hz shall be provided along with all protections, switchgears, circuit breakers, cables etc. and required civil work. The rating and vector group shall be as per manufacturer recommendation

c) Metering shall be done in compliance to provisions of Central Electricity Authority (Installation and Operation of Meters) Amendment Regulations, 2013. 0.2 accuracy class meters along with necessary CTs and PTs shall be provided in designated solar feeders in 415 V switchgears.

2.5 PLANT METERING AND DATA LOGGING :

PV array energy production : LT 415V energy meter shall be incorporated in the system.

PV module temperature sensor (Platinum RTD)

Ambient temperature sensor (Platinum RTD)

Solar Irradiance : An integrating Pyrano meter (Class II or better) shall be provided, with the sensor mounted on a Horizontal plane at a shadow free suitable location near solar arrays to measure solar irradiance. The readings shall be integrated with data logging system.

Temperature Sensor: Integrated temp sensors for measuring the module surface temp., inverter inside enclosure temp, and ambient temp to be provided with readings integrated with the data logging system.

Software and communication compatibility

The project envisages a communication interface with plant DCS / EMS which shall be able to support

Real time data logging

Event logging

Supervisory control

Operational modes

Set point editing

Work Stations with each solar system : with latest Intel processor at the time of supply with 1TB HDD, 8GB DDR4 RAM, 2 Parallel & 2 Serial Port, Wi-Fi LAN Card, DVD RW Drive, 20" LED, USB Scroll Mouse, along with 1 KVA UPS and one A3 Laser Printer shall be supplied for plant data monitoring.

SPV MONITORING SOFTWARE

The Supplier shall supply necessary Software required. The supplier shall also provide training for the use of software.

The software should be compatible to latest Microsoft windows systems (Windows-10 or Higher Version system).

Data logging system: A data logging system (Hardware and software) for plant control and monitoring shall be provided such that the following parameters shall be measured and displayed continuously.

a. PV module temperature
b. Ambient temperature
c. Solar irradiation/ insolation
d. AC / DC current and Voltages
e. Efficiency of the inverter
f. Solar system efficiency
g. Display of I-V curve of the solar system
h. Any other parameter considered necessary by supplier of the solar PV system based on prudent practice.
i. KW reading DC/AC i.e. input output (instantaneous power)
j. KWh Energy reading
k. KVAR reading

Data logger/PC based monitoring system must record these parameters for study of effect of various environmental & grid parameters on energy generated by the solar system and various analysis would be required to be provided through bar charts, curves and tables.

The above data has to be integrated into the plant network for monitoring through DCS / EMS to monitor plant performance.

2.6 EARTHING PROTECTION:

The earthing terminal of all PV modules shall be interconnected by using 2.5 Sq.mm PVC insulated copper wire, which shall be interconnected to the module mounting structure at least at 2 points in each row of the PV module. The earth mesh so formed shall be interconnected with plant grid

2.7 TEST CERTIFICATES :

Tests as per I.S.S / IEC / Equivalent (with its latest editions and amendments and as per the mandatory requirement of MNRE) shall be conducted and the test results (in quadruplicate) should be furnished and got approved before despatching the materials to site. Critical test in invertor and PV modules will be witnessed by Owner

2.7 Site Testing
Bidder

Annexure II

Intelligent Controllers

Shall have following minimum features

i) Each intelligent PCC, PMCC and MCC shall be provided with multi-function microprocessor based Numerical protective relay/ relay with intelligent controller.

This numerical relay shall have the following functions:-

a) Metering
b) Protection
c) Control
d) Monitoring
e) Communication through IEC 61850 protocol shall be used and shall be directly linked to DCS / EMS / PLC without converters. The Intelligent controllers shall be connected in daisy chain (in groups) or in star connection for linking to redundant controllers of DCS through Profibus using suitable device such as Y-link.

ii) Each panel shall be supplemented with required additional control element for features not covered by intelligent controllers.

iii) Numerical Relays of all modules in PCC / PMCC/ MCC shall be interlinked to DCS / EMS / PLC through open protocol IEC61850. Suitable hardware, software, cabling and any other interface requirement shall be taken care by this Bidder.

iv) Software for Numerical relays shall be supplied and shall be configurable from DCS / EMS / PLC based control system. Using this software, the following functions shall be carried out:-

a) Control of breakers (Close / Open / Trip)
b) Program or modify set points
c) Load or save set point from or to a disk
d) Read actual values
e) Monitor status
f) Read pre-trip data and trip record
g) Display dynamic trending of actual values
h) Get help on topic
i) Print

v) The device should have a control voltage of wide band from 110 to 240 V AC/DC, as applicable.

vi) Intelligent controller in a 415V / PMCC / MCC shall be directly interfaced to DCS / EMS / PLC control system through IEC 61850 Communication protocol for monitoring and through Hard wired interface for critical feedbacks and

for commands with suitable interposing relay via remote I/O panel in MCC Room. The protection system should be independent / autonomous of the system i.e. motor protection & control should continue to be available even in the event of a communication or automation system failure.

Communication with DCS

i) Co-ordination between the switchgear manufacturer and DCS Supplier for protocol / mapping, procedures, interface and testing is included in the scope of services.

ii) Software for intelligent controller shall be supplied and suitably interfaced with DCS. It shall be possible to configure a device either individually or over a communication network. For this purpose, provision for connecting a laptop should be available at Numerical Relays/ Intelligent controller.

iii) Minimum of 2 Nos. laptop shall be provided along with PCCs / PMCCs / MCCs with all accessories, fully loaded software for Uploading / Downloading the switchgear data. In order to achieve minimum response time, the device shall be capable of transmitting data at a speed, suitable for operation with high speed bus systems.

Operations and Indications

i) Close/ open operations of all Incomer, Bus coupler & outgoing feeder breakers in "test" position, for all 0.415 kV feeders shall be through Push Buttons and test / service selector switches provided at the respective modules.

ii) Modules shall have ON, OFF & TRIP (LED indications provided.)

Interface with Control System

SL. NO.	DESCRIPTION	TYPE OF I/O
A.	**Incomer (ACB Controlled)**	
	Breaker Close	DO
	Breaker Trip	DO
	Line PT under voltage	DI
	Line PT Fuse Fail	DI
	Breaker ON	DI
	Breaker OFF	DI
	Incomer Disturbance (Control Supply Fail)	DI
	Numerical relay Unhealthy	DI
	Trip Coil Healthy	DI
	Incomer Available (Breaker in service/spring charged/ switchgear in remote)	DI

SL. NO.	DESCRIPTION	TYPE OF I/O
	Electrical Trip (Lockout relay optd)	DI
	Numerical relay	Interface through IEC 61850 protocol.
B.	**Incomer (MCCB Controlled)**	
	MCCB Close	DO
	MCCB Trip	DO
	Current feedback	AI
	MCCB ON	DI
	MCCB OFF	DI
	Incomer Disturbance (Contol supply fail)	DI
	Electrical Trip	DI
C.	**Bus Coupler (ACB Controlled)**	
	Breaker Close	DO
	Breaker Trip	DO
	Incomer-1 check Syn	DO
	Incomer-2 check Syn	DO
	Bus coupler check Syn	DO
	Breaker ON	DI
	Breaker OFF	DI
	Buscoupler Disturbance (Control Supply Fail)	DI
	Numerical relay unhealthy	DI
	Trip Coil Healthy	DI
	Bus-A Under Voltage	DI
	Bus-A PT Fuse Fail	DI
	Bus-B under voltage	DI
	Bus-B PT Fuse fail	DI
	DC Supply-1 fail	DI
	DC Supply-2 fail	DI
	Buscoupler Available (Bkr. In service/spring charged/swgr in remote)	DI
	Electric Trip (Lockout relay optd)	DI
	Numerical relay	Interface through IEC 61850 protocol
D.	**Bus Coupler (MCCB Controlled)**	
	MCCB Close	DO
	MCCB Trip	DO
	Current feedback	AI
	MCCB ON	DI
	MCCB OFF	DI
	Bus coupler Disturbance (Control Supply Fail)	DI
	DC Supply-1 Fail	DI
	DC Supply-2 Fail	DI
	Electrical Trip	DI

SL. NO.	DESCRIPTION	TYPE OF I/O
E.	**Outgoing ACB Feeder**	
	Breaker Close	DO
	Breaker Trip	DO
	Breaker ON	DI
	Breaker OFF	DI
	O/G Feeder Disturbance (Control Supply Fail)	DI
	Numerical relay unhealthy	DI
	Trip Coil healthy	DI
	O/G Feeder Available (Breaker in service/spring charged/swgr. In remote)	DI
	Electrical Trip (Lockout relay optd)	DI
	Numerical relay	Interface through IEC 61850 protocol
F.	**ACB Controlled Motor Feeder**	
	Start Command	DO
	Stop Command	DO
	ON Feedback	DI
	OFF Feedback	DI
	Electrical trip (Lockout relay)	DI
	Emergency LPBS Stop	DI
	Module Disturbance (Control supply fail)	DI
	Module available (Breaker in service position, Switchgear in remote & breaker spring charged)	DI
	Numercial realy unhealthy	DI
	Trip coil healthy	DI
	Numerical relays	Interface through IEC 61850 protocol
G.	**Undirectional LT Drive (MCCB/MPCB Controlled)**	
	Start Command	DO
	Stop Command	DO
	ON Feedback	DI
	OFF Feedback	DI
	Module disturbance (Control supply fail)	DI
	Emergency LPBS Stop	DI
	Intelligent Controllers	Interface through IEC 61850 protocol or Profibus.

SL. NO.	DESCRIPTION	TYPE OF I/O
H.	**Bidirectional LV Drive with Non-Integral starters (Soot blower)**	
	Forward Command	DO
	Reverse Command	DO
	Forward Feedback	DI
	Revers Feedback	DI
	Module disturbance (Control supply fail)	DI

NOTE: The above I/O shall be hard wired to DCS/ EMS / PLC.

Metering and Protection

The feeders shall have the following protections / metering required for the switchgear panels. The minimum protections / metering required for various typical feeders including ACB operated feeders are given below. For non ACB controlled feeders having intelligent controller, the metering indicated shall be in-built.

i) ACB Controlled feeders with numerical relays

A)	**Incomers**		
	Protections	**Metering (for remote)**	**Local Indication**
	Instantanous over current protection 50	Current in all the three phases	Current in all the three phases
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selecter switch
	Instantanous earth protection 50N	kW	
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Under voltage protection 27		
	Restricted earth fault protection 64R		
	Backup (Standby) earth fault protection 64S		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed		

	with numerical relay.		
	Check synchronizing 25 through relay mounted in bus coupler.		
B)	**Bus Couplers**		
	Protections	**Metering (for remote)**	**Local Indication**
	Instantanous over current protection 50	Current in all the three phases	Current in all the three phases
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	Voltmeter with voltage selecter switch for Bus A
	Instantanous earth protection 50N	kW	Voltmeter with voltage selecter switch for Bus B
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Under voltage protection 27		
	Check synchronizing 25		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		
C)	**Motor Feeders (90KW and above only)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Numerical Composite motor protection to cover a minimum of protections such as negative phse current (46), thermal over load (49), phase over current (50/51), earth fault (50N/51N), locked rotor (51LR), No. of starts per hour (66), breaker failure (50BF), under voltage (27 from PT)	Current in all the three phases	Current (Y phase)
	Apart from above	kW, kWH	

	protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		
D)	**Outgoing Feeder (630A and above)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Instantanous over current protection 50	Current in all the three phases	Current (Y phase)
	IDMT over current protection 51	Voltage – Phase to phase, phase to neutral	
	Instantanous earth protection 50N	kW	
	IDMT Earth fault protection 51N	kWH	
	Circuit breaker failure protection 50BF		
	Apart from above protection relays, each electrically operated breaker shall be provided with anti pumping (94), lockout (86) and trip circuit supervision (95) relays. Lockout relay shall be a hand reset type and shall not be clubbed with numerical relay.		

ii) MCCB Controlled feeders rated below 630A.

A)	**Incomers (with motorized MCCB)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection	Current transducer (Y phase)	Current (Y phase)
	Short circuit protection		Voltmeter with voltage selector switch

B)	Bus Couplers (with motorized MCCB)		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection	Current transducer (Y phase)	Current (Y phase)
	Short circuit protection		
C)	**Outgoing Feeder (Below 630A) with MCCB (non motorized)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection		Current (Y phase)
	Short circuit protection		
D)	**Incomers for ACDB/MLDB/PDB MCCB (non motorized)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Over current protection		Voltmeter with voltage selecter switch
	Short circuit protection		Electronic energymeter with communication port suitable for IEC 61850 protocol

iii) Other feeders

A)	Bus PT / Line PT Modules		
	Protections	**Metering (for remote)**	**Local Indication**
	Under voltage protection 27	Voltage – phase to phase, phase to neutral	
	Fuse failure protection		
B)	**Motor feeders upto 18.5kW (MPCB with Contactors)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Intelligent controllers with current measuring module and overload & short circuit protection.		
C)	**Motor feeders above 18.5kW but below 90kw (MCCB with Contactors)**		
	Protections	**Metering (for remote)**	**Local Indication**
	Intelligent controllers with current measuring module and Overload, single phase preventor & short circuit protection.	Phase current (for motors of rating 30KW and above)	

iv) DC System

A)	**Incomer Breaker/MCCB**		
	Protections	**Metering (for remote)**	**Local Indication**
	With indication only no protection with O/L alarm to DCS / EMS / PLC	Bus voltage	Load Voltage
			Bus Voltage
			Shunt with ammeter
B)	**Outgoing Feeder**		
	With indication only no protection with O/L alarm to DCS / EMS / PLC		Shunt with ammeter

Note:

Fuse failure relay shall be provided on the secondary side of voltage transformer to monitor HV and LV fuses

Sl.N.	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's Reply
1	Vol. II, Section 5.0	**5.10.2.9**	Page : 5 of 12	The design and construction of cooling tower foundations ..... All lateral force shall be resisted only by piles. Effect of pile cap & basin wall shall not considered for resisting lateral load transferred from superstructure....	The referred clauses are contradictory. Type of foundation for all structures shall be as per approved final geotechnical investigation report. Please confirm.	All references to pile foundation in Clause 5.10.2.9 shall be considered applicable if pile foundation is recommended for NDCT in the approved soil investigation report.
2	Vol. II, Section 5.0	**5.1.5.2**	Page : 8 of 17	Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit.....		

2 X 660 MW UDANGUDI SUPER CRITICAL POWER PROJECT STAGE-I

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
				Pre bid Reply		
1	VOLL-II, SEC 2.21	ANNEX 2.21.1	4 of 4	Preformed pipe sections shall be used for pipes and fittings of density 140 kg/m3. Slab or mattress shall be used for valve boxes and equipments of density 100kg/m3	There is contradiction between Cl no 4.1.1 and Annex 2.21.1 regarding insulation material for pipes and fittings. It is not possible to use pipe section for all pipes and fittings. As per standard practice and as executed in many projects, pipe section having density of 150kg/m3 shall be used for first layer of insulation up to thickness of 75mm and for pipe sizes up to 355.6mm diameter. Subsequent layers will be bonded mineral (rock) wool mattresses. Please confirm.	For pipes: Noted. For Valve boxes and equipments bidder to follow specification.

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
				Pre bid Reply		
2	Plot Plan drg no. 00-1115125-G-001-Rev-B.	--	-- --	TP-12 is shown connected through conveyor to the 1st TP of unit-III of stage-2.	As per coal flow diagram space for future expansion is to be kept in TP-4 and TP-7 only and No expansion provision is required in TP-12. Please clarify the requirement.	Bidder to follow Plot Plan drg no. 00-1115125-G-001-Rev-B. All the future provision requirement at JNT-12 for feeding unit-III shall be provided. This requirement is inline with stage -II provision in Stage –I JNT-7 Refer Vol II sec 1page 16 of 191clause no. 10b. Future conveyor from JNT-12 shall be capable of reaching the unit-III JNT height . Accordingly JNT-12 shall be designed.
3	Under Clause 23.0, Vol. I, Section – 4.0, SCC			Penalty for poor Performance	We request TANGEDCO to replace "PENALTY/ PENALTIES" with "Liquidated Damages". "Cap for Liquidated Damages for Performance Guarantees" is not specified. As per standard industry practice we request Owner to specify the cap as "10% of the Unit Contract Price" in line with the current prevailing norms in the Industry.	Bidder to follow specification.

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
						Pre bid Reply
					Also, we request TANGEDCO to consider the aggregate liability of the Contractor towards payment of Liquidated Damages for Delay and Liquidated Damages for Performance Guarantees not to exceed 15% of the Unit Contract Price. The above request is in line with the prevailing industry norms.	
4	Under Clause 24.0, Vol. I, Section – 2.0, GCC			Liquidated Damages for Delay in completion	We request TANGEDCO to amend the clause as "The delivery/completion period given in the clause 5.0 Section 4 "Work Completion Period" shall be guaranteed under liquidated damages clause given below: Time is the essence of the contract. If the Contractor fails to perform the work within the time specified in the contract or any extension thereof the Company shall recover	Bidder to follow specification.

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
					Pre bid Reply	
					from the Contractor as liquidated damages a sum of half percent (0.5%) of the ~~total~~ Unit contract price for each completed week of delay of Unit. However, the total liquidated damages shall not exceed 10% of the ~~total~~ Unit contract price ~~value~~. This clause shall be read along with clauses 6.3 and 6.4 of Section-4 Vol-1″.	
5		GCC	clause 24		Liquidated Damages for Delay in Completion	We understand LD shall be applicable unit wise. For the Purpose of LD, Contract Price of each Unit shall be considered as 50% of Total Contract Price. Please clarify.	Bidder to follow the specification.
6		SCC	clause 23.		Penalty for Poor Performance	Tender is silent on Ceiling on Liquidated damages/ penalty for towards shortfall in performance parameters. We request to consider a 10% ceiling for the same	Bidder to follow the specification.

2 X 660 MW UDANGUDI SUPER CRITICAL POWER PROJECT STAGE-I

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
				Pre bid Reply		
7		GCC & SCC	clause 24 & clause 23	Liquidated Damages for Delay in Completion Penalty for Poor Performance	Further tender is silent on Over all ceiling for liquidated damages (LD) for delay in completion and LD / penalty for poor performance We request to consider a 15% Combined ceiling for the Overall LD /penalty for delay in completion and performance shortfall	Bidder to follow the specification.
8		GCC	Clause 46.0	Limitations of Liabilities	Though JDU formats specify limitation of liability of Bidder but Tender GCC provisions are not clear or specific on Limitation of liability. We understand that the aggregate liability of the Contractor to the Employer, whether under the Contract, in tort or otherwise, shall not exceed the total Contract Price .Please clarify	Bidder to follow the specification.

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
				Pre bid Reply		
9	Comprehensive plot plan for stage-I, II & III	.....	.....	Comprehensive plot plan for stage-I, II & III , 00-1115125-G-001, REV 0B	We understand that the scope of works under the present bid is for stage I only within the plant boundary as per Plot Plan-00-1115112-G-001, REV 0. Please confirm.	Comprehensive Plot plan 00-1115125-G-001, REV 0B indicates the areas for stage-I, II & III facilities. Scope of work for Stage-1 shall be as defined in the tender specification and as in the above plot plan.
	Plot plan	.....	.....	Plot Plan- 00-1115112-G-001, REV 0.		
10	Comprehensive plot plan for stage-I, II & III	.....	.....	Comprehensive plot plan for stage-I, II & III , 00-1115125-G-001, REV 0B	With reference to comprehensive plot plan, scope of following works may please be clarified / confirmed. • Extent of Grading works • Boundary wall • Roads & drains We understand that scope of above mentioned works to be considered shall be within the plant boundary of stage-I only as shown in Plot Plan- 00-1115112-G-001, REV 0.	
	Plot plan	.....	.....	Plot Plan- 00-1115112-G-001, REV 0.		Comprehensive Plot plan 00-1115125-G-001, REV 0B indicates the areas for stage-I, II & III facilities. Scope of work for Stage-1 shall be as defined in the tender specification and as in the above plot plan.

2 X 660 MW UDANGUDI SUPER CRITICAL POWER PROJECT STAGE-I

Sl. No	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's REPLY
				Pre bid Reply		
11	Comprehensive plot plan for stage-I, II & III	.....	.....	Comprehensive plot plan for stage-I, II & III , 00-1115125-G-001, REV 0B	We understand that scope of Storm Water Diversion Channels is excluded from bidder's scope. Please confirm.	Confirmed.
	Sl. 235 of Pre-bid clarification reply-1			The peripheral channel along the western boundary of the project site to drain off the runoff from watersheds on the western side of the project site mentioned in the specification need not be considered		

SN	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO'S REPLY
Pre bid Reply						
1.	Vol.II, Sec 2	1.0.0	63 of 66	One (1) no. water tube type, natural circulation, pressurized furnace, HSD fired, outdoor type auxiliary boiler with its auxiliaries, having steaming capacity of Minimum 50 TPH with steam parameters of 16 kg/Sq. cm(g) pressure and 350 deg.C steam temperature.....	Auxiliary boiler will be in operation only during the start-up of the main boiler. Steam produced from Aux boiler will be used for the following purposes: 1. HFO heating & tracing 2. HFO atomization 3. De-aerator pegging 4. Turbine gland sealing 5. Feeding SCAPH etc. From our experience it has been observed that the cumulative sum of all the above requirements during start-up will be less than 60 T/hr. Further, OTSC units operating at a (minimum) SH/RH outlet temperature of 568/596 °C respectively require auxiliary steam at (280-300) °C for turbine gland sealing. Hence, most of the auxiliary boilers supplied by BHEL for OTSC units are sized to deliver steam at 290°C. Therefore an auxiliary boiler of 60TPH capacity and Super heater outlet parameters of 19 ata & 290°C [in line with the one offered for TANGEDCO/	Based on the BTG requirement, auxiliary boiler capacity and steam parameters shall be provided subjected to review and approval by owner during detailed engineering. However bidder shall meet the specification for the minimum requirements.

SN	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO'S REPLY
Pre bid Reply						
					North Chennai (1x800 MW), Stage-III] shall be offered. Kindly Confirm.	
2.	Vol.II, Sec 2	1.0.0.f	63 of 66	Non steaming type Economiser system with connecting pipes, headers, etc. with nonreturn valves ,vents , drains and sampling connections	Auxiliary boiler is required for start up only and hence the design has been standardized with feed water being directly admitted into the drum without involving Economizer. This arrangement makes the aux boiler compact and eliminates any un warranted material/ maintenance. All the auxiliary boilers supplied by BHEL are able to efficiently suffice the auxiliary steam requirement of the corresponding units. Hence we recommend that the Economiser can be eliminated from the auxiliary boiler. [in line with the one offered for TANGEDCO/ North Chennai (1x800 MW),Stage-III] Kindly confirm.	Bidder to follow specification.

SN	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO'S REPLY
Pre bid Reply						
3.	Vol.II, Sec 2	Annex 2.1.2.1	66 of 66	Efficiency of boiler: About 88 %	Auxiliary boiler will be in operation for a period of (10-12) hrs during the start up of the main boiler. Hence, the amount of savings obtained by going for a high efficient boiler (around 88 %) will be negated by the high capital and maintenance cost. Hence, a compact auxiliary boiler of efficiency around 80 % will be supplied. [in line with the one offered for TANGEDCO/ North Chennai (1x800 MW),Stage-III] Kindly confirm.	Bidder to follow specification.

S.No	Volume	Section/ Sub-Section	Clause	Page no	Bid Specification	Pre bid Query	TANGEDCO'S Reply
1	Cable Tray Installation DWG.NO.10-1115112-E-223,Rev.0, Sheet 1 of 4, B) 5.				Power Cable laying	In line with the standard engineering practices followed in all GENCO projects, we have envisaged LV power cables up to 120 sq.mm in double layer. Please confirm.	Bidder to follow specification.
2	Typical Control Scheme for LV Service Transformer (Dry Type) DWG.No.10-1115112-E-226,Rev.o,Sheet 1 of 1				Control cable	The requirement of 12Cx1.5 sq.mm from dry type transformer to HT switchgear is not clear. In line with the tripping circuit shown in the same drawing , we have envisaged 5C X 1.5sq.mm (for WTI trip, WTI Alarm, DO) from dry type transformer to HT switchgear instead of 12C x 1.5 sq.mm. Please confirm.	Bidder to follow specification and tender drawings.
3	Typical Control Scheme for HT Switchgear Motor Feeder (>2000 kW) DWG.No.10-1115112-E-228,Rev.0,Sheet 1 of 1& Single Line Diagram for HT Unit Switchgear - 1A / 2A (11BBA / 12BBA) DWG.NO.10-1115112-E-205,Sheet 1 of 1, Rev.0				Differential Protection for HT Motors	In view of the contradiction between the specification clauses, request client to clarify whether differential protection is required for HT motors of above 1000kW or for HT motors of above 2000kW.	Differential protection is required for HT motors of above 1000kW, as per tender specification and single line diagrams.
4	II	4.0	2.4.0	48 of 372	Typical Control Scheme for HT Switchgear Motor Feeder (>2000 kW) DWG.No.10-1115112-E-228,Rev.0, Note : 2 Interposing Relay	In view of the contradiction between the specification clause and scheme drawing, request client to clarify the location of IPR. Whether its part of DCS or its part of HT switchgear.	Bidder to follow specification and tender drawings.

S.No	Volume	Section/ Sub-Section	Clause	Page no	Bid Specification	Pre bid Query	TANGEDCO'S Reply
5	II	3.0	(4.8.0 f, j)	134, 135 of 353	Local trial start of Motor is envisaged from Local push button station also. Local start push button shall be hardwired to DCS/ respective control system so as to check the process permissive for starting the fans/pumps, whereas local stop push button shall be directly hard wired to concerned switch gear for tripping.	As per specification, start from LPBS is hardwired to DCS and stop from LPBS is hardwired to Switchgear. However, as per Control Scheme for HT Switchgear Motor Feeder, DWG.No.10-1115112-E-228,DWG. No.10-1115112-E-227, it is indicated that 5Cx1.5 sq.mm cable from LPBS to HT switchgear. And there is no hardwired cable from LPBS to DCS. Request client to clarify the contradiction.	Cables from LPBS to DCS is routed through HT Switchgear
6	Typical Control Scheme for HT Switchgear Auxilary Transformer feeder DWG.No.10-1115112-E-225,Rev.0,Sheet 1 of 1				Multi Function Relay	We have envisaged all the protections required for the Auxiliary Transformer feeder by one no. of Multi function Relay. Another no. of Multi function Relay for same Auxiliary Transformer feeder is not envisaged by us. Please confirm.	Bidder to follow specification and tender drawings.
7	1741 _Pre-Bid Queries 1 ,Replies to Pre-bid clarifcations, S.No :: 296, Page 76 of 171				Short time current withstanding time of NGR	The protections envisaged for the HT systems will act before 1 sec. Hence, we have envisaged the short time current withstanding of NGR as 5 sec, instead of 5 mins. This is inline with the standard practices followed in all GENCO projects. Please confirm.	Bidder to follow specification.

S.No	Volume	Section/ Sub-Section	Clause	Page no	Bid Specification	Pre bid Query	TANGEDCO'S Reply
8	1743_ Reply2 -Part-2 ,Replies to Pre-bid clarifications, Sl.No :: 431, Page 146 of 196				Electrical equipment such as motors, push button stations, lighting fixtures, junction boxes located in areas such as fuel oil handling areas, hydrogen gas handling area, hydrogen generation plant, coal dust areas etc. shall be provided with flameproof type enclosures as per relevant standards.	IS ::5572 - CLASSIFICATION OF HAZARDOUS AREAS (OTHER THAN MINES) HAVING FLAMMABLE GASES AND VAPOURS FOR ELECTRICAL INSTALLATION , IEC 60079-1 Electrical apparatus for explosive gas atmospheres. Hence, these two standards are not applicable for coal dust area. Hence, in line with the same we have not envisaged Flame proof enclosures for motors, push button stations, lighting fixtures, junction boxes in Coal Dust area. Please confirm our understanding.	Flame proof enclosure shall be provided for electrical equipments located in Coal dust area also as specified. Bidder to follow specification
9	II	3.0	4.2.2	160 of 353	The continuous current rating of the feeders shall be based on the name plate current rating of the connected equipment with 10% margin at design ambient condition, rounded off to next higher standard rating unless specified otherwise.	We understand that the mentioned clause is applicable only for non-process power feeders and not for motor feeders and power feeders for process application.For outgoing motor feeders and power feeders of process application will be designed based on the operating load with rounded off to standard rating.Please confirm our understanding.	The clause referred is applicable for all the feeders. Bidder to follow specification.

S.No	Volume	Section/ Sub-Section	Clause	Page no	Bid Specification	Pre bid Query	TANGEDCO'S Reply
10	General				Type Tests	We will submit valid type test certificate for similar rated equipments. Conducting of Type tests is not envisaged unless there is a design change. Please confirm.	Bidder to follow specification.
11	II	3.0	5.14, 5.1.20	287,288 of 353	For low bay and medium bay areas, LED light fittings of well glass / medium bay type shall be used for the installations having room height of above 5 meter.	In line with the tabulation for luminaries recommendation in cl ::5.1.20, we understand that coal handling plant shall be envisaged with conventional type of fixtures instead of LED type. Please confirm our understanding.	For coal handling plant also, it shall be LED type only.
12	Main Single Line Diagram for Auxiliary Power Distribution DWG.No.10-1115112-E-201,Rev.0, Notes ::5 & 1743_ Reply2 -Part-2 ,Replies to Pre-bid clarifications, S.No :: 138, Page 44 of 196 - Power Distribution.					We have envisaged the power distribution generally in line with the tender SLD. However, in certain areas power distribution are envisaged based on the proximity of the load. Please confirm.	Bidder to follow specification and tender drawings.
13	II	3.0	4.3.0	100 of 353	For each mechanical system, separate set of service transformers shall be provided. Loads of two systems shall not be fed from the same transformer.	For each mechanical system, we have envisaged dedicated switchgear in line with the Main Single Line Diagram for Auxiliary Power Distribution DWG.No.10-1115112-E-201,Rev.0. However dedicated set of service transformers are not envisaged for certain mechanical systems. Please confirm.	Bidder to follow specification and tender drawings.

S.No	Volume	Section/ Sub-Section	Clause	Page no	Bid Specification	Pre bid Query	TANGEDCO'S Reply
14	1741_ Reply1 ,Replies to Pre-bid clarifications, S.No ::221, Page 59 of 171					As per the clarification, we understand that the patrol road along boundary shall have 0.50 mt wide shoulder on either side. Please confirm.	Bidder to follow specification. Clause 5.2.3.4 says "Patrol road along boundary wall shall be single lane road." " Single lane roads shall be of 4.0 m wide with 1.0 m wide shoulders on both sides of the road."
15	II	5	5.2.15.6	Page : 23 of 38	Dry Ash Storage Silo Area - paved area of 5000 sqm	We presume that the paved area for lorry parking shall be 500sqm not 5000sqm . Please confirm.	Specification requirement as reproduced below shall be provided." Sufficient paved area not less than 5000 Sq.m at locations pointed out by owner for lorry parking etc. shall be provided."

SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

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

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

C 0 N T E N T

STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

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

2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following

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 backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction

likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the

engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0 Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :
i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
iii) soling of roads, paths, etc., and hard core ;
iv) macadam surfaces such as water bound, and bitumen/tar bound;
v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :
i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded

in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :
i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the

workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades

etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be

provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his

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.

3.5.4.5 Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.

All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably praticable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer’s prior approval on the method of pumping to be adopted shall be

taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

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

3.9.0 Lighting

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

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

f) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified as below:

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) In case of open footings (rafts/ pilecaps/ drains/ cable trench/ pipe trench/ sub soil beams etc.) up to the depth of 2.0 metres, alround excavation of 30 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities. (Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in item of work in the schedule of quantities).

d) In case of open footings (Rafts/ pilecaps / drains/ cable trench/ pipe trench/ sub soil beams etc.) at a depth of more than 2.0 metre, alround excavation of 75 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities. (Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in item of work in the schedule of quantities).

e) IN TRENCHES FOR BURIED PIPES & CABLES

Width of Trench

i) Upto one metre depth the authorized width of trench for excavation

shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on concrete bed/ cushioning layer, the authorized width shall be the external diameter of pipe (not socket/ collar) plus 25 cm or the width of concrete bed/ cushioning layer whichever is more.

ii) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical upto depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom. Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. However, any additional excavation beyond the limit specified for firm soil herein shall not be measured for payment for excavation, backfilling, carriage, dewatering etc. item of work in the schedule of quantities as these are deemed to be included in item of work in the schedule of quantities.

iii) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.

f) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

g) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

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

i) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

j) Special dewatering of ground water by well point method and side protection work by sheet piling are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)

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

C 0 N T E N T

SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Prepare detailed drawings of supports, templates, hangers, etc. required for

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

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

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other*waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

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

d) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour

Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

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

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

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

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the

edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

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

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

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

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at

site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

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

3.07.00 Water-Cement Ratio

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

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of	Slump in mm with Standard Cone as	Use for which concrete is suitable

workability	per IS: 1199		
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm

Lean concrete - 40 mm

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

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

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

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

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

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

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

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be

adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of

Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators

can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 *mm* in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortars.

k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

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

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the

final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for “Reinforcement couplers for mechanical splices of bars in concrete” as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or

severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

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

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

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned

not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

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

3.20.02 Cleaning and Treatment of Forms

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

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

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

3.20.07 Re-use of Forms

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

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be

required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

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

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to

establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the

central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be

thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard,

lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown

on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer’s satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer

surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having

three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items

and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.

b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include all arrangement for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.

b) No deductions shall be made for the following:

i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;

ii) Opening upto 0.1 sq.m.

iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23^0C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.

c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour

and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.

d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.

f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.

e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.

e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of

volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement

IS: 455 - Indian Standard Specification for Slag Cement

IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures

IS: 516 - Indian Standard Specification for Methods of Test for Strength

of Concrete

IS: 702 - Indian Standard specification for industrial bitumen.

IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement

IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks

IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS: 2571 - Code of practice for laying in-situ cement concrete floors.

IS: 2645 - Integral cement water proofing compound

IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS: 2750 - Indian Standard Specification for steel scaffoldings.

IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS: 3414 - Code of practice for design and installation of joints in buildings.

IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS: 3696 - Safety Code for Scaffolding and Ladders

IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS: 4014 - Code of practice for steel tubular scaffolding.

IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement

IS: 4082 - Indian Standard Specification for Recommendation on

Stacking and Storage of Construction Materials at site

IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS: 4926 - Indian Standard Specification for Ready Mixed Concrete

IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground

IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.

IS: 5256 - Code of practice for sealing joints in concrete lining on canals.

IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting

Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.

IS: 8989 - Safety Code for Erection of Concrete Framed Structures.

IS: 9012 - Recommended method for shortcreting.

IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.

IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

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

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

C 0 N T E N T

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well-seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). 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 BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall be made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 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, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to 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.

2.02.02 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.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of 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 bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 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.

3.02.00 Door and Window Shutters

All doors 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.

3.03.00 Partitions, Panelling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in "Schedule of Item" for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges, holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

SECTION – D

SUB-SECTION – D4

ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

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

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

C 0 N T E N T

ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix

by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Hessian base self-finished felt, type 3, grade I.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fibre base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Fibre base self-finished felt, type 2, grade 2.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Fibre base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fibre based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fibre-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC 836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70^0C minimum, 300%

elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkali and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane is applied.

c) Finishing coats:

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish:

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh

and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing by Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose, drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

i) Primer (For vertical faces only), as per I.S. 3384.

ii) Hot applied blown bitumen at the rate of 1.2 Kg/m2

iii) Hessian base, bitumen felt type 3 grades 2

iv) Hot applied blown bitumen @ 1.2 Kg/m2

v) Hessian base, bitumen felt type 3 grade 2

vi) Hot applied blown bitumen @ 1.2 Kg/m2

B) Extra Heavy treatment (Three layers of felt)

i) Primer (for vertical faces only) as per I.S. 3384

ii) Hot applied bitumen at the rate of 1.2 Kg/m2

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m2

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m2

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m2

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years.

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

a)	IS: 73	-	Paving Bitumen
b)	IS: 702	-	Industrial Bitumen
c)	IS: 1203	-	Methods of testing tar and bitumen
d)	IS: 1322	-	Bitumen felts for waterproofing and damp proofing.
e)	IS: 1346	-	Code of practice for waterproofing of roofs with bitumen felts.
f)	IS: 1609	-	Damp-proofing Treatment using Bitumen Felts – Code of Practice
g)	IS: 3067	-	Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
h)	IS: 3384	-	Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labor, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

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

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

C 0 N T E N T

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

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

2.00.00 INSTALLATION

2.01.00 Materials

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

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

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

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

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

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardware's where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) “Double Plate Flush Door Shutters.”

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18-gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Jindal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15-micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper “Lines and levels”, and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one meters from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in IS:3614 (Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open outside.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true plane, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures

h) Provision for hardware and fixtures to be installed at site.

i) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

a) Installations shall be at correct location, elevation and in general, on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for Doors, windows etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall by retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in “Schedule of Items”. Frame for steel or aluminum shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminum partition frames shall be in Kg. Paneling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire proof door shall be in Sqm in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

   i) 100 mm brass butt hinges with screws - 3 Nos.

   ii) 150 mm brass tower bolts with screws - 1 No.

   iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.

   iv) 30 mm brass ring pull handle with Plates and screws - 1 No.

   v) 150 mm brass coat hook with screws - 1 No.

   vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

   i) Concealed hanging arrangement for door leaves.

   ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.

   iii) Heavy duty, cylinder look on active leaf.

   iv) Pull handle of approved design on both leaves.

   v) Doors stops for both leaves.

   vi) Overhead door closure for both leaves.

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i) 100 mm butt hinges - 3 Nos. on each leaf.

ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.

iii) 200 mm anodized aluminum pull handle - 1 No. of each leaf.

iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i) 100 mm butt hinges - 3 Nos.

ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside face

iii) 200mm anodised aluminum Pull handle - 1 No.

iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, see “Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 12" peg stays - 1 No. per leaf

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.
(As per IS-1948 latest editions)

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 300 mm peg stays - 1 No per leaf

iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf

iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment - 2 Nos. per leaf

iii) Spring Catch - 1 No. per leaf

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

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

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

C 0 N T E N T

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials:

a) Glare reducing or beat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.

c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.

d) Obscure glasses shall have a cast surface in one side.

e) Coloured and figured glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.

g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes were six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor’s own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 I.S. CODES

Following are some of the important I.S. Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.

5.00.00 RATES

Rates of glass and glazing if not included in respective items for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ items provided. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

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

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

C 0 N T E N T

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

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

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.

f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20-gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

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 galvanized and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 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 opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 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.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer’s instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters

and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.

SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

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

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

C 0 N T E N T

MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with IS: 816.

c) Welding of aluminium shall be done accordance with IS: 2812, “Arc welding of Aluminium and Alloys.” Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied be brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, then those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

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.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture’s literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturer’s instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.

c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as nut version are acceptable. The bolt version anchors consist of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.
e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5-micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more than $\pm$0.05mm. all steel wire shall be hot dipped galvanised wire. The Dia. shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wires for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild

steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:
Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02 Barbed Wire Fencing

The barbed wire shall be conforming to IS:278 latest editions. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for ‘light-coated wire’ of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two-line wire and two-point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one-line wire (Type A - around both line wire, Type B - around one-line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75$\pm$12mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four

evenly spaced row of line wire in all. The top line wire shall be doubled, making five-line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be as follows

   i) Permissible deviation from, straightness – 1 in 1000.

   ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks, and other blemishes.

d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanized Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanized Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASURMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.
Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

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

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

C 0 N T E N T

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours' immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours'

immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.
Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

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.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. 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 is 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 while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially 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 must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days' work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, 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. Where face bricks are used carborundum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All 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.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by especially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days' work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building 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 when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double Chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one-layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.06.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly over burnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 sqm in section;

e) Chases of section not exceeding 50 cm in girth;

f) Iron fixtures, such as wall ties and hold fasts for doors and windows;

g) Cement concrete blocks as fcr hold fasts and holding down bolts;

h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

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

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

C 0 N T E N T

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items, the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cement in the specified proportion shall be

mixed dry, on a watertight platform and minimum water added to achieve working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1-part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the

Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1-part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1-part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1-part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the

lime punning. The punting shall be applied by skilled workman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1-part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall be measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

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

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

C 0 N T E N T

PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of Paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer’s test certificate. All paint shall be subject to analysis from random samples taken at site from painter’s bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not be yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well-known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pre-treated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work, the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477 (Part-1) ‘Code of practice for painting of ferrous metals in building’ and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc. and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1-part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers, the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conforming to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Sub sequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a

hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

IS: 2338 (I & II)	Code of Practice for finishing of wood and wood based materials.
IS: 2339	Specification for Aluminium, Paints for general purposes in dual containers.
IS: 2395	Code of Practice for painting concrete, masonry, and Plaster surface.
IS: 2932	Specification for enamel, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e. Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.

SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

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

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

C 0 N T E N T

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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

i) Integral finish to concrete base

ii) Terrazzo finish

iii) Granolithic finishes

iv) Patent Stone

v) Metallic Hardener like “Ironte”/Hardonate Finish

vi) Mastic Asphalt finishes

vii) Chemical Resistant finish

b) Tiled Finishes

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesse rae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

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Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and

detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.
The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish to Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still `green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

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2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may very in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to achieve the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1-part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1-part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the

topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine cannot be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1-part cement, 1-part coarse sand, 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary, the surface ‘of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1-part cement and 2-part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with

a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/ `Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is `green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1-part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.

The finish shall be laid while the concrete underbed is still very `green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small

quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the

thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1-part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1-part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The

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

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

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

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

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

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

e) Grinding and Polishing

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

2.02.02 Chequered Tile Finish

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

a) Thickness

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

b) Tiles: Chequered

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

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

c) Under-bed
As per clause 2.02.01 (c).

d) Laying
As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawling, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1-part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

c) Laying
Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed
Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-

mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm^2. The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1-part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The

joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to

stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall

be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally, clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form an inverted ‘Y’.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, Ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.

SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

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

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

C 0 N T E N T

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED (SANDWICHED INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF_2) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) 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 275 gm/sqm.

iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.

v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cum. for glass wool & 48 Kg/cum. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF_2 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 requirement of IS:14246 and shall conform to class 3 for the durability.

ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007 : Code of practice for laying of asbestos cement sheets.

IS: 2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

IS: 1626 : Specification for asbestos cement building pipes, gutters and fittings.

IS: 277 : Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in "Schedule of Items" and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-635-600-C014

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

C 0 N T E N T

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,

unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

a) Plaster of Paris board (decorative)

b) Expanded polystyrene insulation board with plastic fascia.

c) Fibre Insulation board.

d) Bonded wooden particle board (Plain and decorative)

e) Glass fibre reinforced polystyrene sheets.

f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C" or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia. galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length: each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.

b) Typical Intermediate framing for support where required.

c) Hanger fastening details.

d) Panels - unit support at ceiling penetrations.

e) Details of splicing method for main and cross runners.

f) A table indicating load bearing capacity of main and cross runner

g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the “Schedule of Items”. No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.

SECTION - D

SUB-SECTION – D15

WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-635-600-C015

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

C 0 N T E N T

WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:

a) Cast Iron pipe

b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)

c) Concrete pipe

d) Asbestos cement pipe

e) PVC pipe

f) Stoneware pipe

g) Vitrified pipe

h) Lead pipe (not to be used for portable water)

2.02.01 Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/ Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) **European type**

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) **Squatting type**

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, Part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll bolder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall

have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified, the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia.	:	1 in 35
150 mm nominal dia.	:	1 in 65
230 mm nominal dia.	:	1 in 120
300 mm nominal dia.	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be

done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. 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 smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement: 2 sand) which shall be rammed with caulking tool. After a day’s work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement: 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earth ware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 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 hand packing 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 minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leak-proof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating

pipe of at least 100 m dia. whose top shall he provided with a suitable mosquito proof wire mesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge, a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, 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 the vertical pipe jointed to it so as to provide the required test head or the top end 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.

Subsidence of test water may be due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt. XVI)	:	Laying of water and sewer lines, including appurtenant items.

IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt. I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS: 1592	:	Asbestos cement pressure pipes,
IS: 1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).
IS: 2065	:	Code of Practice for Water Supply in buildings.
IS: 2501	:	Copper tubes for general engineering purposes.
IS: 2556	:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement
IS: 2633	:	Method of testing, uniformity of coating on zinc coated articles.
IS: 3076	:	Low density polyethylene pipes for portable water supplies.
IS: 3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter).
IS: 3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).
IS: 4827	:	Specification for electro plated coatings of nickel and chromium on copper and copper alloy.
IS: 4964	:	High-density polyethylene pipes for portable water supplies.
IS: 12701	:	Rotational moulded polyethylene water storage tanks

6.00.00 RATE AND MEASUREMENT

6.01.00 RATE

6.01.01 G.I. Pipes for Water Supply

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.

6.01.02 Rainwater Down-comers

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also includes cost of jointing and making good the opening in structure.

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of “Schedule of Items”. Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in “Schedule of Items”.

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I. Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-635-600-C016

ROAD AND DRAINAGE

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

C 0 N T E N T

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 center 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 tons' 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 is 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 cross fall 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 vegetation’s 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

S.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 center 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 proportion 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 tons' 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 center longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the center 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 is laid, rolling shall be commenced with 6 to 8 tons' power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the center longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the center 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 a 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.

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

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

C 0 N T E N T

SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

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

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS: 226 - Structural steel (Standard Quality)

IS: 800 - Code of Practice for general construction in steel.

IS: 806 - Code of practice for use of steel tubes in general building construction.

IS: 808 - Rolled steel beams, channels, and angle sections

IS: 813 - Scheme of symbols for welding

IS: 814 - Covered electrodes for metal arc welding of structural steel

IS: 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS: 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS: 817 - Code of practice for training and testing metal arc welders

IS: 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS: 822 - Code of practice for inspection of welds

IS: 919 - Recommendations for limits and fits for Engineering

IS: 961 - Structural Steel (High Tensile)

IS: 1148 - Rivet bars for structural purposes

IS: 1149 - High tensile rivet bars for structural purposes

IS: 1161 - Steel Tubes for structural purposes

IS: 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS: 1239 - Mild Steel Tubes

IS: 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (Dia 6 to 24 mm)

IS: 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (Dia, range 6 to 39 mm)

IS: 1367 - Technical supply conditions for threaded fasteners

IS: 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS: 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS: 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS: 1731 - Dimensions for steel flats for structural and general engineering purposes

IS: 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS: 1977 - Structural steel (ordinary quality) St-42-0

IS: 2062 - Steel for General Structural Purposes

IS: 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS: 2595 - Code of Practice for Radiographic Testing

IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS: 3757 - High strength structural bolts

IS: 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS: 7205 - Safety Code for Erection of Structural Steelwork

IS: 7215 - Tolerances for fabrication of steel structures

IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS: 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and

amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural steel High Tensile

c) IS: 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS: 1148 - Rivet Bars for structural purpose

b) IS: 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS: 814 - Covered electrodes for metal arc welding of structural steel

b) IS: 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS: 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS: 7280 - Bare wire electrodes for submerged arc welding of structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS: 2062 - Steel for general structural purposes

b) IS: 961 - Structural Steel (High Tensile Quality)

c) IS: 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS: 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready Mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have been conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt. l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to

the steel, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	**%**	**Remarks**
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulphur	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly, the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also require adjustment in the size of each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store

will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory

results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the

beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

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

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information

necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under

expert hand, subject to the approval of the Engineer.

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

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as

specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular

section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

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

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

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

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate

precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively, diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken

not to injure the skin on galvanized surfaces during transport, handling, and erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

i) 10% at random on fillet-joints.

ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor’s shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer’s mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces'/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidder’s rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces'/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidder's rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However, deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted

from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

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

C 0 N T E N T

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking centre lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, levelling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work:

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owne, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times Dia or 200 mm	Bolt length exceeding 8 times Dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14. 7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge

holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance

with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable

and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the “Strength Test” as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

SECTION - D

SUB-SECTION – D19

ROOF DECKING

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

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

C 0 N T E N T

ROOF DECKING

1.00.00 Scope

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deaerator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and center to center of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 150 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing

3.02.01 Sequence of Manufacture/Erection

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self-drilling / self-tapping screws of minimum thread diameter of 5.6mm. These self-drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's

recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of damage in the sheeting.

c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 513- Specification for cold rolled carbon steel sheets.

IS: 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.

IS: 4431 - Specification for carbon & carbon manganese free cutting steel.

IS: 1573 - Electroplated Coatings of zinc on iron and steel.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

SECTION - D

SUB-SECTION – D20

FALSE FLOORING

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

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

C 0 N T E N T

FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supplies of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of + 0.2mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of $\pm$ 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimize dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system

shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorized representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer’s specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks:

a. Level

b. Alignment of joints

c. Thickness of joints

d. Surface finish

e. Colour and texture

f. Details of edges, junctions etc.

g. Performance

h. Criteria specified for strength.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

SECTION – D

SUB-SECTION – D21

BORED CAST-IN-SITU RCC PILES

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

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

CONTENTS

TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENTS

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pull-out loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.

2.10.00 In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However, no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.

2.11.00 In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.

2.12.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.13.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.

2.14.00 The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.

2.15.00 **AVAILABLE SUB-SOIL DATA**

An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.

3.00.00 MATERIALS

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Grade and minimum cement content

Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03 Slump of concrete

The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.05 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.08 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a 'particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.09 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.

4.01.04 Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 Installation Criteria

4.02.01 For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.

4.02.02 For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of Nx size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.

4.02.03 In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.

4.02.04 Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.

4.02.05 A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.

4.02.06 The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.

4.02.07 Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.

4.03.00 Control of position and alignment

4.03.01 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference.

a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more then 750mm) from their designed position at the working level.

4.04.00 Boring

4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.

4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.

4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.

4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC

method is used the bentonite slurry shall be under constant circulation till start of concreting.

4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.

4.05.00 Chiselling

4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.08.05 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.

4.08.06 The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.

4.08.07 Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

4.08.08 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

4.08.09 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.

4.09.00 Cut off level (COL)

4.09.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.

4.09.02 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

4.09.03 When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.

4.10.00 Sequence of Piling

4.10.01 Each pile shall be identified with a reference number.

4.10.02 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

4.11.00 Building up of Piles

4.11.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.12.00 Breaking off of Piles

4.12.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.13.00 Preparation of Pile head

4.13.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.

4.13.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.

4.13.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.

4.13.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.

4.13.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.14.00 Rejection and Replacement of Defective Piles

4.14.01 The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.

4.15.00 Recording of Piling Data

4.15.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shell be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting

up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.

b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimen's vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified elsewhere with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

5.08.01 On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.

5.08.02 For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.

a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to

testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.

b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.

c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.

d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.

e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.

f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.

g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as

mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be borne by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 432 (Part 1 & 11)	-	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	-	Code of practice for plain and reinforced concrete.
IS: 1200 (Part 23)	-	Measurement of Building and Civil Engineering works Piling.
IS: 1786	-	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
IS: 1892	-	Code of practice for Subsurface Investigation for foundation.
IS: 2131	-	Method of Standard Penetration Test for Soils
IS: 2911 Part I/Sec 2	-	Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.
IS: 2911 Part IV	-	Code of practice for design and construction of pile foundation - Load test on piles.
IS: 6926	-	Code of practice for Diamond Core Drilling for Site Investigation for River Valley Projects.
IS: 10262	-	Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.

8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.

8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.

8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.

8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results.

8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile location, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials,

equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.

8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.

8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.

8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tack welding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.

8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.

8.01.12 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

8.01.13 The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.

8.01.14 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not lave been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.

8.02.00 Measurement

8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be

considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.

8.02.02 Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:

i) The weight shall be arrived at by multiplying the actual length measured along with standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.

ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.

iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.

8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.

8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.

8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.

ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M^3

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	**Horizontal/ Lateral (MX)**	**Pul lout/Tension (MT)**
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

a) Minimum length of the pile shall be _____* m below COL.

b) The pile shall be terminated after penetrating through the strata having SPT penetration less than __* cm for ____* blows, for a minimum length of _____* times the diameter of the pile.

A2.2 In Rock

a) Piles shall be installed and socketed into the rocks for a length (socketing length) equal to _____* times the pile diameter subject to a minimum of _____* meter below the socketing horizon.

b) Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____* kg/sq.cm.

A3. Average cut-off level for tender design and initial load test can be assumed as _____* m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.

ANNEXURE-B

List of Equipments

S. No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.

ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5.

ANNEXURE-D

PILE DATA

1. Reference No. Location (Co-ordinates) _____area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:

    i) Freshly supplied mud
    Liquid limit -

    Sand content -

    Density -

    Marsh viscosity -

    Swelling index -

    pH value -

    ii) Contaminated mud
    Density -

    Sand content -

14. SPT* N values in soil (from the nearest bore hole).
+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test
** Unconfined compression strength

15. Chiselling if any, from..…... m to …... m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity
Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement	Stirrups: Type
No._____	No._____
Dia. _____	Dia._____
Depth _____	Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.

TABLE -1

FREQUENCY OF SAMPLING AND TESTING

Sl. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored material debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	 Slump cone test Compressive Strength test	 Each pile As per spec.	 As per Cl. 5.5 As per Cl. 5.5	 As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

SECTION - D

SUB-SECTION – D22

SITE LEVELLING & GRADING WORKS

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

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

C 0 N T E N T

GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification covers 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 includes 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 includes all type of soil including laterite, moorum etc. with/without any percentage of kankar 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 includes 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 chiseling 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 officerin-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 meter 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 chiseling 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 utilized 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 tons' 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 is 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 is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the 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.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

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 centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter 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.

SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

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

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

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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.

GEOTECHNICAL INVESTIGATION REPORT

2X660 MW UDANGUDI SUPERCRITICAL TPS STAGE-I

DOCUMENT NO: PE-DC-435-602-C002, Rev-0

PART-2

CHP & AHP AREA

VOLUME-II

Customer

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

Submitted by

Maharatna Company

PROJECT ENGINEERING MANAGEMENT

POWER PROJECT ENGINEERING INSTITUTE

HRD & ESI COMPLEX

PLOT NO.: 25, SECTOR-16A

NOIDA (U.P.) - 201 301

REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
2X660 MW UDANGUDI SUPERCRITICAL TPS STAGE-I
AT KALLAMOLI, THIRUCHENDUR TALUK,
TUTICORIN DISTRICT, TAMILNADU

PART-2

CHP & AHP AREA

Volume II:Bore log, Field and Laboratory test results

Client:

M/s. Bharat Heavy Electricals Limited

Consultant:

C. E. Testing Company Pvt. Limited
An ISO 9001, 14001& OHSAS 18001 Certified Company
NABL Accredited Laboratory
124A, N.S.C. Bose Road: Kolkata - 700 092
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Email: cetest@cetestindia.com

LIST OF CONTENTS

For C. E. Testing Company Private Limited,

Prepared By	Checked By	Approved By
(S. SARKAR)	(S. NATH)	(DR. M. NAYAK)

PART IA: FIELD TEST RESULTS

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 06/04/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 1

Co-ordinates E=-261 N=1516

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 31/03/2018
Completion Date : 01/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.903 M.
Water Struck At :
Standing Water Level : 2.5 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Medium dense, steel grey to brownish grey, silty sand to sandy silt. Observed conch pcs. & clay binder.		4 5 7 (12)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Medium, light grey, clayey silt with sand mixture.		0 1 2 (3)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			UDS-2	3.50-3.95
		2 3 4 (7)	SPT-3	4.00-4.45
4.55m. Very dense, light to brownish grey, silty sand with conch pcs. Observed decomposed rock. 5.20m.		28 72 10.0 cm Pentn. >100	SPT-4	4.65-4.90
		100 4.0 cm Pentn. Refusal	*SPT-5	5.05-5.09
		00 Refusal 3.0 cm Pentn.	*SPT-6	5.20-5.23
		NX rotary drilling from 5.20m to 20.00m	R1	CR=24% RQD=Nil 5.20-6.00
			R2	CR=27% RQD=Nil 6.00-6.75
			R3	CR=27% RQD=Nil 6.75-7.50
Completely to highly weathered, light to dark grey, coarse to medium grained, highly fractured rock.			R4	CR=20% RQD=Nil 7.50-8.25
			R5	CR=25% RQD=Nil 8.25-9.00
			R6	CR=20% RQD=Nil 9.00-9.75
			R7	CR=25% RQD=Nil 9.75-10.50
10.50m. Highly weathered, light to yellowish grey, coarse to medium grained, highly fractured rock.			R8	CR=33% RQD=Nil 10.50-11.25
			R9	CR=23% RQD=Nil 11.25-12.00
			R10	CR=23% RQD=Nil 12.00-12.75
			R11	CR=28% RQD=Nil 12.75-13.50
			R12	CR=26% RQD=Nil 13.50-14.25
			R13	CR=25% RQD=Nil 14.25-15.00
			R14	CR=24% RQD=Nil 15.00-15.75
15.75m. Highly to moderately weathered, light to yellowish grey, coarse to medium grained, highly fractured rock.			R15	CR=27% RQD=Nil 15.75-16.50
			R16	CR=28% RQD=Nil 16.50-17.25
			R17	CR=29% RQD=Nil 17.25-18.00
			R18	CR=24% RQD=Nil 18.00-18.75
			R19	CR=40% RQD=Nil 18.75-19.50
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R20	CR=46% RQD=Nil 19.50-20.00

BH-1/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 06/04/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 2

Co-ordinates E=-131 N=1515

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 29/03/2018
Completion Date : 31/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.002 M.
Water Struck At :
Standing Water Level : 2.3 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)	
0.00m.					
Loose, light whitish grey, clayey silty sand. Observed conch pcs.		2 3 4 (7)	DS-1	0.50	
1.50m.			SPT-1	1.00-1.45	
Medium, light whitish grey, clayey silt with sand mixture. Observed conch pcs.		2 2 2 (4)	UDS-1	2.05-2.50	
			SPT-2	2.50-2.95	
			DS-2	3.50	
		3 3 5 (8)	SPT-3	4.00-4.45	
5.50m.		87 10.0 cm Pentn.	SPT-4	5.50-5.60	
Very dense, light grey, silty sand with decomposed rock. Observed conch pcs.		100 3.0 cm Pentn. Refusal	*SPT-5	5.80-5.83	
6.00m.		00 2.0 cm Pentn. Refusal (>100)	*SPT-6	6.00-6.02	6.00
		NX rotary drilling from 6.00m to 20.00m	R1	CR=30% RQD=Nil	6.75
			R2	CR=40% RQD=21%	7.50
Highly weathered, light grey, coarse to medium grained, fractured rock.			R3	CR=37% RQD=Nil	8.25
			R4	CR=39% RQD=Nil	9.00
			R5	CR=36% RQD=Nil	9.75
9.75m.			R6	CR=23% RQD=Nil	10.50
Highly weathered, light whitish grey, medium grained, fractured rock.			R7	CR=30% RQD=Nil	11.25
			R8	CR=36% RQD=Nil	12.00
12.00m.			R9	CR=38% RQD=Nil	12.75
			R10	CR=38% RQD=Nil	13.50
			R11	CR=29% RQD=Nil	14.25
			R12	CR=40% RQD=Nil	15.00
Highly to moderately weathered, light whitish grey / light greenish grey, medium grained, fractured rock.			R13	CR=44% RQD=Nil	15.75
			R14	CR=36% RQD=Nil	16.50
			R15	CR=38% RQD=Nil	17.25
			R16	CR=48% RQD=Nil	18.00
			R17	CR=36% RQD=Nil	18.75
			R18	CR=42% RQD=Nil	19.50
N.B. - '*' means sample could not be recovered / sample slip.			R19	CR=45% RQD=Nil	20.00
20.00m.					

BH-2/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 03/04/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. IBH 3

Co-ordinates E=33 N=1493

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 26/03/2018
Completion Date : 27/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.940 M.
Water Struck At :
Standing Water Level : 2.15 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
		5	DS-1	0.50
		2 2 3	SPT-1	1.00-1.45
Soft / medium, light grey, clayey silt with sand mixture. Observed conch pcs.		4	*UDS-1	2.00-2.45
		1 2 2	SPT-2	2.50-2.95
			*UDS-2	3.20-3.65
		5		
		2 2 3	SPT-3	4.00-4.45
		37/62 ≥100		
5.00m.		5.0 cm Pentn.	SPT-4	5.00-5.20
Very dense, light grey, clayey silty sand with decomposed rock. Observed conch pcs.		100/3.0 cm Pentn. Refusal	*SPT-5	5.30-5.33
5.50m.		00 ≥100	*SPT-6	5.50-5.52 5.50
		2.0 cm Pentn.	R1	CR=32% RQD=Nil 6.25
		NX rotary drilling from 5.50m to 20.00m	R2	CR=37% RQD=19% 7.00
			R3	CR=38% RQD=Nil 7.75
Highly to moderately weathered, light grey, coarse to medium grained, fractured rock.			R4	CR=44% RQD=22% 8.50
			R5	CR=45% RQD=Nil 9.25
			R6	CR=47% RQD=Nil 10.00
			R7	CR=45% RQD=Nil 10.75
10.75m.			R8	CR=22% RQD=Nil 11.50
Highly weathered, light grey, coarse to medium grained, fractured rock.			R9	CR=23% RQD=Nil 12.25
12.25m.			R10	CR=25% RQD=Nil 13.00
Highly weathered, light whitish grey, coarse to medium grained, fractured rock.			R11	CR=28% RQD=Nil 13.75
			R12	CR=24% RQD=Nil 14.50
14.50m.			R13	CR=27% RQD=Nil 15.25
			R14	CR=40% RQD=Nil 16.00
			R15	CR=41% RQD=Nil 16.75
Highly to moderately weathered, light whitish grey, coarse to medium grained, fractured rock.			R16	CR=40% RQD=Nil 17.50
			R17	CR=29% RQD=Nil 18.25
			R18	CR=30% RQD=Nil 19.00
N.B. - '*' means sample could not be recovered / sample slip.			R19	CR=34% RQD=Nil
20.00m.				20.00

BH-3/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 4

Co-ordinates E=211 N=1490

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 28/02/2018
Completion Date : 01/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.789 M.
Water Struck At :
Standing Water Level : 1.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed mica, conch pcs. & clay binder.		6 10 11 — 21	DS-1	0.50
			SPT-1	1.00-1.45
			UDS-1	2.00-2.45
2.60m.				
Soft / medium light grey, silty clay / clayey silt with traces of sand mixture. Observed kankar & conch pcs.		1 2 2 — 4	SPT-2	3.00-3.45
			*UDS-2	4.00-4.45
4.80m.				
Very dense, light grey, silty sand with kankar. Observed decomposed rock.		53 47 — ≥100 5.0 cm Pentn.	SPT-3	5.00-5.20
		100 3.0 cm Pentn. Refusal	*SPT-4	5.40-5.43
		100 4.0 cm Pentn. Refusal	*SPT-5	5.55-5.59
5.75m.		100 2.0 cm Pentn. Refusal	*SPT-6	5.75-5.77 5.75
			R1	CR=17% RQD=Nil 7.25
		50 — Refusal	*SPT-7	6.50-6.52 6.50
		2.0 cm Pentn.	R2	CR=20% RQD=Nil 8.00
		NX rotary drilling from 5.75m to 15.00m	R3	CR=25% RQD=Nil 8.75
Completely to highly weathered, light grey, medium to coarse grained, completely fractured rock.			R4	CR=21% RQD=Nil 9.50
			R5	CR=21% RQD=Nil 10.25
			R6	CR=23% RQD=14% 11.00
			R7	CR=24% RQD=13%
		52 — Refusal	R8	CR=18% RQD=Nil
11.75m.		3.0 cm Pentn.	*SPT-8	11.75-11.78 11.75
Completely weathered, light grey, fine grained, moderately fractured rock.		Refusal	R9	CR=16% RQD=Nil 12.50
12.50m.		50 — 2.0 cm Pentn.	*SPT-9	12.50-12.52 12.50
			R10	CR=57% RQD=48% 13.25
Highly to moderately weathered, light to whitish grey, fine grained, moderately fractured rock.			R11	CR=37% RQD=Nil 14.00
			R12	CR=36% RQD=Nil 15.00
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.				

BH-4/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 5

Co-ordinates E=330 N=1491

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	11	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	11
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 28/02/2018
Completion Date : 01/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.064 M.
Water Struck At :
Standing Water Level : 1.85 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed mica, conch pcs. & clay binder.		5 7 8 (15)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
2.60m.				
Soft, light grey, silty clay. Observed sand mixture.		1 2 2 (4)	SPT-2	3.00-3.45
			*UDS-2	4.00-4.45
4.80m.				
Very dense, light grey, silty sand. Observed kankar & decomposed rock.		29 71 (≥100) 5.0 cm Pentn.	SPT-3	5.00-5.20
		100 (≥100) 11.0 cm Pentn.	SPT-4	5.60-5.71
5.80m.		00 Refusal 3.0 cm Pentn.	*SPT-5	5.80-5.83 5.80
		NX rotary drilling from 5.80m to 15.00m	R1	CR=20% RQD=Nil 6.50
			R2	CR=18% RQD=Nil
		50 Refusal 2.0 cm Pentn.	*SPT-6	7.25-7.27 7.25
			R3	CR=15% RQD=Nil
		50 Refusal 3.0 cm Pentn.	*SPT-7	8.00-8.03 8.00
			R4	CR=14% RQD=Nil
Completely to highly weathered, light grey, medium to coarse grained, fractured rock.		50 Refusal 2.0 cm Pentn.	*SPT-8	8.75-8.77 8.75
			R5	CR=19% RQD=Nil
		50 Refusal 3.0 cm Pentn.	*SPT-9	9.50-9.53 9.50
			R6	CR=17% RQD=Nil
		50 Refusal 1.0 cm Pentn.	*SPT-10	10.25-10.26 10.25
			R7	CR=19% RQD=Nil
		50 Refusal 2.0 cm Pentn.	*SPT-11	11.00-11.02 11.00
			R8	CR=22% RQD=Nil 11.75
			R9	CR=22% RQD=Nil 12.50
12.50m.				
Highly weathered, whitish grey, fine grained rock.			R10	CR=29% RQD=Nil 13.25
13.25m.				
Moderately weathered, whitish grey to light grey, fine grained rock.			R11	CR=59% RQD=40% 14.00
			R12	CR=51% RQD=14% 15.00
N.B. – '*' means sample could not be recovered / sample slip. 15.00m.				

BH-5/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 06/04/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. IBH 6

Co-ordinates E=-261 N=1392

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 02/04/2018
Completion Date : 02/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.020 M.
Water Struck At :
Standing Water Level : 2.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m.				
		4	DS-1	0.50
		1 2 2	SPT-1	1.00-1.45
Soft to medium, steel grey to brownish grey, silty clay with sand mixture. Observed conch pcs.		7	UDS-1	2.00-2.45
		2 3 4	SPT-2	2.50-2.95
		8	*UDS-2	3.50-3.95
		3 3 5	SPT-3	4.00-4.45
4.80m.				
Very dense, light to brownish grey, silty sand with mica & conch pcs. Observed decomposed rock.		12 40 48 ≥100 10.0 cm Pentn.	*UDS-3	5.00-5.08
			SPT-4	5.10-5.50
		100 4.0 cm Pentn. Refusal	*SPT-5	5.80-5.84
6.00m.		100 3.0 cm Pentn. Refusal	*SPT-6 R1	6.00-6.03 CR=13%/RQD=0
Completely weathered, light to brownish grey, medium to coarse grained, highly fractured rock.		52 2.0 cm Pentn. Refusal	*SPT-7 R2	6.75-6.77 CR=16%/RQD=0
		50 2.0 cm Pentn. Refusal	*SPT-8 R3	7.50-7.52 CR=18%/RQD=0
8.25m.		Refusal	*SPT-9 R4	8.25-8.28 CR=24%/RQD=0
Highly weathered, light to brownish grey, medium to fine grained, highly fractured rock.		53 3.0 cm Pentn. NX rotary drilling from 6.00m to 15.00m	R5	CR=24% RQD=Nil
9.75m.			R6	CR=26% RQD=Nil
			R7	CR=28% RQD=Nil
			R8	CR=36% RQD=Nil
Highly weathered, light to brownish grey, medium to fine grained, highly fractured rock.			R9	CR=38% RQD=Nil
			R10	CR=35% RQD=Nil
			R11	CR=26% RQD=Nil
			R12	CR=32% RQD=Nil
15.00m.				

6.00 / 6.75 / 7.50 / 8.25 / 9.00 / 9.75 / 10.50 / 11.25 / 12.00 / 12.75 / 13.50 / 14.25 / 15.00

N.B. – '*' means sample could not be recovered / sample slip.

BH-6/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 03/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 7

Co-ordinates E=-16 N=1407

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 27/03/2018
Completion Date : 28/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.858 M.
Water Struck At :
Standing Water Level : 2.1 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light whitish grey, clayey silty sand with conch pcs.		2 3 3 (6)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Loose, light whitish grey, clayey silty sand. Observed conch pcs.		1 2 2 (4)	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			DS-2	3.50
4.00m.		17 35 45 (≥100) 3.0 cm Pentn.	SPT-3	4.00-4.33
Very dense, light whitish grey, silty sand with decomposed rock.		100 3.0 cm Pentn. Refusal	*SPT-4	4.60-4.63
		100 2.0 cm Pentn. Refusal	*SPT-5	4.80-4.82
5.25m.		00 (≥100) 2.0 cm Pentn.	*SPT-6	5.25-5.27
		NX rotary drilling from 5.25m to 15.00m	R1	CR=28% RQD=Nil (5.25-6.00)
			R2	CR=25% RQD=Nil (6.00-6.75)
			R3	CR=29% RQD=Nil (6.75-7.50)
Highly weathered, light grey, coarse grained, fractured rock.			R4	CR=28% RQD=Nil (7.50-8.25)
			R5	CR=27% RQD=Nil (8.25-9.00)
			R6	CR=30% RQD=Nil (9.00-9.75)
			R7	CR=28% RQD=Nil (9.75-10.50)
			R8	CR=28% RQD=Nil (10.50-11.25)
11.25m.			R9	CR=50% RQD=Nil (11.25-12.00)
Moderately weathered, light whitish grey, medium grained, fractured rock.			R10	CR=41% RQD=Nil (12.00-12.75)
			R11	CR=45% RQD=Nil (12.75-13.50)
			R12	CR=48% RQD=Nil (13.50-14.25)
14.25m.			R13	CR=53% RQD=Nil (14.25-15.00)
Moderately weathered, light grey, coarse to medium grained, fractured rock. 15.00m.				

N.B. - '*' means sample could not be recovered / sample slip.

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 8

Co-ordinates E=35 N=1343

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 30/03/2018
Completion Date : 01/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.083 M.
Water Struck At :
Standing Water Level : 2.3 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Loose, brownish grey, silty sand. Observed kankar & mica.		2 3 3 (6)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Medium dense, brownish grey, silty sand with mica & conch pcs. Observed kankar.		5 7 7 (14)	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
4.00m. Very dense, brownish grey, silty sand with kankar, mica & conch pcs. Observed decomposed rock.		16 34 50 (≥100) 5.0 cm Pentn.	*UDS-2	3.50-3.95
			SPT-3	4.00-4.35
4.80m.		100 4.0 cm Pentn. Refusal	*SPT-4	4.60-4.64
		Refusal 100 3.0 cm Pentn.	*SPT-5	4.80-4.83
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock.		NX rotary drilling from 4.80m to 20.00m	R1	CR=34% RQD=Nil 4.80-5.50
			R2	CR=30% RQD=Nil 5.50-6.25
			R3	CR=32% RQD=Nil 6.25-7.00
			R4	CR=29% RQD=Nil 7.00-7.75
8.50m.			R5	CR=27% RQD=Nil 7.75-8.50
			R6	CR=26% RQD=Nil 8.50-9.25
Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R7	CR=33% RQD=Nil 9.25-10.00
			R8	CR=31% RQD=Nil 10.00-10.75
			R9	CR=33% RQD=Nil 10.75-11.50
			R10	CR=26% RQD=Nil 11.50-12.25
			R11	CR=24% RQD=Nil 12.25-13.00
			R12	CR=29% RQD=Nil 13.00-13.75
			R13	CR=30% RQD=Nil 13.75-14.50
			R14	CR=28% RQD=Nil 14.50-15.25
			R15	CR=24% RQD=Nil 15.25-16.00
			R16	CR=26% RQD=Nil 16.00-16.75
			R17	CR=30% RQD=Nil 16.75-17.50
			R18	CR=26% RQD=Nil 17.50-18.25
18.25m.			R19	CR=25% RQD=Nil 18.25-19.00
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R20	CR=22% RQD=Nil 20.00

BH-8/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 26/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 9

Co-ordinates E=-131 N=1258

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 20/03/2018
Completion Date : 21/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.063 M.
Water Struck At :
Standing Water Level : 1.5 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Brownish grey, silty sand. 0.60m.		1	DS-1	0.50
Very soft, light grey, clayey silt with sand. Observed conch pcs.		1 0 1	SPT-1	1.00-1.45
		2	*UDS-1	2.00-2.45
		1 1 1	SPT-2	2.55-3.00
3.50m. Medium dense, light grey, clayey silty sand mixture. Observed conch pcs.		21	*UDS-2	3.50-3.95
		7 9 12	SPT-3	4.10-4.55
4.70m. Very dense, light grey, sandy silt to silty sand with rock pcs. 5.20m.		32 68 8.0 cm Pentn. >100	SPT-4	4.80-5.03
		100 2.0 cm Pentn. Refusal	*SPT-5	5.10-5.12
		100 2.0 cm Pentn. Refusal	*SPT-6	5.20-5.22
			R1	CR=17%/RQD=0
		50 Refusal 3.0 cm Pentn.	*SPT-7	6.00-6.03
			R2	CR=14%/RQD=0
		52 Refusal 2.0 cm Pentn.	*SPT-8	6.75-6.77
Completely to highly weathered, light grey, coarse grained, moderately fractured rock.			R3	CR=18%/RQD=0
		50 Refusal 2.0 cm Pentn.	*SPT-9	7.50-7.52
			R4	CR=16%/RQD=0
		Refusal	*SPT-10	8.25-8.28
		51 3.0 cm Pentn.	R5	CR=21% RQD=Nil
		NX rotary drilling from 5.20m to 15.00m	R6	CR=23% RQD=Nil
9.75m. Highly to moderately weathered, light grey, coarse to fine grained, highly fractured rock.			R7	CR=26% RQD=Nil
			R8	CR=29% RQD=Nil
			R9	CR=49% RQD=Nil
12.00m. Moderately weathered, light brownish grey, fine grained, fractured rock. 12.75m.			R10	CR=60% RQD=20%
			R11	CR=32% RQD=Nil
Highly to moderately weathered, light grey, medium grained, highly fractured rock.			R12	CR=39% RQD=Nil
15.00m.			R13	CR=42% RQD=Nil

5.20 6.00 6.75 7.50 8.25 9.00 9.75 10.50 11.25 12.00 12.75 13.50 14.25 15.00

N.B. – '*' means sample could not be recovered / sample slip.

BH-9/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 10

Co-ordinates E=-261 N=1264

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 02/04/2018
Completion Date : 02/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.724 M.
Water Struck At :
Standing Water Level : 2.2 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light whitish grey, clayey silty sand with conch pcs.		4 5 7 (12)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m.				
Loose, light whitish grey, clayey silty sand. Observed conch pcs.		2 2 3 (5)	UDS-1	2.05-2.50
			SPT-2	2.50-2.95
			DS-2	3.50
		3 4 6 (10)	SPT-3	4.00-4.45
			*UDS-2	5.00-5.45
5.60m.		9 28 47 (75)	SPT-4	5.60-6.05
Very dense, light whitish grey, silty sand with decomposed rock.		69 6.0 cm Pentn. Refusal	SPT-5	6.20-6.26
6.50m.		100 2.0 cm Pentn. Refusal	*SPT-6	6.40-6.42
Highly weathered, light grey, coarse grained, fractured rock.		Refusal	*SPT-7	6.50-6.52
7.25m.		00 2.0 cm Pentn.	R1	CR=24% RQD=Nil (6.50-7.25)
		NX rotary drilling from 6.50m to 15.00m	R2	CR=28% RQD=Nil (7.25-8.00)
			R3	CR=27% RQD=Nil (8.00-8.75)
Highly weathered, light grey, coarse grained, fractured rock.			R4	CR=28% RQD=Nil (8.75-9.50)
			R5	CR=30% RQD=Nil (9.50-10.25)
			R6	CR=29% RQD=Nil (10.25-11.00)
			R7	CR=32% RQD=Nil (11.00-11.75)
11.75m.			R8	CR=31% RQD=Nil (11.75-12.50)
Highly weathered, light whitish grey, medium grained, fractured rock.			R9	CR=37% RQD=Nil (12.50-13.25)
			R10	CR=38% RQD=Nil (13.25-14.00)
			R11	CR=35% RQD=Nil (14.00-15.00)
15.00m.				

N.B. – '*' means sample could not be recovered / sample slip.

BH-10/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 11

Co-ordinates E=-259 N=1150

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	1

Commencement Date : 01/04/2018
Completion Date : 02/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.916 M.
Water Struck At :
Standing Water Level : 2.75 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Light brownish grey, sandy silt. 0.55m.				
Medium dense, light grey, silty sand with clay binder. Observed conch.		8 12 15 (27); 9 10 16 (26)	DS-1; SPT-1; UDS-1; WS-1; SPT-2; *UDS-2	0.50; 1.00-1.45; 2.00-2.45; 2.75; 2.50-2.95; 3.50-3.95
4.00m. Medium dense, light grey, silty sand. Observed conch.		2 4 6 (10)	SPT-3	4.05-4.50
5.10m. Very dense, light grey, silty sand. Observed conch.		9 17 74 (>100); 100 4.0 cm Pentn. Refusal	*UDS-3; SPT-4; *SPT-5; *SPT-6	5.00-5.10; 5.50-5.90; 6.00-6.04; 6.10-6.13
6.10m. Completely/highly weathered, light grey, fine grained, highly fractured rock.		100 Refusal 3.0 cm Pentn. NX rotary drilling from 6.10m to 15.00m	R1; R2; R3	CR=21%/RQD=0; CR=22% RQD=Nil; CR=16%/RQD=0
8.35m. Completely to highly weathered, light grey, coarse to medium grained, highly fractured rock.		50 Refusal 3.0 cm Pentn.; 50 Refusal 2.0 cm Pentn.	*SPT-7; R4; *SPT-8; R5; R6; R7; R8; R9; R10; R11; R12	8.35-8.38; CR=13%/RQD=0; 9.10-9.12; CR=21%/RQD=0; CR=22% RQD=Nil; CR=24% RQD=Nil; CR=29% RQD=Nil; CR=37% RQD=Nil; CR=39% RQD=Nil; CR=27% RQD=Nil; CR=29% RQD=Nil
11.35m. Highly weathered, light grey, medium grained, highly fractured rock. 12.10m.				
Highly weathered, light brownish grey, fine grained, moderately fractured rock. 12.85m.				
Highly weathered, light brownish grey, coarse grained, moderately fractured rock. 14.35m.				
Highly weathered, brownish grey, coarse grained, highly fractured rock. 15.00m.				

6.10 / 6.85 / 7.60 / 8.35 / 9.10 / 9.85 / 10.60 / 11.35 / 12.10 / 12.85 / 13.60 / 14.35 / 15.00

N.B. – '*' means sample could not be recovered / sample slip.

BH-11/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 26/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 12

Co-ordinates E=35 N=1143

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 17/03/2018
Completion Date : 19/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.135 M.
Water Struck At :
Standing Water Level : 1.32 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Yellowish brown, silty fine sand.			DS-1	0.50
0.80m. Very soft, light grey, silty clay with sand mixture. Observed conch pcs.		0 0 1 (1)	SPT-1	1.00-1.45
			UDS-1	2.00-2.45
2.40m. Very loose, light grey, silty sand. Observed kankar & conch pcs.		1 1 2 (3)	SPT-2	2.50-2.95
3.80m. Very dense, light grey, medium grained, silty sand. Observed decomposed rock.		11 28 61 >100 10.0 cm Pentn.	UDS-2	3.50-3.95
			SPT-3	4.00-4.40
4.90m. Highly weathered, deep grey, coarse grained, fractured rock.		100 9.0 cm Pentn. >100 100 2.0 cm Pentn. Refusal	SPT-4	4.60-4.69
5.50m. Highly weathered, deep to light grey, coarse grained, fractured rock.		NX rotary drilling from 4.90m to 20.00m	*SPT-5	4.90-4.93
7.00m.			R1	CR=25% RQD=Nil
			R2	CR=30% RQD=Nil
			R3	CR=33% RQD=Nil
			R4	CR=23% RQD=Nil
			R5	CR=24% RQD=Nil
			R6	CR=29% RQD=Nil
			R7	CR=26% RQD=Nil
			R8	CR=21% RQD=Nil
			R9	CR=24% RQD=Nil
			R10	CR=24% RQD=Nil
			R11	CR=25% RQD=Nil
			R12	CR=24% RQD=Nil
Completely/highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.		Refusal 50 2.0 cm Pentn.	R13	CR=19%/RQD=0
			*SPT-6	14.25-14.27
			R14	CR=20%/RQD=0
		Refusal 50 3.0 cm Pentn.	R15	CR=19%/RQD=0
			*SPT-7	15.75-15.78
			R16	CR=20%/RQD=0
		Refusal 50 2.0 cm Pentn.	R17	CR=16%/RQD=0
			*SPT-8	17.25-17.27
		Refusal 50 3.0 cm Pentn.	R18	CR=17%/RQD=0
			*SPT-9	18.00-18.03
			R19	CR=21%/RQD=0
			R20	CR=20% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.		Refusal 50 2.0 cm Pentn.	R21	CR=18%/RQD=0
20.00m.			*SPT-10	20.00-20.02

BH-12/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 03/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 13

Co-ordinates E=-131 N=1022

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 22/03/2018
Completion Date : 24/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.131 M.
Water Struck At :
Standing Water Level : 1.58 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Brownish grey, silty sand. Observed conch pcs. 0.60m.		1	DS-1	0.50
		1 0 1	SPT-1	1.00-1.45
Very soft, light grey, clayey silt with sand mixture. Observed conch.		2	*UDS-1	2.00-2.45
		1 1 1	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
4.00m. Dense to very dense, light grey, sandy silt with rock pcs.		39	SPT-3	4.00-4.45
		9 18 21	SPT-4	4.70-4.90
		28 72 5.0 cm Pentn. >100	*SPT-5	5.00-5.03
5.10m.		100 3.0 cm Pentn. Refusal	*SPT-6	5.10-5.12
Highly weathered, light grey, coarse grained, highly to moderately fractured rock.		100 Refusal	R1	CR=23% RQD=Nil
		2.0 cm Pentn.	R2	CR=25% RQD=Nil
		NX rotary drilling from 5.10m to 15.00m	R3	CR=17%/RQD=0
6.60m. Completely weathered, light grey, fine grained, highly fractured rock.		50 Refusal	*SPT-7	7.35-7.37
		2.0 cm Pentn.	R4	CR=18%/RQD=0
8.10m.		51 Refusal	*SPT-8	8.10-8.12
		2.0 cm Pentn.	R5	CR=21%/RQD=0
Highly weathered, light grey, coarse grained, moderately fractured rock.			R6	CR=26% RQD=Nil
			R7	CR=21% RQD=Nil
			R8	CR=24% RQD=Nil
11.10m. Highly weathered, light grey, fine grained, moderately fractured rock.			R9	CR=39% RQD=Nil
			R10	CR=31% RQD=Nil
12.60m. Highly weathered, light brownish grey, medium grained, moderately fractured			R11	CR=32% RQD=Nil
			R12	CR=25% RQD=Nil
			R13	CR=30% RQD=Nil
15.00m.				

5.10 5.85 6.60 7.35 8.10 8.85 9.60 10.35 11.10 11.85 12.60 13.35 14.10 15.00

N.B. – '*' means sample could not be recovered / sample slip.

BH-13/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 03/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 14

Co-ordinates E=-129 N=934

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 25/03/2018
Completion Date : 27/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.025 M.
Water Struck At :
Standing Water Level : 1.69 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Brownish grey, silty sand.		1	DS-1	0.50
0.90m. Very soft, light grey, clayey silt with sand. Observed conch.		1 0 1	SPT-1	1.00-1.45
		2	*UDS-1	2.00-2.45
		1 1 1	SPT-2	2.55-3.00
3.40m. Very dense, light grey, sandy silt. Observed conch & rock pcs.		14 21 65 >100 12.0 cm Pentn.	*UDS-2	3.50-3.95
			SPT-3	4.05-4.47
		100 3.0 cm Pentn. Refusal	*SPT-4	4.55-4.58
4.65m. Completely to highly weathered, light grey, coarse grained, highly fractured rock.		100 2.0 cm Pentn. Refusal	*SPT-5 R1	4.65-4.67 CR=18%/RQD=0
		>100 50 2.0 cm Pentn.	*SPT-6 R2	5.25-5.27 CR=26%/RQD=0
6.00m. Highly weathered, light grey, medium to fine grained, moderately fractured rock.		NX rotary drilling from 4.65m to 15.00m	R3	CR=33% RQD=Nil
7.50m. Highly weathered, light grey, coarse to fine grained, moderately fractured rock.			R4	CR=21% RQD=Nil
9.00m. Highly weathered, light grey, medium grained, highly fractured rock.			R5	CR=39% RQD=23%
			R6	CR=30% RQD=Nil
			R7	CR=25% RQD=Nil
			R8	CR=24% RQD=Nil
11.25m. Highly weathered, light brownish grey, fine to coarse grained, moderately fractured rock.			R9	CR=25% RQD=Nil
			R10	CR=27% RQD=Nil
12.75m. Highly weathered, whitish grey, fine to medium grained, moderately fractured rock.			R11	CR=30% RQD=Nil
			R12	CR=29% RQD=Nil
14.25m. Highly weathered, light grey, fine grained, highly fractured rock. 15.00m.			R13	CR=28% RQD=13%
			R14	CR=24% RQD=Nil

4.65 5.25 6.00 6.75 7.50 8.25 9.00 9.75 10.50 11.25 12.00 12.75 13.50 14.25 15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-14/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 15

Co-ordinates E=-261 N=909

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 30/03/2018
Completion Date : 31/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.565 M.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Light brownish grey, silty sand. Observed conch. 0.60m.			DS-1	0.50
Medium dense, light grey, silty sand.		13 14 10 = 24	SPT-1	1.00-1.45
2.00m. Very soft, light grey, clayey silt with sand mixture. Observed conch.		1 0 1 = 1	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
4.00m. Very loose, light grey, silty sand to sandy silt. Observed conch.		1 1 2 = 3	*UDS-2	3.50-3.95
			SPT-3	4.05-4.50
4.80m. Very dense, light grey, silty sand to sandy silt with rock pcs. Observed conch.		8 14 78 = >100 11.0 cm Pentn.	*UDS-3	5.00-5.10
			SPT-4	5.40-5.81
		100 4.0 cm Pentn. Refusal	*SPT-5	5.90-5.94
6.00m. Completely to highly weathered, deep grey, fine to coarse grained, highly fractured rock.		00 Refusal 3.0 cm Pentn. NX rotary drilling from 6.00m to 15.00m	*SPT-6	6.00-6.03
			R1	CR=21%/RQD=0 6.00-6.75
			R2	CR=18%/RQD=0
		50 Refusal 2.0 cm Pentn.	*SPT-7	7.50-7.52
			R3	CR=13%/RQD=0 7.50-8.25
8.25m. Completely to highly weathered, light grey, medium grained, highly fractured rocck.		50 Refusal 3.0 cm Pentn.	*SPT-8	8.25-8.28
			R4	CR=14%/RQD=0
		50 Refusal 3.0 cm Pentn.	*SPT-9	9.00-9.03
			R5	CR=21%/RQD=0 9.00-9.75
			R6	CR=22% RQD=Nil
10.50m. Highly weathered, light grey, coarse grained, moderately fractured rock.			R7	CR=31% RQD=Nil 10.50-11.25
11.25m. Highly weathered, light grey, fine grained, highly fractured rock.			R8	CR=23% RQD=Nil
12.00m. Highly weathered, light brownish grey, fine to medium grained, moderately fractured rock.			R9	CR=34% RQD=Nil 12.00-12.75
			R10	CR=40% RQD=Nil
13.50m. Moderately weathered, light grey, fine grained, moderately fractured rock.			R11	CR=48% RQD=Nil 13.50-14.25
			R12	CR=44% RQD=Nil
15.00m.				14.25-15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-15/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 26/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 16

Co-ordinates E=35 N=877

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	15	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	15
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 19/03/2018
Completion Date : 21/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.064 M.
Water Struck At :
Standing Water Level : 1.3 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Brownish grey, silty fine sand.				
0.70m. Very soft, light grey, clayey silt. Observed conch pcs. & sand mixture.		1 / 0 0 1	DS-1	0.50
			SPT-1	1.05-1.50
1.80m. Very loose, light grey, silty sand. Observed kankar & conch pcs.		1 / 0 0 1	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.80m. Very dense, light grey, silty sand with conch pcs. & decomposed rock. Observed kankar.		≥100 / 100 11.0 cm Pentn.	UDS-2	3.50-3.92
			SPT-3	4.00-4.11
4.50m.		100 4.0 cm Pentn. Refusal	*SPT-4	4.30-4.34
		100 3.0 cm Pentn. Refusal	*SPT-5	4.50-4.53 4.50
		50 Refusal	R1	CR=13%/RQD=0
		50 2.0 cm Pentn. Refusal	*SPT-6	5.25-5.27 5.25
			R2	CR=16%/RQD=0
		50 3.0 cm Pentn. Refusal	*SPT-7	6.00-6.03 6.00
			R3	CR=24%/RQD=0
			R4	6.75 CR=16%/RQD=0
Completely to highly weathered, medium to coarse grained, fractured rock.		50 3.0 cm Pentn. Refusal	*SPT-8	7.50-7.53 7.50
			R5	CR=17%/RQD=0
		50 3.0 cm Pentn. Refusal	*SPT-9	8.25-8.28 8.25
			R6	CR=12%/RQD=0
		50 2.0 cm Pentn. Refusal	*SPT-10	9.00-9.02 9.00
			R7	CR=13%/RQD=0
		50 2.0 cm Pentn. Refusal	*SPT-11	9.75-9.77 9.75
			R8	CR=14%/RQD=0
10.50m.		50 2.0 cm Pentn. Refusal	*SPT-12	10.50-10.52 10.50
			R9	CR=13%/RQD=0
		50 2.0 cm Pentn. Refusal	*SPT-13	11.25-11.27 11.25
			R10	CR=20%/RQD=0
		NX rotary drilling from 4.50m to 20.00m	R11	12.00 CR=24% RQD=Nil
			R12	12.75 CR=21% RQD=Nil
Completely to highly weathered, light to whitish grey, medium to coarse grained, fractured rock.			R13	13.50 CR=22% RQD=Nil
			R14	14.25 CR=19%/RQD=0
		50 Refusal	*SPT-14	15.00-15.02 15.00
		50 2.0 cm Pentn.	R15	CR=24%/RQD=0
			R16	15.75 CR=25% RQD=Nil
		Refusal	R17	16.50 CR=17%/RQD=0
		50	*SPT-15	17.25-17.28 17.25
		3.0 cm Pentn.	R18	CR=21%/RQD=0
18.00m. Highly to moderately weathered, whitish grey, medium grained, fractured rock.			R19	18.00 CR=28% RQD=Nil
			R20	18.75 CR=53% RQD=17%
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R21	19.50 CR=40% RQD=20% 20.00

BH-16/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 17

Co-ordinates E=-168 N=780

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 27/03/2018
Completion Date : 29/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.331 M.
Water Struck At :
Standing Water Level : 1.68 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Brownish grey, silty sand. 0.55m.			DS-1	0.50
Very soft, light grey, clayey silt with sand mixture. Observed conch.		1 0 0 0 1/0 1	SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
		1 0 0 0 1/0 1	SPT-2	2.50-2.95
3.50m. Very dense, light grey, sandy silt. Observed conch & rock pcs. 4.40m.		42 58 >100 (10.0 cm Pentn.) (100 4.0 cm Pentn. Refusal) Refusal	UDS-2 SPT-3 *SPT-4 *SPT-5	3.50-3.80 3.95-4.20 4.30-4.34 4.40-4.43
Highly weathered, light grey, medium to coarse grained, moderately to highly fractured rock. 5.75m.		100 3.0 cm Pentn. NX rotary drilling from 4.40m to 15.00m	R1 R2 R3	CR=24% RQD=Nil CR=25% RQD=Nil CR=29% RQD=Nil
Highly weathered, light whitish grey, coarse grained, moderately fractured rock. 8.75m.			R4 R5 R6	CR=32% RQD=29% CR=23% RQD=Nil CR=21% RQD=Nil
Highly weathered, light grey, medium grained, moderately fractured rock. 9.50m.			R7 R8	CR=24% RQD=Nil CR=26% RQD=Nil
Highly weathered, light brownish grey, medium grained, moderately fractured rock. 12.50m.			R9 R10 R11	CR=26% RQD=Nil CR=36% RQD=Nil CR=27% RQD=Nil
Highly weathered, light grey, medium grained, highly fractured rock. 14.00m.			R12 R13	CR=21% RQD=Nil CR=29% RQD=Nil
Highly weathered, light grey, fine grained, moderately fractured rock. 15.00m.			R14	CR=38% RQD=Nil

4.40 5.00 5.75 6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00 15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-17/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 18

Co-ordinates E=-315 N=734

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 28/03/2018
Completion Date : 29/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.829 M.
Water Struck At :
Standing Water Level : 2.69 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, silty sand.		6 7 9 — 16	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Medium, light grey, silty clay with sand mixture. Observed kankar, conch pcs.		2 2 3 — 5	UDS-1	2.00-2.45
			SPT-2	2.55-3.00
		2 3 4 — 7	UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.90m.				
Very dense, brownish grey, medium grained, silty sand with mica & conch pcs. Observed decomposed rock.		14 35 51 — ≥100 (5.0 cm Pentn.)	*UDS-3	5.00-5.10
			SPT-4	5.15-5.50
		100 4.0 cm Pentn. Refusal	*SPT-5	5.70-5.74
6.00m.		Refusal	*SPT-6	6.00-6.03
Highly weathered, whitish grey, medium grained, completely fractured rock.		00 — 3.0 cm Pentn. NX rotary drilling from 6.00m to 15.00m	R1	CR=22% RQD=Nil (6.00-6.75)
			R2	CR=24% RQD=Nil (6.75-7.50)
7.50m.				
Highly weathered, whitish grey, medium grained, completely fractured rock.			R3	CR=28% RQD=Nil (7.50-8.25)
8.25m.				
Highly weathered, light to brownish grey, medium to coarse grained, fractured rock.			R4	CR=26% RQD=Nil (8.25-9.00)
			R5	CR=31% RQD=Nil (9.00-9.75)
			R6	CR=33% RQD=Nil (9.75-10.50)
			R7	CR=26% RQD=Nil (10.50-11.25)
			R8	CR=36% RQD=Nil (11.25-12.00)
12.00m.				
Highly weathered, whitish grey to light grey, medium grained, fractured rock.			R9	CR=32% RQD=19% (12.00-12.75)
			R10	CR=28% RQD=Nil (12.75-13.50)
			R11	CR=35% RQD=Nil (13.50-14.25)
			R12	CR=39% RQD=Nil (14.25-15.00)
15.00m.				

N.B. – '*' means sample could not be recovered / sample slip.

BH-18/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 06/04/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 19

Co-ordinates E=-261 N=670

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 30/03/2018
Completion Date : 30/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.850 M.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Soft to medium, steel grey to brownish grey, clayey silt with sand mixture / clayey silty sand. Observed kankar & conch pcs.		2 3 4 (7) 1 1 2 (3) 2 2 3 (5)	DS-1 SPT-1 UDS-1 SPT-2 UDS-2 SPT-3	0.50 1.00-1.45 2.00-2.45 2.50-2.95 3.50-3.95 4.00-4.45
4.55m.				
Very dense, brownish grey, medium grained, silty sand with mica. Observed conch pcs. & decomposed rock.		25 28 37 (≥100) 9.0 cm Pentn. 100 3.0 cm Pentn. Refusal Refusal 00 3.0 cm Pentn.	*UDS-3 SPT-4 *SPT-5 *SPT-6	5.00-5.17 5.30-5.69 5.85-5.88 5.95-5.98
5.95m.				5.95
Highly weathered, steel grey to brownish grey, medim to coarse grained, completely fractured rock.		NX rotary drilling from 5.95m to 15.00m	R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12	CR=27%/RQD=0 CR=24% RQD=Nil CR=24% RQD=Nil CR=21% RQD=Nil CR=25% RQD=Nil CR=23% RQD=Nil CR=24% RQD=Nil CR=26% RQD=Nil CR=33% RQD=Nil CR=22% RQD=Nil CR=30% RQD=Nil CR=28% RQD=Nil
				6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00
11.00m.				
Highly weathered, whitish grey to brownish grey, medium grained, partly fractured rock.				
15.00m.				15.00

N.B. – '*' means sample could not be recovered / sample slip.

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 20

Co-ordinates E=-131 N=670

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 28/03/2018
Completion Date : 29/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.583 M.
Water Struck At :
Standing Water Level : 1.6 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Brownish grey, silty fine sand with conch pcs. 0.80m.		2 1 1 = 2	DS-1	0.50
			SPT-1	1.00-1.45
Very soft, light grey, clayey silt with sand mixture / clayey silty sand. Observed conch pcs. & clay binder.		2 0 1 = 1	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.60m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs. 4.40m.		100 12.0 cm Pentn. = >100	*UDS-2	3.50-3.65
			SPT-3	3.95-4.07
		100 3.0 cm Pentn. Refusal = Refusal	*SPT-4	4.20-4.23
			*SPT-5	4.40-4.42
Highly weathered, deep to light grey, coarse to medium grained, fractured rock. 5.75m.		100 2.0 cm Pentn.	R1	CR=31% RQD=Nil 4.40-5.00
			R2	CR=30% RQD=Nil 5.00-5.75
		NX rotary drilling from 4.40m to 15.00m	R3	CR=37% RQD=Nil 5.75-6.50
Highly weathered, light grey, coarse grained, fractured rock with high % of conch pcs. 6.50m.			R4	CR=30% RQD=Nil 6.50-7.25
Highly weathered, light grey, coarse to medium grained, fractured rock. 8.00m.			R5	CR=28% RQD=Nil 7.25-8.00
			R6	CR=22% RQD=Nil 8.00-8.75
		50 2.0 cm Pentn. = >100	R7	CR=17%/RQD=0 8.75-9.50
			*SPT-6	9.50-9.52
			R8	CR=22%/RQD=0 9.50-10.25
Completely to highly weathered, light grey, medium grained, fractured rock.			R9	CR=30% RQD=Nil 10.25-11.00
			R10	CR=23% RQD=Nil 11.00-11.75
			R11	CR=21% RQD=Nil 11.75-12.50
			R12	CR=16%/RQD=0 12.50-13.25
		50 3.0 cm Pentn. = >100	*SPT-7	13.25-13.28
			R13	CR=24%/RQD=0 13.25-14.00
			R14	CR=23% RQD=Nil 14.00-15.00
15.00m.				

N.B. - '*' means sample could not be recovered / sample slip.

BH-20/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 26/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 21

Co-ordinates E=3 N=739

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 21/03/2018
Completion Date : 22/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.732 M.
Water Struck At :
Standing Water Level : 1.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Brownish grey, fine sand with conch pcs. 0.80m.			DS-1	0.50
		0 1 0 (1)	SPT-1	1.00-1.45
Very soft, light grey, silty clay with sand mixture / clayey silty sand. Observed kankar, conch pcs. & clay binder.			UDS-1	2.00-2.45
		0 0 1 (1)	SPT-2	2.55-3.00
3.30m. Very dense, light grey, silty sand with kankar & decomposed rock.		5 33 62 (≥100) 5.0 cm Pentn.	*UDS-2	3.50-3.58
			SPT-3	3.65-4.00
		100 3.0 cm Pentn. Refusal	*SPT-4	4.20-4.23
4.50m.		100 2.0 cm Pentn. Refusal	*SPT-5	4.50-4.52
			R1	CR=14%/RQD=0
		Refusal	*SPT-6	5.25-5.27
		50 2.0 cm Pentn.	R2	CR=24%/RQD=0
		NX rotary drilling from 4.50m to 15.00m	R3	CR=21% RQD=Nil
			R4	CR=25% RQD=Nil
			R5	CR=21% RQD=Nil
			R6	CR=26% RQD=Nil
Completely to highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R7	CR=20% RQD=Nil
			R8	CR=24% RQD=Nil
		Refusal	R9	CR=16%/RQD=0
		50 2.0 cm Pentn.	*SPT-7	11.25-11.27
		Refusal	R10	CR=17%/RQD=0
		50 3.0 cm Pentn.	*SPT-8	12.00-12.03
			R11	CR=21%/RQD=0
			R12	CR=28% RQD=Nil
		Refusal	R13	CR=12%/RQD=0
		50 7.0 cm Pentn.	*SPT-9	14.00-14.07
			R14	CR=20% RQD=Nil
15.00m.				

4.50 / 5.25 / 6.00 / 6.75 / 7.50 / 8.25 / 9.00 / 9.75 / 10.50 / 11.25 / 12.00 / 12.75 / 13.25 / 14.00 / 15.00

N.B. – '*' means sample could not be recovered / sample slip.

BH-21/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 03/04/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. IBH 22

Co-ordinates E=35 N=669

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 23/03/2018
Completion Date : 24/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.249 M.
Water Struck At :
Standing Water Level : 1.7 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light grey, silty sand. Observed mica & conch pcs.		6 3 3 (6)	DS-1	0.50
			SPT-1	1.00-1.45
2.50m.			*UDS-1	2.00-2.45
Very loose, light grey, sandy silt to silty sand. Observed kankar, conch pcs. & clay binder.		0 0 1 (1)	SPT-2	2.55-3.00
3.90m.			*UDS-2	3.50-3.95
Very dense, light grey, silty sand with conch pcs. & decomposed rock.		2 10 88 ≥100 — 9.0 cm Pentn.	SPT-3	4.00-4.39
		100 3.0 cm Pentn. Refusal	*SPT-4	4.60-4.63
4.80m.		100 2.0 cm Pentn. Refusal	*SPT-5	4.80-4.82
		Refusal	R1	CR=15%/RQD=0
		50 2.0 cm Pentn.	*SPT-6	5.50-5.52
			R2	CR=23%/RQD=0
Completely/highly weathered, deep grey, coarse grained, fractured rock.		NX rotary drilling from 4.80m to 20.00m	R3	CR=26% RQD=Nil
		Refusal	R4	CR=16%/RQD=0
		50 2.0 cm Pentn.	*SPT-7	7.75-7.77
			R5	CR=17%/RQD=0
8.50m.		50 Refusal 2.0 cm Pentn.	*SPT-8	8.50-8.52
			R6	CR=21%/RQD=0
Highly weathered, deep to brownish grey, coarse to medium grained, fractured rock.			R7	CR=28% RQD=Nil
			R8	CR=21% RQD=Nil
			R9	CR=21% RQD=Nil
11.50m.			R10	CR=28% RQD=Nil
Highly weathered, brownish grey to whitish grey, medium to coarse grained, fractured rock.			R11	CR=27% RQD=Nil
			R12	CR=28% RQD=Nil
14.50m.			R13	CR=25% RQD=Nil
Highly weathered, brownish grey, medium grained, fractured rock. Observed reddish spots. 15.25m.			R14	CR=27% RQD=Nil
		Refusal	R15	CR=19%/RQD=0
		50 2.0 cm Pentn.	SPT-9	16.00-16.02
			R16	CR=24%/RQD=0
Completely to highly weathered, brownish grey to light grey, medium to coarse grained, fractured rock. Observed reddish spots.			R17	CR=23% RQD=Nil
			R18	CR=20% RQD=Nil
			R19	CR=24% RQD=Nil
N.B. – '*' means sample could not be recovered / sample slip.			R20	CR=21% RQD=15%
20.00m.				

4.80 5.50 6.25 7.00 7.75 8.50 9.25 10.00 10.75 11.50 12.25 13.00 13.75 14.50 15.25 16.00 16.75 17.50 18.25 19.00 20.00

BH-22/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 06/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 23

Co-ordinates E=36 N=374

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 01/04/2018
Completion Date : 02/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.713 M.
Water Struck At :
Standing Water Level : 2.52 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, yellowish brown, clayey sandy silt. Observed conch pcs.		4 5 5 (10)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m.				
Soft to medium, light brownish grey, silty clay with sand mixture / clayey silty sand. Observed kankar, conch pcs.		0 1 1 (2)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
		1 2 2 (4)	UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.50m.			SPT-4	4.70-4.83
Very dense, brownish grey, silty sand. Observed conch pcs. & decomposed rock.		100 13.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal	*SPT-5	4.95-4.99
5.10m.		00 Refusal 3.0 cm Pentn.	*SPT-6	5.10-5.13
Highly weathered, light to brownish grey, medium to coarse grained, moderately fractured rock.		NX rotary drilling from 5.10m to 20.00m	R1	CR=26% RQD=Nil
			R2	CR=36% RQD=20%
6.60m.			R3	CR=18%/RQD=0
		50 Refusal 4.0 cm Pentn.	*SPT-7	7.35-7.39
			R4	CR=26%/RQD=0
Highly weathered, light to brownish grey, medium to coarse grained, moderately fractured rock.			R5	CR=24% RQD=Nil
			R6	CR=25% RQD=Nil
			R7	CR=24% RQD=Nil
10.35m.			R8	CR=28% RQD=Nil
			R9	CR=33% RQD=Nil
			R10	CR=22% RQD=Nil
			R11	CR=37% RQD=Nil
Highly to moderately weathered, whitish grey to brownish grey, medium grained, highly fractured rock.			R12	CR=32% RQD=Nil
			R13	CR=40% RQD=Nil
			R14	CR=34% RQD=Nil
			R15	CR=41% RQD=Nil
			R16	CR=35% RQD=Nil
			R17	CR=21% RQD=Nil
			R18	CR=28% RQD=Nil
			R19	CR=23% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R20	CR=30% RQD=Nil

5.10 / 5.85 / 6.60 / 7.35 / 8.10 / 8.85 / 9.60 / 10.35 / 11.10 / 11.85 / 12.60 / 13.35 / 14.10 / 14.85 / 15.60 / 16.35 / 17.10 / 17.85 / 18.60 / 19.35 / 20.00

BH-23/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 17/04/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO. IBH 24

Co-ordinates E=5 N=323

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 09/04/2018
Completion Date : 10/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.917 M.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed conch pcs.		6 6 5 — 11	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, clayey silty sand. Observed kankar & conch pcs.		1 0 1 — 1	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		1 1 1 — 2	SPT-3	4.05-4.50
4.90m.		24 76 — >100	SPT-4	5.00-5.22
Very dense, light grey, silty sand. Observed conch pcs. & decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-5	5.30-5.34
5.40m.		100 3.0 cm Pentn. Refusal	*SPT-6	5.40-5.43 5.40
			R1	CR=16%/RQD=0
		50 — Refusal	*SPT-7	6.00-6.04 6.00
Completely weathered, light grey, medium grained, highly to moderately fractured rock.		4.0 cm Pentn.	R2	CR=14% RQD=Nil
		50 — Refusal	*SPT-8	6.75-6.78 6.75
		3.0 cm Pentn.	R3	CR=16% RQD=Nil
7.50m.		50 — Refusal	*SPT-9	7.50-7.52 7.50
		2.0 cm Pentn.	R4	CR=22% RQD=Nil
		NX rotary drilling from 5.40m to 15.00m		8.25
Highly weathered, light grey, medium to coarse grained, moderately fractured rock.			R5	CR=24% RQD=Nil
				9.00
			R6	CR=22% RQD=Nil
				9.75
			R7	CR=24% RQD=Nil
10.50m.				10.50
Highly weathered, deep grey, coarse grained, highly to moderately fractured rock.			R8	CR=22% RQD=Nil
				11.25
			R9	CR=24% RQD=Nil
12.00m.				12.00
Highly weathered, deep grey, coarse grained, highly to moderately fractured rock.			R10	CR=31% RQD=Nil
				12.75
			R11	CR=33% RQD=Nil
13.50m.				13.50
Highly weathered, light grey, fine grained, moderately fractured rock.			R12	CR=28% RQD=Nil
				14.25
N.B. – '*' means sample could not be recovered / sample slip.			R13	CR=32% RQD=Nil
15.00m.				15.00

BH-24/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 17/04/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH 25

Co-ordinates E=-79 N=261

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 03/04/2018
Completion Date : 09/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.870 M.
Water Struck At :
Standing Water Level : 2.84 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed conch pcs.		6 5 4 = 9	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Loose, light grey, clayey silty sand. Observed conch pcs.		1 2 2 = 4	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
			UDS-2	3.50-3.95
4.00m.				
Dense to very dense, light grey, silty sand with kankar, mica & conch. Observed decomposed rock.		7 13 19 = 32	SPT-3	4.00-4.45
		23 77 = >100	*UDS-3	5.00-5.08
		6.0 cm Pentn.	SPT-4	5.10-5.31
		100 3.0 cm Pentn. Refusal	*SPT-5	5.40-5.43
5.50m.		Refusal	*SPT-6	5.50-5.53
Highly weathered, light grey, medium grained, highly fractured rock.		100 3.0 cm Pentn.	R1	CR=24%/RQD=0
6.25m.		NX rotary drilling from 5.50m to 15.00m		
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R2	CR=26% RQD=Nil
			R3	CR=27% RQD=Nil
			R4	CR=24% RQD=Nil
			R5	CR=33% RQD=Nil
			R6	CR=26% RQD=Nil
			R7	CR=24% RQD=Nil
10.75m.				
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R8	CR=29% RQD=Nil
			R9	CR=32% RQD=Nil
			R10	CR=30% RQD=Nil
			R11	CR=28% RQD=Nil
			R12	CR=35% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.			R13	CR=34% RQD=Nil
15.00m.				

6.25 7.00 7.75 8.50 9.25 10.00 10.75 11.50 12.25 13.00 13.75 14.50 15.00

BH-25/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 05/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH26 Co-ordinates E=-145 N=265

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 12/04/2018
Completion Date : 13/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.094 M.
Water Struck At :
Standing Water Level : 2.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium, light brownish grey, clayey silt with sand.		7 4 8	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Soft to medium, light grey, clayey silt with sand mixture. Observed kankar & conch pcs.		1 1 2	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		1 2 4	SPT-3	4.05-4.50
4.60m.				
Very dense, light grey, silty sand. Observed conch & decomposed rock.		9 22 >100 (12.0 cm Pentn.)	SPT-4	5.05-5.47
		100 4.0 cm Pentn. Refusal	*SPT-5	5.65-5.69
5.75m.		Refusal	*SPT-6	5.75-5.78
		100 3.0 cm Pentn.	R1	CR=22% RQD=Nil 5.75-6.50
Highly weathered, light grey, coarse grained, highly to moderately fractured rock.		NX rotary drilling from 5.75m to 15.00m	R2	CR=24% RQD=Nil 6.50-7.25
			R3	CR=25% RQD=Nil 7.25-8.00
8.00m.			R4	CR=29% RQD=13% 8.00-8.75
Highly weathered, light grey, medium to coarse grained, highly to moderately fractured rock.			R5	CR=31% RQD=Nil 8.75-9.50
			R6	CR=26% RQD=Nil 9.50-10.25
10.25m.			R7	CR=28% RQD=Nil 10.25-11.00
Highly weathered, deep grey, coarse grained, moderately fractured rock.			R8	CR=35% RQD=Nil 11.00-11.75
			R9	CR=34% RQD=25% 11.75-12.50
12.50m.			R10	CR=34% RQD=Nil 12.50-13.25
Highly to moderately weathered, whitish grey to brownish grey, coarse to medium grained, moderately fractured rock.			R11	CR=30% RQD=Nil 13.25-14.00
N.B. - '*' means sample could not be recovered / sample slip.			R12	CR=42% RQD=Nil 14.00-15.00
15.00m.				

BH-26/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH27

Co-ordinates E=-137 N=214

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 14/04/2018
Completion Date : 15/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.971 M.
Water Struck At :
Standing Water Level : 2.85 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, light grey, clayey silt with sand. Observed kankar.		7 6 5 (11)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, silty sand with mica, kankar & conch pcs. Observed clay binder.		1 1 2 (3)	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
3.50m.				
Medium, light grey, clayey silt with sand, mica, kankar & conch pcs.		2 4 4 (8)	UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.60m.		38 62 (>100)		
Very dense, brownish grey, silty sand with mica & conch pcs. Observed decomposed rock.		10.0 cm Pentn.	SPT-4	4.80-5.05
		100 5.0 cm Pentn. Refusal	*SPT-5	5.15-5.20
5.30m.		100 3.0 cm Pentn. Refusal	*SPT-6	5.30-5.33 5.30
			R1	CR=12% RQD=Nil
		55 3.0 cm Pentn. Refusal	*SPT-7	6.00-6.03 6.00
			R2	CR=16% RQD=Nil
Completely to highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		53 3.0 cm Pentn. Refusal	*SPT-8	6.75-6.78 6.75
			R3	CR=16% RQD=Nil
		52 2.0 cm Pentn. Refusal	SPT-9	7.50-7.52 7.50
		NX rotary drilling from 5.30m to 15.00m	R4	CR=21% RQD=Nil
8.25m.				8.25
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=26% RQD=Nil
				9.00
			R6	CR=29% RQD=Nil
9.75m.				9.75
			R7	CR=26% RQD=Nil
				10.50
			R8	CR=30% RQD=Nil
				11.25
			R9	CR=26% RQD=Nil
				12.00
Highly weathered, brownish grey, medium to fine grained, highly fractured rock.			R10	CR=28% RQD=Nil
				12.75
			R11	CR=30% RQD=Nil
				13.50
			R12	CR=33% RQD=Nil
				14.25
N.B. - '*' means sample could not be recovered / sample slip.			R13	CR=35% RQD=Nil
15.00m.				15.00

BH-27/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH28 | Co-ordinates E=-100 N=231

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 13/04/2018
Completion Date : 14/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.968 M.
Water Struck At :
Standing Water Level : 2.85 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Loose, light brownish grey, silty sand. Observed kankar.		7 5 4 (9)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m Very soft, light grey, clayey silt with sand, kankar & conch pcs.		1 0 1 (1)	UDS-1	2.00-2.45
			SPT-2	2.55-3.00
			*UDS-2	3.50-3.95
		1 2 2 (4)	SPT-3	4.05-4.50
4.80m Very dense, brownish grey, silty sand with mica, kankar & conch pcs. Observed decomposed rock.		12 38 50 (>100) 10.0 cm Pentn.	SPT-4	5.00-5.40
		100 4.0 cm Pentn. Refusal	*SPT-5	5.50-5.54
5.60m Highly weathered, deep grey, medium grained, highly fractured rock.		Refusal	*SPT-6	5.60-5.63
6.25m		100 3.0 cm Pentn.	R1	CR=22% RQD=Nil
		NX rotary drilling from 5.60m to 15.00m	R2	CR=26% RQD=Nil
Highly weathered, deep grey, medium to coarse grained, highly fractured rock.			R3	CR=29% RQD=17%
			R4	CR=24% RQD=18%
			R5	CR=26% RQD=Nil
			R6	CR=28% RQD=Nil
			R7	CR=26% RQD=Nil
			R8	CR=37% RQD=22%
			R9	CR=35% RQD=Nil
			R10	CR=34% RQD=Nil
			R11	CR=30% RQD=Nil
			R12	CR=32% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 15.00m			R13	CR=25% RQD=Nil

5.60 6.25 7.00 7.75 8.50 9.25 10.00 10.75 11.50 12.25 13.00 13.75 14.50 15.00

BH-28/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH29

Co-ordinates E=-232 N=158

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 14/04/2018
Completion Date : 15/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.619 M.
Water Struck At :
Standing Water Level : 2.82 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, brownish grey, silty sand. Observed conch pcs.		8 6 4 (10)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
			UDS-1	2.00-2.45
Very soft, light grey, clayey silt with sand. Observed conch pcs.		1 0 1 (1)	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		1 2 2 (4)	SPT-3	4.00-4.45
4.50m.				
Very dense, light grey, silty sand with decomposed rock.		100 12.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal	SPT-4 *SPT-5	4.80-4.92 5.00-5.04
5.10m.		Refusal	*SPT-6	5.10-5.13 5.10
Highly weathered, deep grey, medium grained, moderately fractured rock.		100 3.0 cm Pentn.	R1 R2	CR=24% RQD=Nil 5.75 CR=23% RQD=Nil 6.50
6.50m.		Refusal	R3	CR=17% RQD=Nil
Completely to highly weathered, fine to medium grained, highly fractured rock.		50 3.0 cm Pentn.	*SPT-7 R4	7.25-7.28 7.25 CR=16% RQD=Nil
		Refusal	*SPT-8	8.00-8.02 8.00
		50 2.0 cm Pentn.	R5	CR=22% RQD=Nil 8.75
		NX rotary drilling from 5.10m to 15.00m	R6	CR=21% RQD=Nil 9.50
9.50m.				
Highly weathered, light grey, medium grained, moderately fractured rock.			R7 R8	CR=23% RQD=13% 10.25 CR=24% RQD=Nil 11.00
11.00m.				
Highly weathered, light brownish grey, medium to coarse grained, fractured rock.			R9 R10 R11	CR=22% RQD=15% 11.75 CR=21% RQD=Nil 12.50 CR=23% RQD=Nil 13.25
13.25m.				
Highly weathered, whitish grey, fine grained, moderately fractured rock.			R12 R13	CR=24% RQD=Nil 14.00 CR=24% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.				
15.00m.				15.00

BH-29/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 11/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH30

Co-ordinates E=−162 N=158

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 24/04/2018
Completion Date : 24/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.700 M.
Water Struck At :
Standing Water Level : 2.88 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light grey, silty sand. Observed conch pcs.		10 6 4 (10)	DS−1	0.50
			SPT−1	1.00−1.45
1.50m.				
Very loose, light grey, clayey sandy silt. Observed kankar & conch pcs.		1 0 1 (1)	UDS−1	2.00−2.45
			SPT−2	2.50−2.95
			*UDS−2	3.50−3.95
4.00m.				
Medium dense, light grey, silty sand with conch pcs. Observed decomposed rock.		5 8 10 (18)	SPT−3	4.05−4.50
5.05m.				
Very dense, light grey, silty sand with conch pcs. Observed decomposed rock. 5.60m.		18 82 12.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal Refusal 100 3.0 cm Pentn.	SPT−4 *SPT−5 *SPT−6	5.05−5.32 5.40−5.44 5.60−5.63
		NX rotary drilling from 5.60m to 15.00m	R1	CR=21% RQD=Nil (6.25)
			R2	CR=22% RQD=Nil (7.00)
			R3	CR=21% RQD=Nil (7.75)
Highly weathered, light grey, medium grained, moderately fractured rock.			R4	CR=23% RQD=Nil (8.50)
			R5	CR=25% RQD=Nil (9.25)
			R6	CR=21% RQD=Nil (10.00)
			R7	CR=23% RQD=Nil (10.75)
10.75m.				
			R8	CR=26% RQD=Nil (11.50)
			R9	CR=29% RQD=Nil (12.25)
Highly weathered, deep grey, coarse grained, highly fractured rock.			R10	CR=32% RQD=Nil (13.00)
			R11	CR=28% RQD=Nil (13.75)
			R12	CR=27% RQD=Nil (14.50)
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.			R13	CR=32% RQD=Nil (15.00)

BH−30/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 11/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH31 | Co-ordinates E=-86 N=158

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 25/04/2018
Completion Date : 26/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.752 M.
Water Struck At :
Standing Water Level : 2.90 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, light grey, clayey silt with sand. Observed kankar.		5 6 5 (11)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Loose, brownish grey, clayey silty sand with kankar & conch pcs. Observed mica.		1 2 2 (4)	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
3.50m.				
Medium dense, brownish grey, clayey silty sand with kankar & conch pcs. Observed mica.		5 4 7 (11)	*UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.50m.				
Very dense, light grey, silty sand with mica, kankar & conch pcs. Observed decomposed rock.		38 62 10.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal	SPT-4 *SPT-5	4.80-5.05 5.20-5.24
5.40m.		Refusal	*SPT-6	5.40-5.43 5.40
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		00 3.0 cm Pentn. NX rotary drilling from 5.40m to 15.00m	R1 R2 R3 R4 R5 R6 R7 R8	CR=22% RQD=Nil 6.00 CR=23% RQD=Nil 6.75 CR=26% RQD=Nil 7.50 CR=29% RQD=Nil 8.25 CR=33% RQD=Nil 9.00 CR=38% RQD=Nil 9.75 CR=26% RQD=Nil 10.50 CR=26% RQD=Nil 11.25
6.75m.				
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.				
11.25m.				
Highly weathered, deep grey, medium to fine grained, highly fractured rock.			R9 R10 R11 R12 R13	CR=24% RQD=Nil 12.00 CR=28% RQD=Nil 12.75 CR=24% RQD=Nil 13.50 CR=29% RQD=Nil 14.25 CR=30% RQD=Nil 15.00
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.				

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 17/04/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH32 | Co-ordinates E=-14 N=169

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 08/04/2018
Completion Date : 09/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.885 M.
Water Struck At :
Standing Water Level : 2.79 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Siff, light grey, clayey silt with sand. Observed kankar.		3 5 6 — 11	DS-1	0.50
			SPT-1	1.00-1.45
1.55m				
Loose, brownish grey to light grey, silty sand with kankar & conch pcs. Observed mica & clay binder.		2 2 2 — 4	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
4.00m				
Medium dense, brownish grey, silty sand with kankar, mica & conch pcs. Observed decomposed rock.		7 10 12 — 22	SPT-3	4.00-4.45
5.00m		40 60 — >100	SPT-4	5.00-5.25
Very dense, brownish grey, silty sand with kankar, mica & conch pcs. Observed decomposed rock.		10.0 cm Pentn.	*SPT-5	5.40-5.44
5.50m		100 4.0 cm Pentn. Refusal	*SPT-6	5.50-5.53
		100 3.0 cm Pentn. Refusal	R1	CR=18% RQD=Nil
		52 — Refusal	*SPT-7	6.25-6.28
		3.0 cm Pentn.	R2	CR=16% RQD=Nil
		55 — Refusal	*SPT-8	7.00-7.02
Completely to highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.		2.0 cm Pentn.	R3	CR=21% RQD=Nil
		NX rotary drilling from 5.50m to 15.00m	R4	CR=24% RQD=Nil
			R5	CR=24% RQD=Nil
5.00m				
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R6	CR=28% RQD=Nil
			R7	CR=26% RQD=Nil
10.75m				
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R8	CR=24% RQD=Nil
			R9	CR=22% RQD=Nil
12.25m				
			R10	CR=30% RQD=Nil
Highly weathered, light to brownish grey, fine to medium grained rock.			R11	CR=28% RQD=16%
			R12	CR=40% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.			R13	CR=36% RQD=Nil
15.00m				

5.50
6.25
7.00
7.75
8.50
9.25
10.00
10.75
11.50
12.25
13.00
13.75
14.50
15.00

BH-32/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 19/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH33

Co-ordinates E=36 N=160

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 01/05/2018
Completion Date : 05/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.804 M.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, light grey, silty sand. Observed kankar.		5 7 6 (13)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m				
Loose to medium dense, brownish grey, silty sand with kankar & conch pcs. Observed clay binder.		2 3 2 (5)	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
			*UDS-2	3.50-3.95
		5 8 10 (18)	SPT-3	4.00-4.45
4.80m				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		25 35 40 5.0 cm Pentn. >100	SPT-4	4.80-5.15
		100 4.0 cm Pentn. Refusal	*SPT-5	5.40-5.44
5.50m		Refusal	*SPT-6	5.50-5.53
		100 3.0 cm Pentn.	R1	CR=22% RQD=Nil (5.50-6.25)
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		NX rotary drilling from 5.50m to 15.00m	R2	CR=24% RQD=Nil (6.25-7.00)
			R3	CR=25% RQD=Nil (7.00-7.75)
7.75m				
Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R4	CR=29% RQD=Nil (7.75-8.50)
			R5	CR=32% RQD=Nil (8.50-9.25)
			R6	CR=24% RQD=Nil (9.25-10.00)
			R7	CR=27% RQD=Nil (10.00-10.75)
			R8	CR=29% RQD=Nil (10.75-11.50)
			R9	CR=32% RQD=Nil (11.50-12.25)
12.25m				
Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R10	CR=24% RQD=Nil (12.25-13.00)
			R11	CR=24% RQD=Nil (13.00-13.75)
13.75m				
Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R12	CR=32% RQD=Nil (13.75-14.50)
N.B. - '*' means sample could not be recovered / sample slip. 15.00m			R13	CR=30% RQD=Nil (14.50-15.00)

BH-33/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH34

Co-ordinates E=95 N=141

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 14/04/2018
Completion Date : 15/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.769 M.
Water Struck At :
Standing Water Level : 2.85 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, brownish grey to light grey, clayey silt with sand mixture.		9 7 5 (12)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, silty sand. Observed kankar & conch pcs.		1 0 1 (1)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			UDS-2	3.50-3.95
3.90m.				
Loose, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		1 2 6 (8)	SPT-3	4.00-4.45
4.70m.		100 5.0 cm Pentn. Refusal	SPT-4	4.70-4.75
		100 2.0 cm Pentn. Refusal	*SPT-5	4.90-4.92
5.00m.		Refusal	*SPT-6	5.00-5.02
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		100 2.0 cm Pentn.	R1	CR=24% RQD=Nil
5.75m.				5.00 / 5.75
Highly weathered, deep grey, coarse grained, fractured rock.		NX rotary drilling from 5.00m to 15.00m	R2	CR=40% RQD=13%
				6.50
			R3	CR=32% RQD=17%
				7.25
Highly weathered, deep grey, coarse grained, fractured rock.			R4	CR=27% RQD=Nil
				8.00
			R5	CR=32% RQD=Nil
8.75m.				8.75
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R6	CR=31% RQD=Nil
				9.50
			R7	CR=29% RQD=Nil
10.25m.				10.25
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R8	CR=21% RQD=Nil
11.00m.				11.00
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R9	CR=36% RQD=16%
				11.75
			R10	CR=44% RQD=15%
12.50m.				12.50
Highly weathered, whitish grey, fine to medium grained, fractured rock.			R11	CR=38% RQD=Nil
				13.25
			R12	CR=36% RQD=Nil
				14.00
N.B. - '*' means sample could not be recovered / sample slip.			R13	CR=33% RQD=Nil
15.00m.				15.00

BH-34/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 05/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH35 | Co-ordinates E=262 N=180

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 15/04/2018
Completion Date : 16/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.779 M.
Water Struck At :
Standing Water Level : 2.77 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Stiff, brownish grey to light grey, clayey silt with sand. Observed kankar & conch pcs.		8 6 5 (11)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Very loose, light grey, silty sand to sandy silt. Observed kankar, conch pcs. & clay binder.		2 1 2 (3)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.50m. Loose, light grey, silty sand to sandy silt. Observed conch pcs. kankar & clay binder.		4 3 5 (8)	UDS-2	3.50-3.95
			SPT-3	4.05-4.50
4.75m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		100 11.0 cm Pentn. >100 100 3.0 cm Pentn. Refusal	SPT-4 *SPT-5	4.80-4.91 5.10-5.13
5.20m. Highly weathered, deep to light grey, coarse to medium grained, fractured rock.		Refusal 100 2.0 cm Pentn.	*SPT-6 R1	5.20-5.22 CR=25% RQD=Nil
6.00m.		NX rotary drilling from 5.20m to 15.00m	R2	CR=39% RQD=28%
			R3	CR=29% RQD=Nil
			R4	CR=28% RQD=Nil
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R5	CR=29% RQD=Nil
			R6	CR=36% RQD=Nil
			R7	CR=21% RQD=Nil
			R8	CR=28% RQD=Nil
11.25m. Highly weathered, whitish grey, medium to fine grained, fractured rock.			R9	CR=23% RQD=Nil
			R10	CR=28% RQD=Nil
			R11	CR=32% RQD=Nil
			R12	CR=29% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.			R13	CR=36% RQD=Nil

5.20
6.00
6.75
7.50
8.25
9.00
9.75
10.50
11.25
12.00
12.75
13.50
14.25
15.00

BH-35/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH36

Co-ordinates E=433 N=160

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 17/04/2018
Completion Date : 17/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.469 M.
Water Struck At :
Standing Water Level : 0.75 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, brownish grey, clayey silt with sand. Observed kankar & conch pcs.		9 7 7 (14)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, silty sand. Observed conch pcs., kankar & clay binder.		4 2 1 (3)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.50m.			UDS-2	3.50-3.95
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		6 21 12 (33)	SPT-3	4.05-4.50
		100 5.0 cm Pentn. Refusal	SPT-4	4.70-4.75
		100 2.0 cm Pentn. Refusal	*SPT-5	4.90-4.92
5.00m.		100 2.0 cm Pentn. Refusal	*SPT-6	5.00-5.02
		Refusal	R1	CR=18% RQD=Nil 5.00
		50 2.0 cm Pentn.	*SPT-7	5.75-5.77
Completely to highly weathered, deep to light grey, coarse grained, fractured rock.		NX rotary drilling from 5.00m to 15.00m	R2	CR=21% RQD=Nil 5.75
			R3	CR=21% RQD=Nil 6.50
			R4	CR=25% RQD=Nil 7.25
8.00m.				8.00
Highly weathered, deep grey to light grey, coarse grained, fractured rock.			R5	CR=32% RQD=13% 8.75
8.75m.			R6	CR=37% RQD=Nil 9.50
			R7	CR=36% RQD=Nil 10.25
			R8	CR=30% RQD=Nil 11.00
Highly weathered, whitish grey, medium to fine grained, highly fractured rock.			R9	CR=36% RQD=Nil 11.75
			R10	CR=37% RQD=Nil 12.50
			R11	CR=25% RQD=Nil 13.25
			R12	CR=21% RQD=Nil 14.00
			R13	CR=29% RQD=Nil 15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-36/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH37

Co-ordinates E=511 N=147

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	1

Commencement Date : 19/04/2018
Completion Date : 20/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.264 M.
Water Struck At :
Standing Water Level : 1.75 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, brownish grey, sandy silt to silty sand. Observed kankar, conch pcs. & clay binder.		7 8 11 (19)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m			WS-1	1.75
Loose, light grey, silty sand. Observed kankar & conch pcs.		7 3 3 (6)	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.80m			*UDS-2	3.50-3.95
Medium dense, light grey, silty sand with conch pcs. Observed kankar & decomposed rock.		7 11 10 (21)	SPT-3	4.05-4.50
4.70m		100 5.0 cm Pentn. Refusal	SPT-4	4.70-4.75
Very dense, light grey, silty sand with conch pcs. Observed kankar & decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-5	4.90-4.94
5.00m		Refusal	*SPT-6	5.00-5.03
		100 3.0 cm Pentn.	R1	CR=35% RQD=Nil (5.00-5.75)
		NX rotary drilling from 5.00m to 15.00m	R2	CR=25% RQD=Nil (5.75-6.50)
			R3	CR=24% RQD=Nil (6.50-7.25)
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R4	CR=23% RQD=Nil (7.25-8.00)
			R5	CR=24% RQD=Nil (8.00-8.75)
			R6	CR=21% RQD=Nil (8.75-9.50)
9.50m			R7	CR=29% RQD=Nil (9.50-10.25)
			R8	CR=39% RQD=Nil (10.25-11.00)
			R9	CR=40% RQD=Nil (11.00-11.75)
Highly weathered, whitish grey, medium grained, moderately to highly fractured rock.			R10	CR=36% RQD=Nil (11.75-12.50)
			R11	CR=28% RQD=Nil (12.50-13.25)
			R12	CR=31% RQD=Nil (13.25-14.00)
			R13	CR=22% RQD=Nil (14.00-15.00)
N.B. - '*' means sample could not be recovered / sample slip. 15.00m				

BH-37/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH38

Co-ordinates E=557 N=147

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 21/04/2018
Completion Date : 22/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.729 M.
Water Struck At :
Standing Water Level : 0.85 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, brownish grey, clayey silt with sand. Observed kankar & conch pcs.		8 9 6 (15)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, clayey silty sand. Observed kankar & conch pcs.		3 1 2 (3)	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.90m.		29 71 (>100)	*UDS-2	3.50-3.95
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		2.0 cm Pentn.	SPT-3	4.00-4.17
4.50m.		100 2.0 cm Pentn. Refusal (Refusal)	*SPT-4	4.40-4.42
			*SPT-5	4.50-4.52
		100 2.0 cm Pentn.	R1	CR=22% RQD=Nil
		NX rotary drilling from 4.50m to 15.00m		4.50 / 5.25
			R2	CR=21% RQD=Nil
Highly weathered, deep to light grey, coarse grained, moderately to highly fractured rock.				5.25 / 6.00
			R3	CR=29% RQD=Nil
				6.00 / 6.75
			R4	CR=22% RQD=Nil
				6.75 / 7.50
			R5	CR=25% RQD=Nil
8.25m.				7.50 / 8.25
Highly weathered, light grey, coarse grained, highly fractured rock.			R6	CR=34% RQD=Nil
9.00m.				8.25 / 9.00
			R7	CR=41% RQD=Nil
				9.00 / 9.75
			R8	CR=37% RQD=Nil
				9.75 / 10.50
			R9	CR=31% RQD=Nil
				10.50 / 11.25
Highly weathered, whitish grey, medium to fine grained, moderately fractured rock.			R10	CR=32% RQD=Nil
				11.25 / 12.00
			R11	CR=28% RQD=Nil
				12.00 / 12.75
			R12	CR=25% RQD=Nil
				12.75 / 13.50
			R13	CR=27% RQD=Nil
				13.50 / 14.25
N.B. - '*' means sample could not be recovered / sample slip.			R14	CR=21% RQD=Nil
15.00m.				14.25 / 15.00

BH-38/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 05/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH39

Co-ordinates E=433 N=98

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 18/04/2018
Completion Date : 19/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.535 M.
Water Struck At :
Standing Water Level : 0.70 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light to brownish grey, sandy silt to silty sand. Observed conch pcs., kankar & clay binder.		8 9 6 (15)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, silty sand. Observed kankar & conch pcs.		2 1 2 (3)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.50m.				
Medium dense, light grey, silty sand with conch pcs. Observed kankar & decomposed rock.		7 15 9 (24)	UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.90m.		100 6.0 cm Pentn. Refusal	SPT-4	4.90-4.96
Very dense, light grey, silty sand with conch pcs. Observed kankar & decomposed rock.		100 3.0 cm Pentn. Refusal	*SPT-5	5.20-5.23
5.30m.		Refusal	*SPT-6	5.30-5.32
		100 2.0 cm Pentn.	R1	CR=37% RQD=Nil 5.30-6.00
		NX rotary drilling from 5.30m to 15.00m	R2	CR=36% RQD=Nil 6.00-6.75
Highly weathered, deep to light grey, coarse grained, moderately to highly fractured rock.			R3	CR=36% RQD=Nil 6.75-7.50
			R4	CR=31% RQD=Nil 7.50-8.25
			R5	CR=29% RQD=Nil 8.25-9.00
9.00m.				
			R6	CR=45% RQD=Nil 9.00-9.75
			R7	CR=41% RQD=Nil 9.75-10.50
			R8	CR=29% RQD=Nil 10.50-11.25
Highly to moderately weathered, whitish grey, medium to fine grained, fractured rock.			R9	CR=30% RQD=Nil 11.25-12.00
			R10	CR=26% RQD=Nil 12.00-12.75
			R11	CR=40% RQD=Nil 12.75-13.50
			R12	CR=29% RQD=Nil 13.50-14.25
N.B. - '*' means sample could not be recovered / sample slip.			R13	CR=41% RQD=Nil 14.25-15.00
15.00m.				

BH-39/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 11/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH40 | Co-ordinates E=511 N=93

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 24/04/2018
Completion Date : 25/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : −0.246 M.
Water Struck At :
Standing Water Level : 1.9 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, brownish grey to light grey, silty sand to sandy silt. Observed kankar & conch pcs.		9 7 5 (12)	DS−1	0.50
			SPT−1	1.00−1.45
1.50m				
Very loose, light grey, silty sand. Observed kankar & conch pcs.		1 0 1 (1)	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
3.50m				
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		11 34 55 (>100) 12.0 cm Pentn.	UDS−2	3.50−3.95
			SPT−3	4.00−4.42
		100 4.0 cm Pentn. Refusal	*SPT−4	4.80−4.84
5.00m		Refusal	*SPT−5	5.00−5.03
		100 3.0 cm Pentn.	R1	CR=28%/RQD=0
		NX rotary drilling from 5.00m to 20.00m	R2	CR=27% RQD=Nil
			R3	CR=25% RQD=Nil
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R4	CR=24% RQD=Nil
			R5	CR=24% RQD=Nil
			R6	CR=29% RQD=Nil
			R7	CR=25% RQD=Nil
			R8	CR=29% RQD=Nil
11.00m			R9	CR=31% RQD=Nil
Highly weathered, deep to whitish grey, medium grained, moderately fractured rock.			R10	CR=27% RQD=Nil
			R11	CR=40% RQD=26%
			R12	CR=32% RQD=Nil
			R13	CR=27% RQD=Nil
14.75m			R14	CR=29% RQD=Nil
Highly to moderately weathered, brownish grey to light grey, medium to fine grained, fractured rock.			R15	CR=32% RQD=Nil
			R16	CR=31% RQD=Nil
			R17	CR=29% RQD=Nil
			R18	CR=43% RQD=Nil
			R19	CR=51% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.			R20	CR=48% RQD=Nil
20.00m				

5.00 5.75 6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00 14.75 15.50 16.25 17.00 17.75 18.50 19.25 20.00

BH−40/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 28/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH41 | Co-ordinates E=327 N=808

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 12/03/2018
Completion Date : 13/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.681 M.
Water Struck At :
Standing Water Level : 1.4 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Very soft / soft, steel grey, clayey silt. Observed sand mixture.		1 1 1 — 2	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Medium dense, steel grey, silty sand. Observed kankar, conch pcs. & clay binder.		3 5 6 — 11	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.00m. Very dense, brownish grey to light grey, medium grained, silty sand with mica & conch pcs. Observed kankar & decomposed rock.		16 30 54 — >100 (10.0 cm Pentn.)	*UDS-2	3.00-3.45
			SPT-3	3.50-3.90
4.50m. Completely to highly weathered, brownish grey to light grey, medium grained, highly fractured rock.		100 12/0 cm Pentn. — >100 (3.0 cm Pentn. Refusal); 52 — Refusal (2.0 cm Pentn.); 54 — Refusal (3.0 cm Pentn.); NX rotary drilling from 4.50m to 20.00m	SPT-4	4.20-4.32
			*SPT-5 R1	4.50-4.53 CR=13%/RQD=0
			*SPT-6 R2	5.25-5.27 CR=14%/RQD=0
			*SPT-7 R3	6.00-6.03 CR=21%/RQD=0
			R4	CR=24% RQD=Nil
			R5	CR=22% RQD=Nil
			R6	CR=26% RQD=Nil
			R7	CR=24% RQD=Nil
			R8	CR=23% RQD=Nil
			R9	CR=21% RQD=Nil
8.25m. Highly weathered, whitish grey to brownish grey, fine to medium grained, moderately fractured rock.			R10	CR=24% RQD=Nil
			R11	CR=22% RQD=Nil
			R12	CR=25% RQD=Nil
			R13	CR=26% RQD=Nil
			R14	CR=22% RQD=Nil
			R15	CR=24% RQD=Nil
15.75m. Highly weathered, whitish grey to brownish grey, fine to medium grained, moderately fractured rock.			R16	CR=27% RQD=Nil
			R17	CR=26% RQD=Nil
			R18	CR=22% RQD=Nil
			R19	CR=20% RQD=Nil
			R20	CR=31% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R21	CR=28% RQD=Nil

4.50 5.25 6.00 6.75 7.50 8.25 9.00 9.75 10.50 11.25 12.00 12.75 13.50 14.25 15.00 15.75 16.50 17.25 18.00 18.75 19.50 20.00

BH-41/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 28/03/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH42 | Co-ordinates E=385 N=827

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	1

Commencement Date : 13/03/2018
Completion Date : 16/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.740 M.
Water Struck At :
Standing Water Level : 1.53 m.

DESCRIPTION	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Steel grey, clayey silt. Observed sand mixture.		DS-1	0.50
0.90m. Loose to medium dense, steel grey, silty sand. Obsered kankar, conch pcs. & clay binder.	1 1 3 (4)	SPT-1	1.00-1.45
		WS-1	1.53
		*UDS-1	2.00-2.45
	3 7 7 (14)	SPT-2	2.50-2.95
3.00m. Very dense, brownish grey to light grey, silty sand with mica & conch pcs. Observed kankar & decomposed rock.	16 30 54 (≥100) 5.0 cm Pentn.	SPT-3	3.50-3.85
	42 58 5.0 cm Pentn. >100	SPT-4	4.00-4.20
4.25m.	100 4.0 cm Pentn. Refusal	*SPT-5	4.25-4.29
		R1	CR=13%/RQD=0
	52 Refusal 2.0 cm Pentn.	*SPT-6	5.00-5.02
		R2	CR=16%/RQD=0
Completely to highly weathered, light to brownish grey, medium to coarse grained, moderately fractured rock.	55 Refusal 3.0 cm Pentn.	*SPT-7	5.75-5.78
		R3	CR=24%/RQD=0
	NX rotary drilling from 4.25m to 20.00m	R4	CR=22% RQD=Nil
		R5	CR=25% RQD=Nil
8.00m.		R6	CR=27% RQD=Nil
Highly weathered, whitish grey to brownish grey, fine to medium grained, moderately fractured rock.		R7	CR=24% RQD=Nil
		R8	CR=22% RQD=Nil
		R9	CR=24% RQD=Nil
		R10	CR=26% RQD=Nil
		R11	CR=25% RQD=Nil
		R12	CR=24% RQD=Nil
		R13	CR=22% RQD=Nil
		R14	CR=22% RQD=Nil
		R15	CR=24% RQD=Nil
		R16	CR=21% RQD=Nil
16.25m.		R17	CR=26% RQD=Nil
Highly weathered, whitish grey to brownish grey, fine to medium grained, moderately fractured rock.		R18	CR=26% RQD=Nil
		R19	CR=27% RQD=Nil
		R20	CR=35% RQD=Nil
N.B. – '*' means sample could not be recovered / sample slip.		R21	CR=36% RQD=Nil
20.00m.			

4.25 5.00 5.75 6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00 14.75 15.50 16.25 17.00 17.75 18.50 19.25 20.00

BH-42/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 28/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH43

Co-ordinates E=359 N=944

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 06/03/2018
Completion Date : 07/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.576 M.
Water Struck At :
Standing Water Level : 1.4 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m.				
Soft / medium, light grey, silty clay / clayey silt. Observed sand mixture.		1 2 2 (4)	DS-1	0.50
			SPT-1	1.00-1.45
		2 2 2 (4)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.40m.				
Very dense, light to brownish grey, medium grained, silty sand with mica & conch pcs. Observed decomposed rock.		21 24 44 (68)	SPT-3	3.50-3.95
		38 62 9.0 cm Pentn. >100	SPT-4	4.20-4.44
		100 3.0 cm Pentn. Refusal	*SPT-5	4.60-4.63
4.80m.		100 2.0 cm Pentn. Refusal	*SPT-6	4.80-4.82
			R1	CR=15%/RQD=0
		52 Refusal 2.0 cm Pentn.	*SPT-7	5.50-5.52
			R2	CR=24%/RQD=0
Completely to highly weathered, brownish grey to light grey, medium grained, highly fractured rock.		NX rotary drilling from 4.80m to 15.00m	R3	CR=21% RQD=Nil
			R4	CR=22% RQD=Nil
			R5	CR=24% RQD=Nil
8.50m.			R6	CR=28% RQD=Nil
Highly weathered, brownish grey to light grey, medium grained, highly fractured rock.			R7	CR=32% RQD=15%
10.00m.			R8	CR=25% RQD=Nil
Highly weathered, whitish grey, medium grained, moderately fractured rock.			R9	CR=34% RQD=Nil
11.50m.			R10	CR=23% RQD=Nil
Highly weathered, brownish grey to greyish brown, medium grained, highly fractured rock.			R11	CR=21% RQD=Nil
			R12	CR=23% RQD=Nil
			R13	CR=21% RQD=Nil
15.00m.			R14	CR=24% RQD=Nil

6.25 7.00 7.75 8.50 9.25 10.00 10.75 11.50 12.25 13.00 13.75 14.50 15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-43/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 28/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH44

Co-ordinates E=-80 N=958

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 10/03/2018
Completion Date : 11/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.259 M.
Water Struck At :
Standing Water Level : 1.41 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Soft, steel grey, clayey silt. Observed sand mixture.		0 1 2 — 3	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Loose to medium dense, steel grey, silty sand. Observed kankar, conch pcs. & clay binder.		2 4 6 — 10	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			*UDS-2	3.00-3.45
3.60m. Very dense, brownish grey, medium grained, silty sand with high % of conch pcs. Observed kankar & decomposed rock.		33 77 — ≥100 7.0 cm Pentn.	SPT-3	4.00-4.22
		100 3.0 cm Pentn. Refusal	*SPT-4	4.50-4.53
4.80m.		100 2.0 cm Pentn. Refusal	*SPT-5	4.80-4.824.80
			R1	CR=19%/RQD=0
		50 2.0 cm Pentn.	*SPT-6	5.50-5.525.50
			R2	CR=23%/RQD=0
Completely to highly weathered, light to brownish grey, medium to coarse grained, moderately fractured rock.		NX rotary drilling from 4.80m to 15.00m	R3	CR=24% RQD=Nil 6.25
			R4	CR=20% RQD=Nil 7.00
			R5	CR=21% RQD=Nil 7.75
			R6	CR=24% RQD=Nil 8.50
9.25m. Highly weathered, whitish grey to light grey, medium grained, highly fractured rock.			R7	CR=23% RQD=Nil 9.25
			R8	CR=22% RQD=Nil 10.00
			R9	CR=24% RQD=Nil 10.75
12.25m. Highly weathered, brownish grey, medium grained, fractured rock.			R10	CR=24% RQD=Nil 11.50
			R11	CR=23% RQD=Nil 12.25
			R12	CR=21% RQD=Nil 13.00
			R13	CR=23% RQD=Nil 13.75
15.00m.			R14	CR=22% RQD=Nil 14.50 15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-44/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 15/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH45

Co-ordinates E=280 N=1191

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	1

Commencement Date : 08/03/2018
Completion Date : 09/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.288 M.
Water Struck At :
Standing Water Level : 1.35 m.

DESCRIPTION	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Steel grey, clayey silt. Observed sand mixture.		DS-1	0.50
0.80m. Loose, steel grey, silty sand. Observed kankar, conch pcs. & clay binder.	1 1 2 (3)	SPT-1	1.00-1.45
		WS-1	1.35
		*UDS-1	2.00-2.45
	2 3 3 (6)	SPT-2	2.50-2.95
3.05m. Very dense, brownish grey to light grey, medium grained, silty sand with mica & conch pcs. Observed kankar & decomposed rock.	8 30 42 (72)	SPT-3	3.10-3.55
	100 10.0 cm Penth. >100	SPT-4	3.60-3.70
	100 3.0 cm Pentn. Refusal	*SPT-5	3.85-3.88
4.00m.	100 Refusal	*SPT-6	4.00-4.02 4.00
	2.0 cm Penth.	R1	CR=14% RQD=Nil 4.75
	50 Refusal	*SPT-7	4.75-4.77
	2.0 cm Penth.	R2	CR=16% RQD=Nil 5.50
	50 Refusal	*SPT-8	5.50-5.52
	2.0 cm Penth.	R3	CR=18% RQD=Nil 6.25
	52 Refusal	*SPT-9	6.25-6.28
	3.0 cm Penth.	R4	CR=20% RQD=Nil 7.00
Completely to highly weathered, brownish grey, medium to coarse grained, highly fractured rock.	NX rotary drilling from 4.00m to 15.00m	R5	CR=19% RQD=Nil 7.75
	Refusal	*SPT-10	7.75-7.77
	50 2.0 cm Penth.	R6	CR=21% RQD=Nil 8.50
		R7	CR=23% RQD=Nil 9.25
		R8	CR=22% RQD=Nil 10.00
10.00m.		R9	CR=21% RQD=Nil 10.75
		R10	CR=24% RQD=Nil 11.50
		R11	CR=25% RQD=Nil 12.25
Highly weathered, whitish grey to brownish grey, medium grained, fractured rock.		R12	CR=23% RQD=Nil 13.00
		R13	CR=21% RQD=Nil 13.75
		R14	CR=23% RQD=Nil 14.50
N.B. - '*' means sample could not be recovered / sample slip.		R15	CR=25% RQD=Nil 15.00
15.00m.			

BH-45/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 28/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH46

Co-ordinates E=203 N=1375

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 12/03/2018
Completion Date : 13/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.258 M.
Water Struck At :
Standing Water Level : 1.4 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Soft, light grey, clayey silt. Observed kankar, conch pcs. & sand mixture.		1 1 2 (3)	DS-1	0.50
			SPT-1	1.00-1.45
		1 1 1 (2)	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.50m			*UDS-2	3.50-3.60
Very dense, light grey, silty sand with kankar. Observed conch pcs. & gravel.		100 9.0 cm Pentn. >100	SPT-3	4.00-4.09
		100 3.0 cm Pentn. Refusal	*SPT-4	4.30-4.33
4.50m		100 2.0 cm Pentn. Refusal	*SPT-5	4.50-4.52
Completely to highly weathered, light to deep grey, coarse grained, fractured rock.		NX rotary drilling from 4.50m to 15.00m	R1	CR=20%/RQD=0
			R2	CR=21% RQD=Nil
			R3	CR=20% RQD=Nil
6.75m			R4	CR=24% RQD=Nil
Highly weathered, deep to whitish grey, coarse to medium grained, fractured rock.			R5	CR=24% RQD=Nil
			R6	CR=21% RQD=Nil
9.00m			R7	CR=28% RQD=18%
			R8	CR=25% RQD=Nil
Highly weathered, light to whitish grey, coarse to medium grained, fractured rock.			R9	CR=28% RQD=Nil
			R10	CR=30% RQD=Nil
			R11	CR=25% RQD=Nil
			R12	CR=29% RQD=Nil
13.50m			R13	CR=28% RQD=Nil
Highly weathered, light grey to deep grey, coarse to medium grained, highly fractured rock.			R14	CR=24% RQD=Nil
15.00m				

4.50 5.25 6.00 6.75 7.50 8.25 9.00 9.75 10.50 11.25 12.00 12.75 13.50 14.25 15.00

N.B. – '*' means sample could not be recovered / sample slip.

BH-46/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 28/03/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH47

Co-ordinates E=558 N=1559

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	16	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	16
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 09/03/2018
Completion Date : 11/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.430 M.
Water Struck At :
Standing Water Level : 1.4 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m.				
Very soft, light grey, clayey silt. Observed kankar, mica & sand mixture.		2 0 1 1	DS-1 SPT-1	0.50 1.00-1.45
		2 0 1 1	*UDS-1 SPT-2	2.00-2.45 2.50-2.95
3.40m.				
Very dense, deep grey, silty sand wih gravel. Observed conch .pcs.		100 >100 12.0 cm Pentn. 100 3.0 cm Pentn. Refusal 100 2.0 cm Pentn. Refusal	*UDS-2 SPT-3 *SPT-4 *SPT-5	3.50-3.60 4.00-4.12 4.30-4.33 4.50-4.52
4.50m.				4.50
Completely to highly weathered, light grey, coarse grained, fractured rock.			R1	CR=13%/RQD=0
		50 3.0 cm Pentn. Refusal	*SPT-6	5.25-5.28
			R2	CR=14%/RQD=0 5.25
		50 2.0 cm Pentn. Refusal	*SPT-7	6.00-6.02
			R3	CR=16%/RQD=0 6.00
		50 2.0 cm Pentn. Refusal	*SPT-8	6.75-6.77
			R4	CR=13%/RQD=0 6.75
		50 Refusal 2.0 cm Pentn.	*SPT-9	7.50-7.52
			R5	CR=26%/RQD=0 7.50
		NX rotary drilling from 4.50m to 20.00m	R6	CR=29% RQD=Nil 8.25
9.00m.				
Highly weathered, whitish grey to light grey, coarse grained, fractured rock.			R7	CR=26% RQD=Nil 9.00
			R8	CR=24% RQD=Nil 9.75
			R9	CR=25% RQD=Nil 10.50
			R10	CR=22% RQD=Nil 11.25
			R11	CR=21% RQD=Nil 12.00
12.75m.				
Completely weathered, whitish grey to light grey, fine to medium grained, highly fractured rock.			R12	CR=20% RQD=Nil 12.75
		50 Refusal 2.0 cm Pentn.	R13 *SPT-10	CR=18%/RQD=0 13.50 14.25-14.27
			R14	CR=16%/RQD=0 14.25
		50 2.0 cm Pentn. Refusal	*SPT-11	15.00-15.02
			R15	CR=18%/RQD=0 15.00
		50 2.0 cm Pentn. Refusal	*SPT-12	15.75-15.77
			R16	CR=14%/RQD=0 15.75
16.50m.		50 2.0 cm Pentn. Refusal	*SPT-13	16.50-16.52
			R17	CR=14%/RQD=0 16.50
		50 Refusal 3.0 cm Pentn.	*SPT-14	17.25-17.28
Completely to highly weathered, whitish grey to light grey, medium grained, fractured rock.			R18	CR=25%/RQD=0 17.25
		Refusal	R19	CR=17%/RQD=0 18.00
		50 2.0 cm Pentn.	*SPT-15	18.75-18.77
		Refusal	R20	CR=17%/RQD=0 18.75
N.B. - '*' means sample could not be recovered / sample slip.		50 3.0 cm Pentn.	*SPT-16	19.50-19.53
20.00m.			R21	CR=20% RQD=Nil 19.50 20.00

BH-47/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 03/04/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH48

Co-ordinates E=-156 N=743

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 25/03/2018
Completion Date : 28/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.280 M.
Water Struck At :
Standing Water Level : 1.52 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m. Brownish grey, silty clay with conch pcs. 0.70m.		1	DS-1	0.50
Very soft, light grey, clayey silt with sand. Observed conch pcs.		0 0 1	SPT-1	1.00-1.45
2.40m. Very soft, light grey, clayey silt with sand. Observed conch pcs. & clay binder.		1	*UDS-1	2.00-2.45
		1 0 1	SPT-2	2.50-2.95
3.80m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs. 4.60m.		25 75 for 3.0 cm Pentn. >100	UDS-2	3.45-3.90
		100 for 2.0 cm Pentn. Refusal	SPT-3	4.10-4.28
		100 for 2.0 cm Pentn. Refusal	*SPT-4	4.40-4.42
			*SPT-5	4.60-4.62
		NX rotary drilling from 4.60m to 20.00m	R1	CR=40%/RQD=0
			R2	CR=28%/RQD=0
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R3	CR=33% RQD=Nil
			R4	CR=29% RQD=Nil
			R5	CR=32% RQD=Nil
			R6	CR=32% RQD=Nil
			R7	CR=24% RQD=Nil
9.50m.			R8	CR=28% RQD=Nil
Highly weathered, light grey, medium grained, fractured rock.			R9	CR=40% RQD=Nil
			R10	CR=30% RQD=Nil
			R11	CR=29% RQD=Nil
12.50m.			R12	CR=32% RQD=Nil
Highly weathered, whitish grey to light grey, coarse to medium grained, fractured rock.			R13	CR=33% RQD=Nil
			R14	CR=32% RQD=Nil
			R15	CR=30% RQD=Nil
16.25m.			R16	CR=34% RQD=Nil
Highly weathered, light grey, medium to fine grained, moderately to highly fractured rock.			R17	CR=26% RQD=Nil
			R18	CR=34% RQD=Nil
			R19	CR=32% RQD=Nil
			R20	CR=32% RQD=Nil
N.B. - '*' means sample could not be recovered.			R21	CR=33% RQD=Nil
20.00m.				

4.60 5.00 5.75 6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00 14.75 15.50 16.25 17.00 17.75 18.50 19.25 20.00

BH-48/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH49 | Co-ordinates E=-316 N=1488

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 05/05/2018
Completion Date : 06/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.403 M.
Water Struck At :
Standing Water Level : 2.82 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, light grey, clayey silt with sand. Observed kankar.		5 8 7 (15)	DS-1	0.50
			SPT-1	1.00-1.45
1.55m.				
Medium, brownish grey, clayey silt with sand mixture.		1 2 2 (4)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.00m.				
Medium dense, brownish grey, silty sand with conch pcs. Observed clay binder.		5 7 8 (15)	*UDS-2	3.55-4.00
			SPT-3	4.05-4.50
5.00m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		25 30 45 2.0 cm Pentn. >100	SPT-4	5.00-5.32
		100 4.0 cm Pentn. Refusal	*SPT-5	5.60-5.64
5.90m.		Refusal	*SPT-6	5.90-5.94
		100 4.0 cm Pentn.	R1	CR=22% RQD=Nil
Highly weathered, light to brownish grey, coarse grained, highly fractured rock.		NX rotary drilling from 5.90m to 15.00m	R2	CR=21% RQD=Nil
			R3	CR=22% RQD=Nil
			R4	CR=24% RQD=Nil
8.75m.			R5	CR=22% RQD=16%
Highly weathered, light grey, medium to fine grained, moderately fractured rock.			R6	CR=25% RQD=Nil
			R7	CR=23% RQD=Nil
11.00m.			R8	CR=26% RQD=Nil
Highly weathered, light grey, medium to fine grained, moderately fractured rock.			R9	CR=30% RQD=Nil
			R10	CR=24% RQD=Nil
			R11	CR=35% RQD=Nil
			R12	CR=40% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.				

5.90 6.50 7.25 8.00 8.75 9.50 10.25 11.00 11.75 12.50 13.25 14.00 15.00

BH-49/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH50 | Co-ordinates E=-306 N=1430

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 05/05/2018
Completion Date : 06/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.848 M.
Water Struck At :
Standing Water Level : 2.8 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, light grey, clayey silty sand. Observed kankar.		4 7 6 (13)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m				
Loose to medium dense, brownish grey, silty sand with kankar & conch pcs. Observed clay binder.		2 1 2 (3)	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
			*UDS-2	3.50-3.95
		4 6 8 (14)	SPT-3	4.00-4.45
5.00m		28 32 40 (>100) 5.0 cm Pentn.	SPT-4	5.00-5.35
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-5	5.70-5.74
6.00m		Refusal	*SPT-6	6.00-6.03
Highly weathered, brownish grey, coarse grained, highly fractured rock.		100 3.0 cm Pentn. NX rotary drilling from 6.00m to 15.00m	R1	CR=24% RQD=Nil (6.00-6.75)
			R2	CR=25% RQD=Nil (6.75-7.50)
			R3	CR=26% RQD=Nil (7.50-8.25)
			R4	CR=24% RQD=Nil (8.25-9.00)
			R5	CR=24% RQD=Nil (9.00-9.75)
			R6	CR=24% RQD=Nil (9.75-10.50)
			R7	CR=26% RQD=Nil (10.50-11.25)
			R8	CR=22% RQD=Nil (11.25-12.00)
12.00m				
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R9	CR=22% RQD=Nil (12.00-12.75)
13.50m			R10	CR=24% RQD=Nil (12.75-13.50)
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R11	CR=26% RQD=Nil (13.50-14.25)
N.B. - '*' means sample could not be recovered / sample slip.			R12	CR=29% RQD=Nil (14.25-15.00)
15.00m				

BH-50/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH51 | Co-ordinates E=−198 N=1466

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 03/05/2018
Completion Date : 04/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.897 M.
Water Struck At :
Standing Water Level : 2.8 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, light grey, silty sand.		10 12 15 — 27	DS−1	0.50
			SPT−1	1.00−1.45
1.70m				
Medium dense, light grey, silty sand. Observed kankar, conch pcs. & clay binder.		5 6 7 — 13	*UDS−1	2.00−2.45
			SPT−2	2.50−2.95
			*UDS−2	3.50−3.95
4.00m				
Medium dense, light grey, silty sand with clay binder.		8 8 9 — 17	SPT−3	4.05−4.50
5.00m		100 12.0 cm Pentn. >100	SPT−4	5.05−5.17
Very dense, silty sand. Observed decomposed rock.		100 3.0 cm Pentn. Refusal	*SPT−5	5.30−5.33
5.40m		100 3.0 cm Pentn. Refusal	*SPT−6	5.40−5.43
			R1	CR=13%/RQD=0
		50 3.0 cm Pentn. Refusal	*SPT−7	6.00−6.03
			R2	CR=15% RQD=Nil
Completely weathered, light grey, coarse grained, highly fractured rock.		52 4.0 cm Pentn. Refusal	*SPT−8	6.75−6.79
			R3	CR=18% RQD=Nil
		50 2.0 cm Pentn. Refusal	*SPT−9	7.50−7.52
			R4	CR=16% RQD=Nil
8.25m		51 3.0 cm Pentn.	*SPT−10	8.25−8.28
			R5	CR=21% RQD=Nil
		NX rotary drilling from 5.40m to 15.00m		
			R6	CR=21% RQD=Nil
			R7	CR=24% RQD=Nil
Highly weathered, coarse to medium grained, moderately fractured rock.			R8	CR=21% RQD=Nil
			R9	CR=23% RQD=Nil
			R10	CR=22% RQD=Nil
12.75m				
Highly weathered, light brownish grey, medium grained, moderately fractured rock.			R11	CR=21% RQD=Nil
13.50m				
Highly weathered, light greenish grey, medium grained, medium to fine grained, moderately fractured rock.			R12	CR=25% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.			R13	CR=26% RQD=Nil
15.00m				

5.40
6.00
6.75
7.50
8.25
9.00
9.75
10.50
11.25
12.00
12.75
13.50
14.25
15.00

BH−51/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH52 | Co-ordinates E=−77 N=1451

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 02/05/2018
Completion Date : 02/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.815 M.
Water Struck At :
Standing Water Level : 1.9 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
			DS−1	0.50
		2 2 3 (5)	SPT−1	1.00−1.45
Medium, brownish grey, clayey silt with high % of sand mixture. Observed kankar & conch pcs.			*UDS−1	2.00−2.45
		3 3 4 (7)	SPT−2	2.50−2.95
			*UDS−2	3.50−3.95
4.00m.				
Very stiff, light grey, clayey silt with sand. Observed conch pcs. & decomposed rock.		5 11 14 (25)	SPT−3	4.00−4.45
5.00m.				
Very dense, light grey, silty sand. Observed conch pcs. & decomposed rock.		20 35 45 12.0 cm Penth. >100	SPT−4	5.00−5.42
		100 4.0 cm Pentn. Refusal	*SPT−5	5.60−5.64
5.75m.		100 30 cm Pentn. Refusal	*SPT−6	5.75−5.78
		Refusal	R1	CR=16% RQD=Nil
Completely to highly weathered, light grey, coarse to medium grained, highly fractured rock.		52 3.0 cm Pentn.	*SPT−7	6.50−6.53
			R2	CR=21% RQD=Nil
7.25m.		NX rotary drilling from 5.75m to 15.00m		
			R3	CR=24% RQD=Nil
			R4	CR=27% RQD=Nil
Highly weathered, light grey to brownish grey, coarse to medium grained, moderately fractured rock.			R5	CR=25% RQD=Nil
			R6	CR=22% RQD=Nil
			R7	CR=22% RQD=Nil
11.00m.				
			R8	CR=25% RQD=Nil
			R9	CR=28% RQD=Nil
Highly to moderately weathered, light brownish grey, medium grained, moderately fractured rock.			R10	CR=42% RQD=Nil
			R11	CR=23% RQD=Nil
			R12	CR=24% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.				
15.00m.				

5.75
6.50
7.25
8.00
8.75
9.50
10.25
11.00
11.75
12.50
13.25
14.00
15.00

BH−52/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 19/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IBH53 | Co-ordinates E=-212 N=728

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	7
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 04/05/2018
Completion Date : 05/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.913 M.
Water Struck At :
Standing Water Level : 1.82 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Very loose, brownish grey to light grey, silty sand. Observed kankar & conch pcs.		3 1 2 (3)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m				
Loose, light grey, silty sand. Observed kankar, conch pcs. & clay binder.		2 3 4 (7)	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
3.10m				
Very dense, light grey, silty sand with conch pcs. & decomposed rock.		100 5.0 cm Pentn. Refusal	SPT-3	3.40-3.45
		100 2.0 cm Pentn. Refusal	*SPT-4	3.60-3.62
3.70m			*SPT-5	3.70-3.72
Highly weathered, deep grey, medium grained, fractured rock.		NX rotary drilling from 3.70m to 15.00m	R1	CR=27%/RQD=0
4.25m				4.25
			R2	CR=23% RQD=Nil
				5.00
		Refusal	R3	CR=21% RQD=Nil
		100 2.0 cm Pentn.		5.75
			R4	CR=25% RQD=Nil
				6.50
Completely to highly weathered, deep to light grey, coarse to medium grained, highly to moderately fractured rock.			R5	CR=32% RQD=Nil
				7.25
		Refusal	R6	CR=19% RQD=Nil
		52 2.0 cm Pentn.	*SPT-6	8.00-8.02
				8.00
			R7	CR=26% RQD=Nil
				8.75
			R8	CR=20% RQD=Nil
				9.50
		Refusal	R9	CR=16% RQD=Nil
10.25m		53 2.0 cm Pentn.	*SPT-7	10.25-10.27
				10.25
			R10	CR=36% RQD=Nil
				11.00
			R11	CR=37% RQD=Nil
				11.75
Highly weathered, light to whitish grey, medium to fine grained, fractured rock.			R12	CR=31% RQD=Nil
				12.50
			R13	CR=38% RQD=Nil
				13.25
			R14	CR=37% RQD=Nil
				14.00
			R15	CR=22% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.				
15.00m				15.00

BH-53/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 25/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. ICST1 | Co-ordinates E=44 N=1483

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 21/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.957 M.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Loose, light grey, silty sand. Observed kankar.		2 3 5 (8)	DS-1	0.50
			SPT-1	1.00-1.45
1.45m. Loose, brownish grey, clayey silty sand. Observed kankar & conch pcs.		1 2 3 (5)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
		1 2 2 (4)	*UDS-2	3.50-3.95
			SPT-3	4.05-4.50
5.00m. Very dense, light grey, silty sand with kankar, mica & conch pcs. Observed decomposed rock. 5.50m.		33 67 10.0 cm Pentn. >100 Refusal 100 3.0 cm Pentn. Refusal	SPT-4 *SPT-5 *SPT-6	5.00-5.25 5.40-5.43 5.50-5.53 5.50
		100 3.0 cm Pentn.	R1	CR=30% RQD=Nil 6.50
		NX rotary drilling from 5.50m to 26.50m	R2	CR=32% RQD=Nil 7.50
Highly to moderately weathered, brownish grey, medium to coarse grained, highly fractured rock.			R3	CR=36% RQD=Nil 8.50
			R4	CR=37% RQD=Nil 9.50
			R5	CR=41% RQD=Nil 10.50
10.50m. Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R6	CR=22% RQD=Nil 11.50
			R7	CR=21% RQD=Nil 12.50
Highly to moderately weathered, brownish grey, medium to fine grained, highly fractured rock. 13.50m. 13.75m.			R8	CR=24% RQD=Nil 13.50

BH-1/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 25/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. ICST1 | Co-ordinates E=44 N=1483

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 21/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.957 M.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.75m.			R9	CR=32% RQD=Nil
				14.50
			R10	CR=26% RQD=Nil
				15.50
Highly/moderately weathered, brownish grey, medium to fine grained, highly fractured rock.			R11	CR=36% RQD=Nil
				16.50
			R12	CR=41% RQD=Nil
				17.50
			R13	CR=29% RQD=Nil
18.50m.				18.50
			R14	CR=32% RQD=13%
				19.50
			R15	CR=34% RQD=Nil
				20.50
			R16	CR=35% RQD=Nil
				21.50
Highly weathered, brownish grey, medium to fine grained, highly fractured rock.			R17	CR=36% RQD=16%
				22.50
			R18	CR=31% RQD=Nil
				23.50
			R19	CR=32% RQD=Nil
				24.50
			R20	CR=32% RQD=Nil
				25.50
			R21	CR=35% RQD=18%
26.50m.				26.50

N.B. – '*' means sample could not be recovered / sample slip.

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 25/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. ICST2 | Co-ordinates E=511 N=129

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 21/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.90 M.
Water Struck At :
Standing Water Level : 1.0 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, clayey silty sand. Observed kankar.		8 6 4 (10)	DS-1	0.50
			SPT-1	1.00-1.45
1.70m.				
Very loose, light grey, clayey silty sand. Observed kankar & conch pcs.		1 1 2 (3)	SPT-2	2.50-2.95
4.00m.		25 75/9.0 cm Pentn. (≥100)	SPT-3	4.00-4.24
Very dense, light grey, silty sand with decomposed rock.		100/4.0 cm Pentn. Refusal	*SPT-4	4.50-4.54
4.60m.		Refusal	*SPT-5	4.60-4.63
		100/3.0 cm Pentn.	R1	CR=22% RQD=Nil
		NX rotary drilling from 4.60m to 26.60m		5.60
Highly weathered, light grey, coarse to medium grained, highly fractured rock.			R2	CR=22% RQD=Nil
				6.60
			R3	CR=25% RQD=Nil
7.60m.				7.60
Highly weathered, light grey, coarse to medium grained, highly fractured rock.			R4	CR=26% RQD=Nil
				8.60
			R5	CR=28% RQD=Nil
9.60m.				9.60
Highly weathered, light grey, coarse to medium grained, highly fractured rock.			R6	CR=24% RQD=Nil
10.60m.				10.60
Highly weathered, light grey, coarse to medium grained, highly fractured rock.			R7	CR=28% RQD=Nil
				11.60
			R8	CR=29% RQD=Nil
12.60m.				12.60
Highly weathered, light grey, fine grained, highly fractured rock.			R9	CR=31% RQD=Nil
13.75m.				13.60

BH-2/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 25/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. ICST2 | Co-ordinates E=511 N=129

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	5
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 21/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.90 M.
Water Struck At :
Standing Water Level : 1.0 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.75m. Highly weathered, light grey, fine grained, highly fractured rock.			R10	CR=30% RQD=Nil
14.60m.				14.60
			R11	CR=24% RQD=Nil
Highly weathered, light grey, fine grained, highly fractured rock.				15.60
			R12	CR=26% RQD=Nil
				16.60
			R13	CR=21% RQD=Nil
17.60m.				17.60
			R14	CR=26% RQD=Nil
				18.60
			R15	CR=28% RQD=Nil
				19.60
			R16	CR=30% RQD=Nil
				20.60
Highly weathered, light grey, fine grained, highly fractured rock.			R17	CR=35% RQD=Nil
				21.60
			R18	CR=38% RQD=Nil
				22.60
			R19	CR=40% RQD=Nil
				23.60
			R20	CR=26% RQD=Nil
				24.60
			R21	CR=30% RQD=Nil
				25.60
			R22	CR=34% RQD=Nil
26.60m.				26.60

N.B. – '*' means sample could not be recovered / sample slip.

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 11/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. IPMT1 | Co-ordinates E=-171 N=802

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	5
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 23/04/2018
Completion Date : 24/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.264 M.
Water Struck At :
Standing Water Level : 1.0 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, sandy silt with clay binder.		4 6 6 (12)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
			*UDS-1	2.00-2.45
Very loose, light grey, clayey silty sand with conch pcs.		1 0 1 (1)	SPT-2	2.55-3.00
		23 47 30 (>100) 5.0 cm Pentn.	SPT-3	4.10-4.45
4.50m.				
Very dense, light grey, silty sand with conch pcs. & decomposed rock.		100 3.0 cm Pentn. Refusal	*SPT-4	4.80-4.83
5.00m.		Refusal	*SPT-5	5.00-5.02
		100 2.0 cm Pentn.	R1	CR=16% RQD=Nil
		NX rotary drilling from 5.00m to 25.00m		5.00 / 6.00
			R2	CR=17% RQD=Nil
				6.00 / 7.00
			R3	CR=29% RQD=10%
				7.00 / 8.00
Completely/highly weathered, light to brownish grey, medium to coarse grained, moderately fractured rock.			R4	CR=20% RQD=Nil
				8.00 / 9.00
			R5	CR=24% RQD=Nil
				9.00 / 10.00
			R6	CR=21% RQD=Nil
				10.00 / 11.00
			R7	CR=20% RQD=10%
				11.00 / 12.00
12.00m.				
Highly weathered, whitish grey to light grey, medium grained, completely fractured rock.			R8	CR=40% RQD=Nil
12.60m.				

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 11/05/2018	Sheet No:

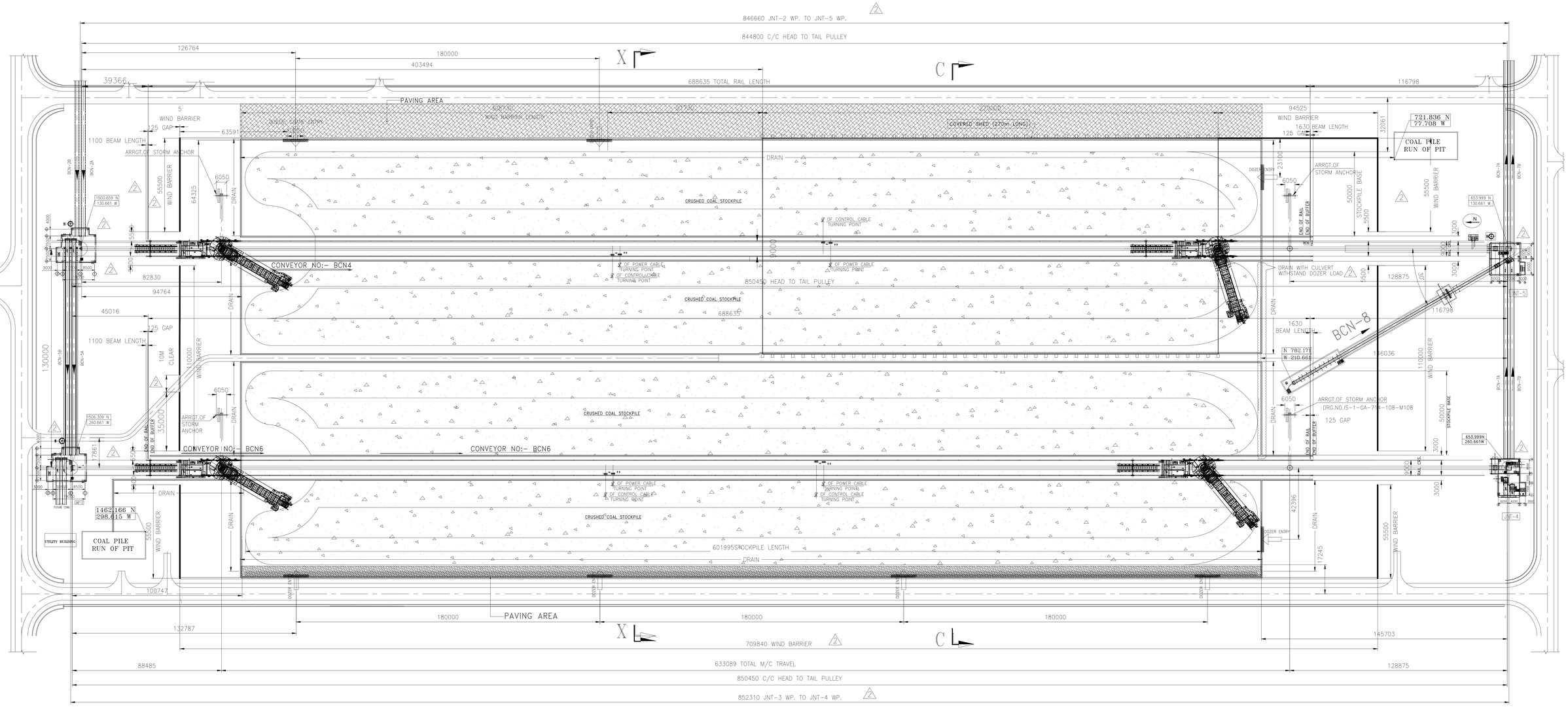
BORE LOG DATA SHEET

BORE HOLE NO.IPMT1 | Co-ordinates E=-171 N=802

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 23/04/2018
Completion Date : 24/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.264 M.
Water Struck At :
Standing Water Level : 1.0 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
12.60m.				13.00
			R9	CR=35% RQD=Nil
				14.00
			R10	CR=26% RQD=Nil
				15.00
Highly weathered, whitish grey to light grey, medium grained, completely fractured rock.			R11	CR=33% RQD=Nil
				16.00
			R12	CR=31% RQD=Nil
				17.00
			R13	CR=25% RQD=Nil
				18.00
			R14	CR=35% RQD=Nil
19.00m.				19.00
			R15	CR=29% RQD=Nil
				20.00
			R16	CR=27% RQD=Nil
				21.00
			R17	CR=32% RQD=Nil
Highly weathered, brownish grey, medium grained, fractured rock.				22.00
			R18	CR=38% RQD=Nil
				23.00
			R19	CR=32% RQD=Nil
				24.00
			R20	CR=30% RQD=Nil
N.B. – '*' means sample could not be recovered / sample slip.				25.00
25.00m.				



KEY PLAN OF COAL STOCK PILE INCLUDING CIVIL DETAILS LIKE ROADS, DRAINS & PAVEMENT (SCALE 1:1)

FOR SECTION 'CC' REFER SHT. 6 OF 6
FOR SECTION 'XX' REFER SHT. 6 OF 6

JSHETTY	JV	DUT	30.09.19	2	DRG. IS REVISED AS PER CLIENTS COMMENTS
R.B.G	VVS	P.P.S	28.08.19	1	DRG. IS REVISED AS PER CLIENTS COMMENTS
MECH	SEC	NAME	DATE	REV.	AMENDMENTS

CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION

CUSTOMER CONSULTANT : TATA CONSULTING ENGINEERS LIMITED BANGALORE

PROJECT : 2 x 660 MW UDANGUDI TPP-STAGE-1

BHARAT HEAVY ELECTRICALS LTD.
INDUSTRIAL SYSTEMS GROUP, BANGALORE

	NAME	SIGN	DATE	NO.OF VAR
DRN.	PRITHVIRAJ SOLANKI		08.07.2019	
CHD.	VIJAY V. SONI		08.07.2019	
APPD.	RENISH GARMORA		08.07.2019	

JOB No.:
STATUS OF DRAWING : FOR APPROVAL
DISTRIBUTION OF PRINTS : QTY.

REV.		NAME	SIGN	DATE
2	ALTERED			
	CHECKED			
	APPROVED			

DIRECTORY : A1-688
FILE NO. : -
SCALE N.T.S.
WEIGHT(Kgs.)
ITEM NO.
NO.OF ITEMS

ELECON DRG. NO. C37054 REV. 2

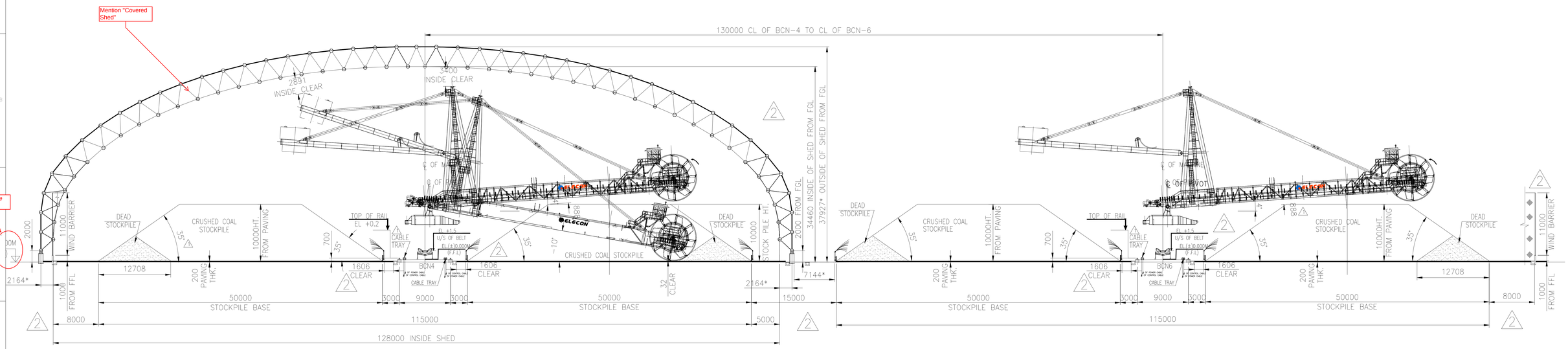
TITLE : G.A OF RAIL & RAIL FIXING ACCESSORIES & STOCK YARD LAYOUT FOR SCR

DRAWING NO. IS-1-GA-714-108-M104 REV. 2

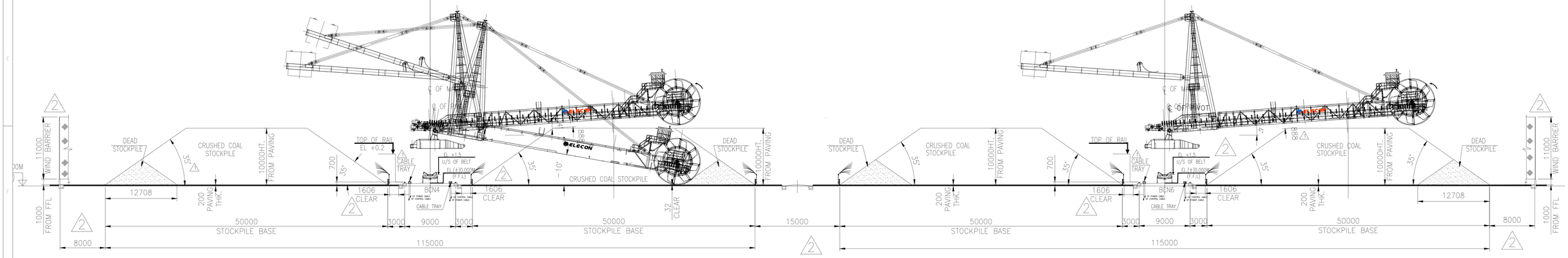
SHEET NO. 5 NO.OF SHTS. 6

Mention "Covered Shed"

Please make the value legible



SECTION– CC(WIND BARRIER & CLOSED SHED)



JSHETTY	JV	DUT	30.09.19	2	DRG. IS REVISED AS PER CLIENTS COMMENTS
R.B.G	VVS	P.P.S	28.08.19	1	DRG. IS REVISED AS PER CLIENTS COMMENTS
MECH	SEC	NAME	DATE	REV.	AMENDMENTS

CUSTOMER : TAMILNADU GENERATION AND DISTRIBUTION CORPORATION

CUSTOMER CONSULTANT : TATA CONSULTING ENGINEERS LIMITED BANGALORE

PROJECT : 2 x 660 MW UDANGUDI TPP–STAGE–1

BHARAT HEAVY ELECTRICALS LTD.
INDUSTRIAL SYSTEMS GROUP, BANGALORE

	NAME	SIGN	DATE
DRN.	PRITHVIRAJ SOLANKI		08.07.2019
CHD.	VIJAY V SONI		08.07.2019
APPD.	RENISH GARMORA		08.07.2019

JOB No.:
STATUS OF DRAWING : FOR APPROVAL
DISTRIBUTION OF PRINTS | QTY.

REV.		NAME	SIGN	DATE
2	ALTERED			
	CHECKED			
	APPROVED			

DIRECTORY : A1-688
FILE NO. : -
SCALE N.T.S.
WEIGHT(Kgs.)
ITEM NO.
NO.OF ITEMS
NO.OF VAR

ELECON DRG. NO. C37054 REV. 2

TITLE : G.A OF RAIL & RAIL FIXING ACCESSORIES & STOCK YARD LAYOUT FOR SCR

DRAWING NO. IS-1-GA-714-108-M104 REV. 2

SHEET NO. 6 NO.OF SHTS. 6

SIZE–A1

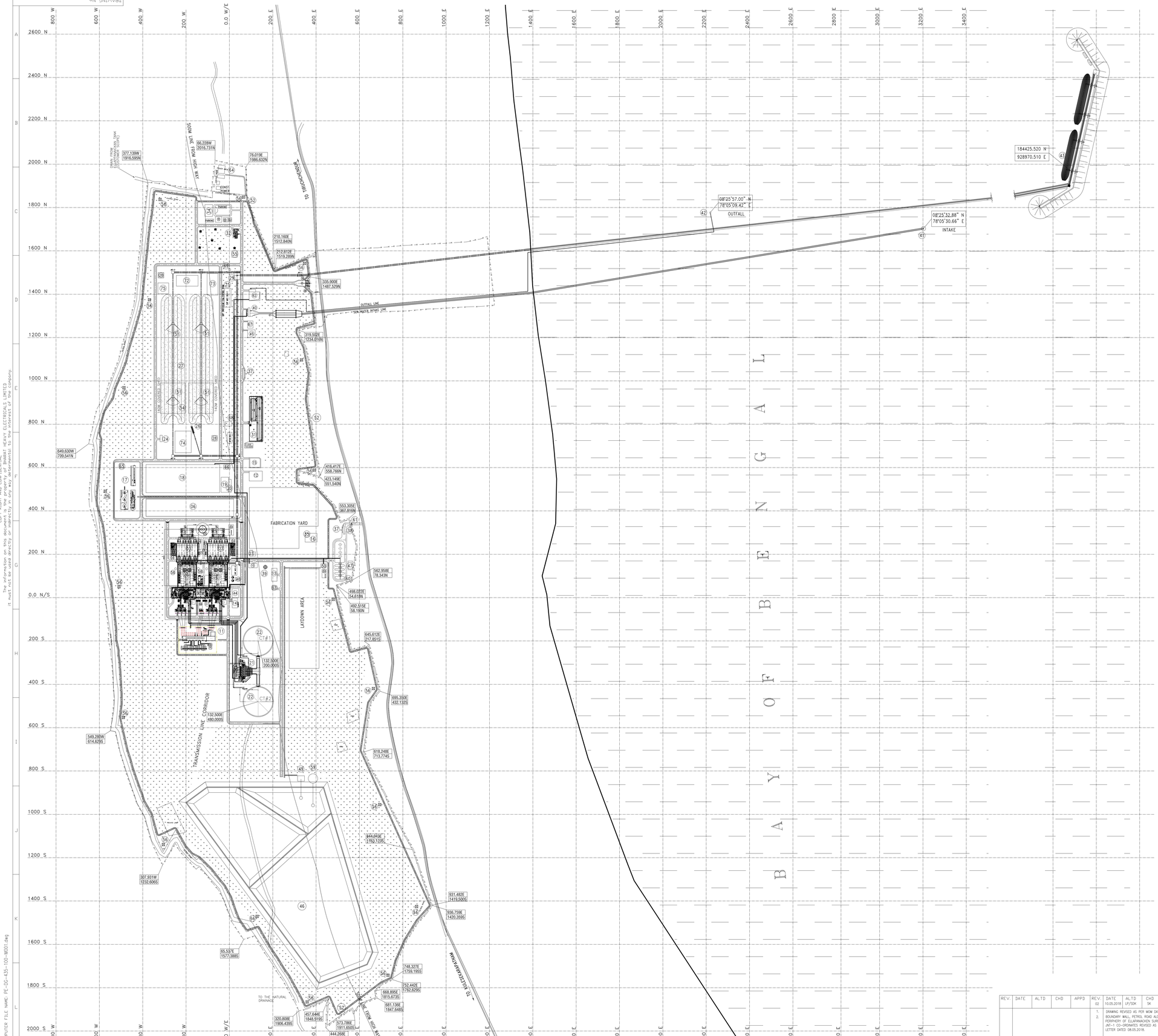
FORM–66.101

REF.DRG.NO. | SIGN & DATE | INVENTORY NO.

DRAWING No. PE-DG-435-100-M001

FIRST ANGLE PROJECTION | ALL DIMENSIONS ARE IN MM

CUSTOMER'S DRAWING No.



NOTES:–

1. ALL DIMENSIONS ARE IN MM & LEVELS IN METERS.
2. ALL COORDINATES ARE IN METRES UNLESS OTHERWISE SPECIFIED.
3. EL 0.0M CORRESPONDS TO RL(+)3.80M WHICH IS FINISHED FLOOR LEVEL (FFL) OF TG BUILDING.
4. FGL OF BOP AREA SHALL BE RL(+)3.3M.
5. LOCATION/SIZE OF BOP FACILITIES IS TENTATIVE ONLY.
6. CO-ORDINATE SYSTEM AS PER SURVEY DRAWING (REV-5 DATED 09.05.18):–

CO-ORDINATES	MCP-1	SCP-1	PLANT 0,0 AS PER SURVEY	CONSTRUCTION 0,0 (GRID A1)
EAST	363.531	412.087	0.00	(–)26.8132
NORTH	1724.658	1445.005	0.00	149.9623

LEGENDS:–

	PLANT PROPERTY LINE
	PLANT BOUNDARY WALL (COMPOUND WALL)
SHOULDER LINE PAVEMENT LINE	ROADS (DOUBLE LANE)
	ROADS (SINGLE LANE)
	GREEN BELT
	PIPE RACK
	SEA WATER
	PIPE SLEEPER

REFERENCE DRAWING:–

1. CUSTOMER PLOT No. : 00–1115112–G–001
1. SURVEY DWG. No. : SUV/2018/4115/Features & Spot level

LIST OF BUILDINGS/FACILITIES:–

Nos.	DESCRIPTION
01	POWER HOUSE BUILDING
02	STEAM GENERATOR
03	ELECTROSTATIC PRECIPITATOR
04	ESP ELECTRICAL BUILDING
05	CHIMNEY
06	FGD AREA
07	TRANSFORMER AREA
08	EMERGENCY DG BUILDING
09	ASH CONVEYING AIR COMPRESSOR HOUSE
10	AHS SEA WATER TANK AND BA SLURRY PUMP HOUSE
11	GIS SWITCH YARD AREA
12	ETP
13	WORKSHOP
14	COMPRESSOR HOUSE
15	STP
16	HYDROGEN GENERATION CUM STORAGE PLANT
17	FUEL OIL AREA
18	DESAL & DM PLANT
19	DESALINATED WATER STORAGE TANK
20	DESALINATED WATER PUMP HOUSE
21	CW PUMP HOUSE
22	NATURAL DRAFT COOLING TOWER
23	AUXILARY BOILER
24	BULDOZER SHED AND REPAIR SHOP
25	COAL HANDLING MCC & CONTROL ROOM
26	EMERGENCY RECLAIMING HOPPER
27	COAL STORAGE AREA
28	COAL RUNOFF POND
29	CRUSHER HOUSE
30	AHP MCC BUILDING
31	PERMANENT STORES
32	FIRE STATION
33	CANTEEN & DORMITORY
34	ADMIN. BUILDING
35	GAS CYLINDER SHED
36	MAIN GATE AND SECURITY OFFICE
37	WEIGH BRIDGE
38	GUARD HOUSE
39	SERVICE & POTABLE WATER OVERHEAD STORAGE TANK
40	SEA WATER INTAKE PUMP HOUSE
41	SEA WATER INTAKE
42	SEA WATER OUTFALL
43	COAL JETTY
44	SERVICE BUILDING
45	ELETRO CHLORINATION BUILDING
46	ASH POND
47	SILO UTILITY BUILDING
48	CONDENSATE STORAGE TANK
49	ASH WATER RECOVERY PUMP HOUSE
50	FLY ASH SLURRY PUMP HOUSE
51	STACKER CUM RECLAIMER
52	COMPOUND WALL
53	DISPENSERY
54	COVERED STOCK PILE
55	CANTEEN
56	WATCH TOWER
57	POST OFFICE & BANK
58	MILL REJECT SILO
59	CLARIFOCULATTOR NEAR ASH DYKE
60	FLY ASH SILO
61	MATERIAL GATE
62	SEA WATER OUTFALL STORAGE TANK AND PUMPHOUSE
63	CHEMICAL LAB
64	EXISTING 110Kv SUBSTATION
65	DIESEL BUNK
66	CPU REGENERATION
67	BRINE WATER TANK & HORIZONTAL PUMP
68	DUST SUPPRESSION PUMP HOUSE+OVERHEAD TANK
69	COMPRESSOR HOUSE FOR DE SYSTEM
70	BUFFER HOPPER TOWER
71	VACCUM PUMP HOUSE UNIT 1 & 2
72	STORAGE YARD FOR STACKER RECLAIMER–1 (SIZE 50MX100M)
73	STORAGE YARD FOR STACKER RECLAIMER–2 (SIZE 50MX100M)
74	STORAGE YARD FOR CHP (SIZE 75MX100M)
75	CHP UTILITY BUILDING

REV.	DATE	ALTD	CHD	APPD
02	10.05.2018	LP/SDK	SK	JJ
1.	DRAWING REVISED AS PER MOM DATED 27.4.18, BOUNDARY WALL, PETROL ROAD ALONG WESTERN PERIPHERY OF ELLAPPANACKEN SURPLUS ROUTE & JNT–1 CO–ORDINATES REVISED AS PER CUSTOMER LETTER DATED 08.05.2018.			

REV.	DATE	ALTD	CHD	APPD
01	13.04.18	LP SK/–	SK SK/–	JJ SK/–
1.	DRAWING REVISED AS PER CUSTOMER'S COMMENT.			

JOB NO. 435
STATUS CONTRACT
DISTRIBUTION

PROJECT	2X660 MW UDANGUDI SUPERCRITICAL TPS, STAGE–I
CUSTOMER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
CONSULTANT	DESEIN PRIVATE LIMITED, DESEIN HOUSE, NEW DELHI
	BHARAT HEAVY ELECTRICALS LTD, POWER SECTOR, PROJECT ENGINEERING MANAGEMENT, NOIDA

DEPT CODE		NAME	SIGN	DATE
M	DRN	SDK	Sd/–	19.02.2018
	DES'N	LP	Sd/–	19.02.2018
	CHD	SK	Sd/–	19.02.2018
	APPD	JJ	Sd/–	19.02.2018

TITLE: PLOT PLAN

DEPT. | SCALE 1:6000 | SIGN | DRAWING NO. PE–DG–435–100–M001 | SHEET 1 1 OF | REV. 02

SIZE–A0

COMPUTER FILE NAME: PE–DG–435–100–M001.dwg

Annexure

C1

DATE:31/08/2021

REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
I.	CRANES : -			
1	Portal Gantry Crane 500T	15	24500.00	24500.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	10940.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	53560.00
4	PORTAL CRANE, 360T	15	14070.00	13390.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	52770.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	68610.00	65280.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	31880.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	19920.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	28690.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	30130.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	25110.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	34580.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	14390.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18050.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	15940.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	20720.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10360.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	12750.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10420.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10200.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8440.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9560.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9560.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5210.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	5880.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5150.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4230.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	2910.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2180.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2180.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	680.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	370.00

Annexure

C1

DATE:31/08/2021

REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	650.00	640.00
31	FORK LIFT 3T	5	540.00	530.00

Annexure C2 DATE:31/08/202

REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
I.	CRANES: -			
1	Portal Gantry Crane 500T	15	27230.00	27230.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12160.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	59520.00
4	PORTAL CRANE, 360T	15	15630.00	14880.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	58630.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	72540.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	35420.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	22140.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	31880.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	33480.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	27900.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	38420.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	15990.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20060.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	17710.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	23020.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	11510.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14170.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11580.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11330.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9380.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	10620.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	10620.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5790.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6540.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5720.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4700.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3240.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2430.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2430.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	760.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	410.00

ANNEXURE-T I
DT: 31/08/2021

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	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 OIL)	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m^3/Hr)	1160
22	Air Blower (Flow: 20000 m^3/Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB 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

ANNEXURE-T I
DT: 31/08/2021

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1260
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4060
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360
96	Plasma Cutting Machine (With complete accessories)	310
97	JCB make DG Set 80 KVA	670
98	Diesel Generating Set 82.5 KVA	610
99	Portable Jacking Oil Pump	1080
100	Alloy Analyser	1770

ANNEXURE-T II
DT: 31/08/2021

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	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 CAPACITY WITHOUT STORAGE TANK	7070
3	-DO- , WITH STORAGE TANK	8080
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON OIL)	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON OIL)	2020
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON OIL)	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750 LPH	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET,250 KVA	1970
11	DIESEL GENERATING SET,25 KVA	560
12	VACUUM PUMP(ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010

ANNEXURE-T II
DT: 31/08/2021

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 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
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

REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/09/2021 to 31/8/2023 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/09/2019 to 31/8/2021 (BEYOND USEFUL LIFE)
30	FORK LIFT 5T	5	720.00	710.00
31	FORK LIFT 3T	5	600.00	590.00

ANNEXURE-T II
DT: 31/08/2021

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGONISTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast - 9 metres (4X400 W)	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	510
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500

ANNEXURE-T II
DT: 31/08/2021

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/09/2021 to 31/8/2023
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400
96	Plasma Cutting Machine (With complete accessories)	340
97	JCB make DG Set 80 KVA	740
98	Diesel Generating Set 82.5 KVA	680
99	Portable Jacking Oil Pump	1200
100	Alloy Analyser	1970

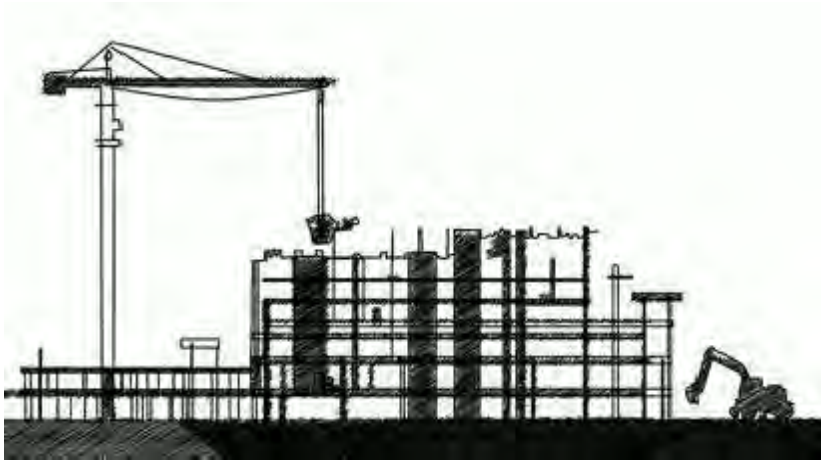
HEALTH, SAFETY and ENVIRONMENT PLAN

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)	

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?		

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	FORMAT NO: **HSEP:14-F32B** REV NO.: 00 PAGE NO. 01 OF 1
	Job Safety Analysis Format	

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

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)

Project		**Vendor**			**Package/Unit**	
Sl. No.	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 references
#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. No.	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	Percentage Shortfall attributable to contractor w.r.t. “Plan - Shortfall attributable to BHEL” for the month as per Form-14	PERFORMANCE	35		As per Part-A of Form-14	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. No.	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	Percentage of Manpower Deployed w.r.t. Plan for the month as per Form-14.	RESOURCES	7		As per Part-B2 of Form-14	Daily Log Book entry/Incident Registers/letter references
#3.02	Percentage of T&P Deployed w.r.t. Plan for the month as per Form-14.	RESOURCES	7		As per Part-B1 of Form-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. No.	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
#6.0	Performance against HSE Parameters (as per Annexure-AA)	HSE	10		Score as per Safety Performance Evaluation System, scaled down to 10	Safety Performance Evaluation System
		Total	100			

Less Deduction in Score Due to Fatal Accidents attributable to the Contractor @ 20 points/ accident	
Less Deduction in Score Due to Major Accidents (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.) attributable to the contractor @ 15 points/ accident	
Less Deduction in Score Due to Minor Accidents attributable to the contractor @ 2 points/ accident	
Less Deduction in Score Due to not Maintaining of Labour Colony (if applicable) as per BHEL HSE policy @3 points in a month on verification any day	
Final Score	

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents

Performance Score Summary for the Month	Total Score	Score Obtained
QUALITY	10	
PERFORMANCE	50	
RESOURCES	20	
SITE INFRASTRUCTURE & SERVICE	5	
SITE FINANCE	5	
HSE	10	
OTHERS (deductions if any)	0	-
TOTAL	**100**	

Note:

1) It is only indicative and shall be as per the online format issued by BHEL time to time.
2) No request will be entertained after specified date of current month w.r.t. changes requested in the scores of immediate previous month.

Monthly Safety Performance Evaluation of Contractor

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, colour 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
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

7a	Whether Scaffolding pipes made with steel or aluminium, 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 centre, 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:

- Ø M: Mandatory; O: Optional. Points other than mandatory can be excluded with appropriate justification (scope etc.) by BHEL. Score obtained in selected parameters divided by maximum possible score of selected parameters shall be multiplied by 10 for use in as per point Sl. no. # 6.0 as detailed at page 4 of Form F-15.
- Ø There shall be deduction of marks from overall score for Fatal/ Major/ Minor Accidents and for not maintaining labour colony, as detailed at page 4 of Form F-15.

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.