VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

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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 air port 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

2.1 The scope of works covers balance works of 'Civil, architectural, Mechanical, Electrical, C&I and other allied works of Natural Draught Cooling Tower, NDCT 2 & NDCT 1 of 2X660 MW Udangudi Super Critical Thermal Power Project site including supply of materials for civil **(excluding Cement, Structural steel & Reinforcement steel for civil works)** Mechanical, Electrical & C&I works required, all labour, tools & plants. **BHEL shall provide cement & reinforcement steel for civil work and structural steel for structural works only for incorporation in the permanent works as free supply.**

2.2 The subject tender consists of 2 packages – Package 1 & 2 and the scope covered in each package is mentioned below.

Package 1: NDCT Unit-2

Package 2: NDCT Unit-1

2.3 The scope of work includes supply, construction, erection and commissioning excluding engineering including supply of complete bought out materials, hot water distribution system up to battery limit, cold water basin and outlet channels up to battery limit, sludge pit, stair case from ground level to water distribution level & top of CT and all other equipment and accessories as mentioned herein after.

"**Note:** The NDCT contractor is required to own the owner approved thermal design and GA drawing such that the responsibility of cooling tower performance shall remain with the bidder in all manners. Any questions or clarifications regarding thermal design may be sought by the NDCT contractor to satisfy himself of its veracity. The tentative quantities for thermo- hydraulic components (Fills and distribution system) listed for S. nos. 24 and 25 of price bid as per BHEL's design indicated in Annexure -1 of section IA and the same is calculated based on the area inside the NDCT at respective levels shown in the GA drawing. If found necessary, "the NDCT contractor may suggest modifications to

the thermos-hydraulic components (listed at S. Nos. 24 and 25 in the price bid) with technical reasoning/ analysis/ calculations to justify the measures to improve the thermal performance of the NDCT which will be guaranteed by the bidder" and such the responsibility of cooling tower performance shall remain with the bidder in all manners.

The NDCT contractor is required to estimate the "lump sum" cost of the thermo-hydraulic components based on his modified arrangement (if any) or as per Annexure-A. This lump sum rate arrived towards the item no. 24 & 25 are firm and NDCT Contractor cannot claim any extra payment in case of any increase or decrease of quantity of components against these two items.

While suggesting justifiable reasons for changes as above the NDCT contractor shall abide by the following constraints. Also, the NDCT contractor shall guarantee the NDCT performance considering the constraints that are inviolable.

1) Civil design of NDCT shell, shell profile and shell dimensions at various heights
2) Foundation of NDCT
3) Air inlet height
4) Basin & internal structure column- beam grid dimensions and elevations
5) Water distribution ducts
6) Layout of CW hot water inlet header to cooling tower
7) Height and diameter of NDCT

Once the changes with justifiable reasons/ analyses / calculations provided by the NDCT contractor are accepted by BHEL/ consultant and duly incorporated, the NDCT contractor will vet the final thermal design & GA of NDCT and furnish the performance guarantee. The thermal design and GA vetted by the NDCT contractor shall be furnished to customer for approval. The NDCT contractor shall vet the thermal design as above within two weeks of award of contract, for further approval by BHEL/ customer.

The GA drawing already approved by owner may be required to be approved again depending on changes to the thermos- hydraulic components, if any and the NDCT contractor shall furnish the relevant modifications agreed to by BHEL/ customer to these items (only) keeping the other dimensions frozen for further approval from BHEL/ customer.

The complete design and engineering of NDCT shall remain in the scope of BHEL's consultant.

All mechanical/ electrical/ C&I drawings prepared by BHEL consultant will be reviewed by NDCT contractor before submission to customer for approval.

NDCT Contractor who quotes as per BHEL thermal design, should submit the Guarantee Schedule in the Technical Specification with reference no. SPEC. NO.: PE-TS-435-165-N011, SECTION: III, REV.NO.0, SHEET 1 OF 1.

NDCT Contractor is allowed to Modify the thermo-hydraulic components as per Clause no. 1.01 of Section-I of Technical Specification & Clause 2.3 of Scope of works, Technical Conditions of Contract, only when the NDCT Contractor proposes for the improvement of the 'Guaranteed Cold water temperature'. If NDCT Contractor proposes to modify the Thermal Design, he should submit the Guarantee Schedule in the Technical Specification with reference no. SPEC. NO.: PE-TS-435-165-N011, SECTION: III, REV. NO. 01, SHEET 1 OF 1. Any calculation submitted by NDCT Contractor along with the offer supporting the reduction of cold water temperature will be treated as reference only. The NDCT Contractor shall submit the calculations to BHEL Engineering Department during detailed Engineering stage only for review and approval.

The calculations will be approved by Engineering department of BHEL during detailed Engineering and shall be binding on the NDCT Contractor.

In case, if BHEL is not satisfied with the calculation and NDCT Contractor has failed to support their calculation for the proposed guaranteed temperature, then the NDCT Contractor is bound to accept the BHEL's thermal calculations as per tender conditions.

If NDCT Contractor does not meet the Guaranteed Cold Water Temperature offered by the NDCT Contractor as per the SPEC. NO.: PE-TS-435-165-N011, SECTION: III, REV. NO. 00, SHEET 1 OF 1 (or) SPEC. NO.: PE-TS-435-165-N011, SECTION: III, REV. NO. 01, SHEET 1 OF 1, as applicable, then LD shall be levied as per Cl. No. 11 of Technical Specification.

It is not the intent to list all details herein, scope of supply listed in brief as follows:

I. MECHANICAL:

a. Incoming hot water piping, including vertical run, supported on cooling tower, motorized butterfly valves on hot water risers. Terminal point for hot water pipe shall be as per enclosed NDCT GA drawing. Welding at terminal point, NDT as per the requirement shall be in bidder's scope. Bidder shall also supply a pressure gauge & temperature gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope.

b. Inlet louvers, tower fills & fill support, drift eliminators including all supporting structures fastening arrangements & accessories.

c. Screens along with guides embedded in concrete shall be provided at the outlet of cold water channel.

d. Sluice gate with mechanical jack arrangement and guides in each of the cold water outlet channel connection from the cold water basin.

e. Manually operated chain pulley blocks together with the monorails and supporting frames for the handling of screen and gates.

f. Knife-edge gate valve/ sluice valve in each de-sludge connection and also de-sludge piping up to the disposal point at local storm water drain channels.

g. Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall.

h. Water distribution system consisting of pipes, hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply.

i. Two (2) nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping support, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work at a distance of 100M from sludge pit.

j. Counter flange, bolts, nuts & gasket for all piping connections in the scope of bidders and also at terminals.

II. ELECTRICALS:

a. Complete electrical equipment s per specification/ details indicated in technical specification (Section – II B) shall be in bidder's scope.

b. The scope of power & control cables & special cables shall be as per section II B (electrical).

c. Base plate, foundation plate, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipment & accessories.

III. C & I

a. Removable type pitot tube at each hot water inlet- piping header to measure the flow (during performance guarantee test only). The pitot tube shall be left with customer after the completion of the test.

b. One number pressure gauge and one number temperature gauge at hot water pipe header at T.P.

c. One number psychrometer

d. Local control panel for sump/ sludge pumps (submersible type)

e. Level switches for sump/ tank level high/normal/low/very low interlocks

f. Actuator for motorized BFV at inlet of hot water pipes

IV. CIVIL:

a. Complete balance civil works includes excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form (jump form), laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/ duct, laying and testing hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of the hyperboloid shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channels, etc.

   The scope of this work shall consist of, but not limited to, the construction of reinforced concrete double curvature hyperboloid shell, ring beams, foundations (including blasting/ piling (as applicable)), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated piping work, cold water channel with sluice gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution duct, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs. Sludge pit for each basin section, all other staircases/ ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts including fabrication of, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure, supply & application of painting at site, etc.

b. The civil construction of the cooling tower shall be in accordance with following technical specifications and the data specification sheets enclosed with this specification –

   i. Earthwork in excavation and backfilling
   ii. Cement concrete (plain & reinforced)
   iii. Masonry and allied work
   iv. Finish to masonry and concrete
   v. Metal doors, windows, ventilators, louvers, etc.
   vi. Roof water proofing, insulation and allied work (as applicable)
   vii. Painting, white washing, polishing, etc (as applicable)
   viii. Sheet work in roof and siding (as applicable)

c. The technical specifications are of general nature. Only those portions of the specifications which relate to the various works required to be done as per technical requirements as specified in the tender document need to be considered.

d. The cooling tower shell, ring beams, diagonal columns at base supporting ring beams below shell, cold water basin, fill support frame work, hot water distribution duct, cold water channel, louver, etc. shall be cast in-situ RCC construction.

V. The following are also included in bidder's scope:

a. One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers.

b. Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including as built drawing etc. as specified & as necessary.

c. Supply of first fill of lubricants for all equipment under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant.

d. Supply of commissioning spares as on when required basis.

e. Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipment, material to site, local clearance, storage at site etc & supply of all labour including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & Ps required for execution of complete job including erection & civil works.

VI. Equipment & services to be provided by the purchaser:

a. Supply & erection of incoming hot water piping up to bidder's terminal point
b. Supply & erection of sludge discharge piping beyond the bidder's terminal point, as applicable
c. Cold water outlet channels for cooling tower beyond the bidder's terminal point.
d. For electrical, civil and C & I work refer section C2/ D2, C3 & C4 respectively enclosed herein.

Note: The above provided list is indicative only for the bidder's guideline. For further, detailed scope of work is mentioned in relevant clause no. of technical specification .

Any other structure / foundation not mentioned above, but required for completion of the scope of work 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.

Cement & Reinforcement steel for civil works, Structural steel for structural works shall be provided by BHEL free of cost for incorporating them to the permanent works only.

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 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 on the rates of items of work. Works shall only be carried out with approved structural fabrication drawings.

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 rendered for the different items under bill of quantities.

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

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.

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

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

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.

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

2.12 . For further detailed scope of work, refer relevant chapters in the technical specification.

2.13 Bidder shall visit site for better clarification against present status of 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 – I, to this chapter shall be referred.

2.14 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:

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

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

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

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

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

2.20 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.

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

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.

ANNEXURE- I

2X660MW USTPP
NDCT-1&2 BALANCE WORKS AS ON 08.02.2022

NDCT-2

Sl No	Activity	Present status/Remarks
1	Excavation	107084/115000 cum completed
2	Ring Raft	Completed.
3	Pedestal	1st , 2nd, 3rd lift yet to commence
4	Grillage footing	Grillage footing 12/485 nos completed.
5	Grillage Column below ground level	Yet to commence
4	Backfilling	Yet to commence
6	Grillage Column above ground level	Work yet to start
7	Tie beam & Basin floor	Work yet to start
8	Racker column	Work yet to start
9	Tower crane erection	Work yet to start
10	Ring beam	Work yet to start
11	Shell	Work yet to start

NDCT-1

Sl No	Activity	Present status/Remarks
1	Excavation	Completed
2	Ring Raft	Completed.
3	Pedestal	1st completed. 2nd, 3rd lift yet to commence
4	Grillage footing	Grillage footing 372/485 nos completed.
5	Grillage Column below ground level	First Lift 358/768 nos completed, Second lift 39/768 nos completed
4	Backfilling	9763/120000 Cum completed
6	Grillage Column above ground level	Work yet to start
7	Tie beam & Basin floor	Work yet to start
8	Racker column	Work yet to start
9	Tower crane erection	Work yet to start
10	Ring beam	Work yet to start
11	Shell	Work yet to start

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	
3.1.1.0	**ESTABLISHMENT**			
3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		As provided by TANGEDCO
B	Open space for storage	Yes		As provide by TANGEDCO
C	Construction of bidder's office, canteen and storage building including supply of materials and other services		Yes	At bidder's own cost
D	Bidder's all office equipment's, office / store / canteen consumables		Yes	At bidder's own cost
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	At bidder's own cost
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	At bidder's own cost
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	At bidder's own cost
3.1.1.2	FOR LIVING PURPOSES OF THE BIDDER			
A	Open space		Yes	At bidder's own cost
B	Living accommodation		Yes	At bidder's own cost
3.1.2.0	**ELECTRICITY**			
3.1.2.1	Electricity For construction purposes			

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.1.2.1.1	Single point source	Yes		Chargeable basis as provided by TANGEDCO
3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	At bidder's own cost
3.1.2.2	Electricity for the office, stores, canteen etc of the bidder which include:		Yes	At bidder's own cost
3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	At bidder's own cost
3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	At bidder's own cost
3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	At bidder's own cost
3.1.2.2.4	Living facilities for office use including charges		Yes	At bidder's own cost
3.1.2.2.5	Demobilization of the facilities after completion of works		Yes	At bidder's own cost
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	At bidder's own cost
3.1.3.0	**WATER SUPPLY**			
3.1.3.1	For construction purposes:		**Yes**	At bidder's own cost
3.1.3.1.1	Making the water available at single point		**Yes**	At bidder's own cost
3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At bidder's own cost
3.1.3.2	Water supply for bidder's office, stores, canteen etc.		**Yes**	At bidder's own cost

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.1.3.2.1	Making the water available at single point		**Yes**	At bidder's own cost
3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At bidder's own cost
3.1.4.0	**LIGHTING**			At bidder's own cost
3.1.4.1	For construction work (supply of all the necessary materials) At office storage area At the preassembly area At the construction site / area		Yes	At bidder's own cost
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	At bidder's own cost
3.1.5.0	**COMMUNICATION FACILITIES for site operations of the bidder**	**-**		
3.1.5.1	Telephone, Fax, internet, intranet, email etc		Yes	At bidder's own cost

Sl.No	Description PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
	CONSTRUCTION FACILITIES			
3.2.1.0	**Engineering works for construction**			
3.2.1.1	Providing the construction drawings for all the equipment covered under this scope	Yes		In a progressive manner
3.2.1.2	Drawings for construction methods		Yes	In consultation with BHEL
3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small bore pipes	Yes	Yes	”

Sl.No	Description PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
3.2.1.4	Shipping lists etc for reference and planning the activities	Yes	Yes	”
3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation with BHEL, As per requirement of BHEL targets
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	
3.2.1.7	Weekly construction schedules based on Sl No 3.2.1.5		Yes	
3.2.1.8	Daily construction / work plan based on Sl No 3. 2.1.7		Yes	For daily monitoring meeting at site
3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	At bidder's own cost
3.2.1.10	Preparation of preassembly bay		Yes	At bidder's own cost
3.2.1.11	Laying of racks for gantry crane if provided by BHEL or brought by the contractor / bidder himself			**Not applicable**

3.3 **OPEN SPACE:**

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

3.4 **ELECTRICITY:**

3.4.1 Construction power will be provided to the contractor at one single point within the plant area by BHEL on chargeable basis as per the as per the prevailing rates of TANGEDCO as provided by TANGEDCO.

3.4.2 The present LT tariff VI rate of TANGEDCO is

- Consumption charges at Rs.12.00 per unit
- Fixed MD (Maximum demand) charges as applicable per month
- Electricity Tax on total amount

The TANGEDCO tariff and tax may vary from time to time. 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.

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

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

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.

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.

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

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.

3.5 **WATER:**

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.

3.6 **MATERIAL SUPPLY:**

Supply / providing of all materials required (excluding BHEL supplied materials i.e. cement, reinforcement steel, & structural steel) for the work are in the scope of the contractor.

Supply / providing aggregate, Crushed Stone sand/ M-sand and all other materials required for the work are in the scope of the contractor. **BHEL shall provide Cement, reinforcement steel for civil works, structural steel for structural works only for incorporation in the permanent work AS FREE SUPPLY**.

- Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum 100MT each 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.
- The steel material will be issued from BHEL stores, within the plant premises. Collection and transporting to the place of work is in contractor's scope without any extra cost to BHEL. The steel will be issued to the agency in standard lengths. In some instances, for 8mm, 10mm &12mm dia reinforcement steel will be supplied in coil form. No extra claims will be entertained against issue of Non-standard lengths of steel and de coiling of 8mm, 10mm &12mm dia. steel.
- Bidder to note that steel materials required for Embedment's, inserts, 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.
- 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.

- 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. 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.

3.7 **CONSUMABLE**

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

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.

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.

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.

3.10 **BLASTING**

If required, at any stage of construction, blasting is to carried out by the bidder, 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 TamilNadu State.

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.

Well point dewatering system shall be installed at site for foundation works of NDCT. Required survey of area regarding type and suitability, is in the scope of contractor. Payment for dewatering of ground water will be made as per item no. 102. Measurement of earthwork shall be taken for the purpose of payment. Schedule for mobilization of well point dewatering system shall be finalized at site within 15 days of issuance of LOI and mobilized at site on or before date mutually agreed between contractor and BHEL site in-charge. Arrangement of facility for drainage of water, thus pumped out is in the scope of bidder.

3.12 **BID DRAWINGS**

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

VOLUME-IA PART – I CHAPTER – IV
T&P'S TO BE DEPLOYED BY CONTRACTOR

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

4.2 The contractor is required to arrange the following tentative Major T&Ps and minimum other T&Ps for the satisfactory completion of the work for **each** package.

Sr No	Major T&P	Mobilizing time from the date of start of work
B1	2 No. Pocklain CK90 excavator	1 no. within 20 days, and balance as per site requirement.
B2	2 nos. automatic concrete batching plant with printing facility (each of minimum 30 Cum/Hr capacity) – and DG backup with minimum 2 Nos of silo (100MT each) per batching plant	1 no to be commissioned Within 30 days and 2nd no batching plant shall be commissioned as per the discussion and requirement by BHEL.
B3	Suitable capacity tyre mounted crane – 1 nos	As per site requirement.
B4	Tower crane of suitable capacity for height of approx. 200m and bottom radius 75m along with operator and necessary spares – 1 nos for each NDCT	1nos within 45 days from commencement of work at site.
B4A	Scissor lift of suitable capacity for erection of fill structures.	As per site requirement.
B5	Jump form for shell concreting along with all accessories e.g. required no. of jacks (including spare jacks), power packs, ropes, safety accessories, etc. all complete required for smooth operation of jump form – 1 set for each NDCT	As per site requirement. Date for mobilization of jump-form shall be fixed at site with mutual agreement between BHEL site in-charge and contractor.
B6	Suitable passenger lift cabin for carrying (min 8 passengers) along with all accessories – 1nos for each NDCT	To be arranged at site before completion of work of shell upto existing ground level.

B7	1 nos. concrete pump(60 cum/ hr min capacity & lift 90M)/ concrete boom placer of 36m boom length (as applicable).	1 No within 30 days
B8	4 nos. transit mixer (5/6 M3 capacity) including standby 1 no.	As per site requirement.
B9	8 nos of Steel shuttering sets for raker column and required staging material. Sufficient rings shall be mobilized to support the columns after de-shuttering so that shuttering plates will be used for subsequent column activities.	As per site requirement
Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
B10	2 No. JCB	as per site requirement.
B11	2 nos. dumper (Min 15 cum each)	1 nos. Within 20 days, Balance as per site requirement.
B12	2 nos. diesel Mixer machine of 0.5 cum capacity	As per site requirement.
B13	2 nos. self-priming dewatering pump 5 HP (diesel)	Within 20 days.
B14	2 nos. self-priming dewatering pump 5 HP (electric)	Within 30 days
B15	4 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	Within 60 days.
B16	4 nos. reinforcement bending machine	2 nos. within 20 days, 2 nos. within 45 days
B17	1 no. Vibromax (earth compactor)	As per site requirement.
B18	4 nos. reinforcement cutting machine	2 nos. within 20 days, 2 nos. within 45 days
B19	8 sets of raker column steel shuttering – for each NDCT	As per site requirement.

B20	MS scaffolding pipe / ACROW SPAN	As per site requirement.
B21	Welding machine (submerged arc) – 5 nos	As per site requirement.
B22	1 nos. power driven earth rammer (Roller Type 1/2 T)	As per site requirement.
B23	Civil laboratory equipment's as per list in Sl 4.4.2 with temporary building one AC lab size 4.5mtrx6mtr and 1 non AC lab 4.5 mtrx4.5 mtr.	Within 55 days.
B24	Optical/laser plumb – 3 nos for each NDCT	Before start of shell concreting
B25	2 no total station with adequate arrangement for Surveyors.	1 no. Within 15 days. and balance progressively as per requirement
B26	2 no theodolite 1 second accuracy	1 no. within 15 days. and balance progressively as per requirement
B27	3 no's auto level & staff + 2 no's as required	2 nos. Within 15 days. And balance as per requirement.
B28	150 no's concrete cube moulds	150 nos within 30 days
B29	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/shuttering etc. within site	As per site requirement.
B30	2 nos. drinking water tank – 5000 lit.	1 nos. Within 30 days. Balance as per site requirement.
B31	2 nos. mobile toilet blocks for labour use.	1 no's within 30 days balance within 75 days.
B32	1 nos. truck mounted 125 KVA DG set	1 no. within 30 days
B33	Construction power cable	As per site requirement.
B34	Construction water Pipeline	As per site requirement.
B35	1 Nos ultra-sonography testing machine	As per site requirement.

B36	Concrete vibrator with adequate needle (Minimum 15 Nos diesel/electric)	6Nos (at least 3nos. diesel driven) within 45 Days. Balance as per site requirement.
B37	Portable fire extinguishers as below: Soda acid – 10 sets. Dry chemical powder – 10 sets CO2 – 10 sets. Water & sand bucket (4 buckets in one stand) – 10 sets. Fire hose with nozzle (50 M length) – 5 sets.	25% of each Items within 30 days and balance progressively within 90 days.
B38	1 no. compression testing machine (200 T cap)	1 Nos. within 30 days
B39	1 Nos. Multi stage high lift water pump (for curing) (lifting height 210 metres). One shall be working and other shall be stand by.	Before of start of NDCT shell
B40	Power winch -2.5 T – 3 nos. for Internal / External Finishing as applicable	As per site requirement.
B41	Walky Talky – 6 Nos	As per site requirement.

Note:

1. T&P shown in the above mentioned list and the mobilization schedule is tentative requirement considering parallel working. However, mobilization schedule modification as well as no. of T&Ps as mutually agreed at site for major T&Ps, have to be adhered to. Numbers/ time of requirement will be reviewed time to time at site and contractor will provide required T&P/ equipment's to ensure completion of entire work within schedule/target date of completion without any additional financial implication to BHEL. Vendor shall give advance intimation & certification regarding capacity etc. prior to dispatch of heavy equipment's. Also on completion of the respective activity, demobilization of T&P in total or in part can be done with the due approval of engineer in charge. Retaining of the T&P's during the contract period will be mutually agreed in line with construction requirement.
2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.
3. In the event of contractor failing to arrange the required tools, plants, machineries, equipment, material or non-availability of the same owing to breakdown, BHEL will make alternative arrangement at the risk and cost of the contractor.

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

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

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

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. 6.1.1 of this specification may please be referred for date of start of work.

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

4.4. The Bidder shall establish laboratory arrangements or get the materials tested through approved national accredited laboratory and submit the reports for approval of BHEL/ Customer

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.

4.4.2 Field and laboratory testing procedures for materials follow Indian standard specifications with necessary equipment's like as given in table below:

CONCRETE TESTING EQUIPMENT				
SL NO.	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF 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,	IS 383

			75 micron, Pan and cover	
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	

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.

4.6. The area and infrastructure development of the work area are to be carried out by the customer. However, in construction projects of this magnitude all the areas / approaches might 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.

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

4.8. 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 assistance 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.

VOLUME-IA PART – I CHAPTER – V

T&Ps provided by BHEL

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

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

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

6.1 **TIME SCHEDULE**

6.1.1 The date of commencement of work at site shall be mutually agreed date between bidder and BHEL Site in charge.

6.1.2 The entire works of the Cooling Towers as detailed in the Tender Specification shall be completed as per below schedule against each package from the date of commencement of work for respective packages,

6.1.2.1 Package-1

6.1.2.1.1 Readiness of NDCT-2 for unit synchronization: 20 months

6.1.2.1.2 Final bill & contract closure: 24 months

6.1.2.2 Package-2

6.1.2.2.1 Readiness of NDCT-1 for unit synchronization: 18 months

6.1.2.2.2 Final bill & contract closure: 22 months

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.

6.1.4 The contractor is required to refer Form 15 in Volume 1- BOOK 2 for all the instructions to be taken immediately after receipt of LOI.

6.2 **MOBILISATION**

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

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.

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

6.4 In case the project is to be advanced, the civil / other 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.

6.5 **SUBMISSION OF L3 SCHEDULE**

The contractor shall submit and a detailed area/structure wise L3 schedule within 15 days in consultation with BHEL based on the tentative schedule provided as per the clause 6.7. 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, fabrication & erection 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.

6.6 **GUARANTEE PERIOD**

The Guarantee period shall be as mentioned below:

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

or

6.6.2 18 calendar months from the date of completion of supplies

or

6.6.3 12 calendar months from the date of satisfactory commissioning of the package, **whichever is later**.

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

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

6.7 CIVIL WORKS SCHEDULE FOR 2X660MW UDANGUDI SUPER CRITICAL POWER PROJECT

The schedule for civil works is as given below.

TENTATIVE PLAN FOR Package 1 - NDCT 2 OF UDANGUDI		
Sl.No	**Area of work**	**Completion from the date of commencement of civil work**
1	Pedestals & Internal footing & internal Column below ground level	Progressively by 5th month
2	Basin floor & basin wall	Progressively by 6th month
3	Tower crane erection	Progressively by 5th Month
4	Raker column	Progressively by 8th month
5	Ring beam	Progressively by 10th month
6	RCC shell	Progressively up to 15th month
7	Grillage structure- Above ground level	Progressively by 16th month
8	RCC for Cold water channel	Progressively by 16th month
9	RCC hot water duct	Progressively by 16th month
10	Completion of precast beams	Progressively by 16th month
11	Completion of fills	Progressively by 19th month
12	Completion of hot water inlet pipes	Progressively by 19th month
13	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 20th month
14	Readiness for unit sync	Progressively by 20th month
15	Inspection, testing, entire finishing and handing over	Progressively by 22nd month
16	Final bill submission for entire works (for both the NDCTs)	24th month

TENTATIVE PLAN FOR Package 2- NDCT 1 OF UDANGUDI		
Sl.No	**Area of work**	**Completion from the date of commencement of civil work**
1	Pedestals & Internal footing & internal Column below ground level	Progressively by 2nd month
2	Basin floor & Basin wall	Progressively by 4th month
3	Tower crane erection	Progressively by 4th Month
4	Raker column	Progressively by 6th Month
5	Ring beam	Progressively by 9th month
6	RCC shell	Progressively up to 13th month
7	Grillage structure above ground level	Progressively by 14th month
8	RCC for Cold water channel	Progressively by 15th month
9	RCC hot water duct	Progressively by 15th month
10	Completion of precast beams	Progressively by 15th month
11	Completion of fills	Progressively by 17th month
12	Completion of hot water inlet pipes	Progressively by 17th month
13	All electrical works, staircase, internal painting, cage ladder erection	Progressively by 18th month
14	Readiness for unit sync	Progressively by 18th month
15	Inspection, testing, entire finishing and handing over	Progressively by 20th month
16	Final bill submission for entire works (for both the NDCTs)	22nd month

6.8 INTERMIDIATE MILESTONE

S No	**Description**	**Completion month from the contractual date of start of the work**	**Intermediate Milestone**
Package-1 - NDCT 2			
1	Completion of Raker column	8th Month	M1
2	Completion of RCC shell	15th month	M2
Package-2 - NDCT 1			
1	Completion of Raker column	6th Month	M1
2	Completion of RCC shell	13th month	M2

6.9 The above schedule is tentative.

6.10 The above completion schedule against each structure/ building is for entire completion and handing over the structure/ Building to BHEL. The pedestals, floors, and any structure, required for the start of structural erection work/ civil work/ mechanical equipment erection work, shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement.

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

6.12 In case the activities in the schedule are to be advanced, the related civil/ structural/ other 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.

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

6.14 The other major activities as mentioned in the work schedule given in clause No.6.7 are to be indicated in detailed schedule which will be prepared by the bidder:

6.15 RECORDS TO BE MAINTAINED AT SITE:

6.15.1 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.

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

- ✓ Hindrance Register.
- ✓ Site Order Book.

- ✓ Test Check of measurements.
- ✓ Cement Supply and Consumption Daily Register
- ✓ Records of Test reports of Field tests.
- ✓ Records of manufacture's test certificates.
- ✓ Records of disposal of scraps generated during and after the work completion.

VOLUME-IA PART – I CHAPTER-VII

TERMS OF PAYMENT

7.0 TERMS OF PAYMENT

7.1 Secured Advance

Not applicable

7.2 Advance for Mobilization

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

7.2.2 2% of contract value after receipt of initial security deposit and additional security deposit as applicable (if any), consortium SD as per relevant clauses in the GCC/TCC along with unqualified acceptance of detailed letter of intent.

7.2.3 1.5% of the contract value on completion of site mobilization of machinery & T&Ps as given below and on certification by site in-charge for compliance provided clause 7.2.2 is also complied:

Package – 1:

1. Pocklain CK90 excavator – 1 no
2. Batching plant – 30 cum/hr capacity - 1 no. batching plant with 2 nos silo (100MT each)
3. Transit mixers – 2 nos
4. Concrete pumps – 1 no / this can be replaced with concrete boom placer of 36m boom length as per the requirement at site with the approval of BHEL site in charge

Package – 2:

1. Pocklain CK90 excavator – 1 no
2. Batching plant – 30 cum/hr capacity– 1 no. batching plant with 2 nos silo (100MT each)
3. Transit mixers – 2 nos
4. Concrete pumps – 1 no / this can be replaced with concrete boom placer of 36m boom length as per the requirement at site with the approval of BHEL site in charge

7.2.4 1.5% of contract value on completion of site mobilization of machinery and T&Ps as given below in addition to the above, and on certification by site in-charge for compliance:

Package – 1:

1. Jump form with all accessories – 1 no
2. Mobilization of tower crane of suitable capacity – 1 no
3. Batching plant – 30 cum/hr capacity– 1 no. batching plant with 2 nos silo (100MT each)

Package – 2:

1. Jump form with all accessories – 1 no
2. Mobilization of tower crane of suitable capacity – 1 no
3. Batching plant – 30 cum/hr capacity– 1 no. batching plant with 2 nos silo (100MT each)

7.3 **Interim Payment**

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.

7.3.2. 90% item rate shall be released after completion of works certification by Engineer in charge.

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.

7.3.4. Further, 5% can only be released after successful completion of commissioning and handing over of cooling tower.

7.3.5. All admissible deductions shall be made from the above 90% value

7.3.6. Retention amount shall be as per GCC.

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 and proof of payment shall be submitted to BHEL. The above royalty/ seigniorage charges shall be inclusive within the quoted rate. No extra payment shall be applicable to the vendor.

7.5 **METHOD OF MEASUREMENT**

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

7.6 No claim what so ever may be, will be entertained under this contract, after duly signing the final bill along with measurement books and accepted by BHEL.

ACCOUNTING OF MATERIALS ISSUE

8.0 ACCOUNTING OF MATERIALS ISSUE

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

8.1 ISSUE OF CEMENT

8.1.1 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 cement silo of 100MT capacity, to be installed by the bidder nearer to their batching plants at their own cost. This is only minimum requirement and the No of cement silos shall be increased based on the site requirement. Unloading arrangements shall be provided by the bidder.

8.1.2 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 the property of the contractor and the same shall be disposed by the contractor as per statutory regulation prevailing in the project. The empty cement bags duly accounted for against issue shall be the property of the contractor and the same shall be disposed by the contractor as per statutory regulation prevailing in the project.

8.1.3 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.

8.1.4 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

8.1.5 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.

8.1.6 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 (sand, 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.

8.1.7 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).

SLNO	ISSUE OF MATERIALS	MAX. QTY IN CONTRACTOR'S STORE
1.	Cement	Requirement of one month

8.1.8 RETURN OF CEMENT

i. 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.

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

iii. Sweep cement will not be taken back by BHEL.

8.1.9 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.

For item of works, where volume mix is permitted in writing by the 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).

8.1.9.1 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	Wastage being Limited to one and half percent (+1.5%) of aforesaid theoretical consumption towards allowable wastage.	Free
C-3	Wastage beyond one and half percent (+1.5%) of above (C-1).	Penal rate

8.2 ISSUE OF STEEL

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

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

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

IS: 808-1964 Beams, Channels and Angles

IS: 1730-1961 Plates, Sheets and Strips/Flats
IS: 1732-1971 Rounds including deformed high yield strength bars.

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

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.

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.

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.

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

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

Bidders to ensure that no lamination materials are taken over by them from BHEL.

Fabrication wastage, if any due to above, shall not be compensated by BHEL.

Bidder to note that steel materials required for Embedment's, inserts, MS Grating, Galvanised Grating, GI Handrail, Stainless Steel Handrail, SS Sheets for Bunker liner, 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.

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

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

8.3.1 SCRAP & SERVICEABLE MATERAILS:

1. All Structural steel of length above 2 M except M.S. Plate shall be considered as serviceable materials provided the materials is in good and acceptable condition. Structural steel in length less than 2 M shall be treated as scrap.
2. Plates having both sides greater than 1 Meter 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. Meter shall be considered as serviceable.
3. All pipes measuring 2 M and above in length shall be treated as serviceable materials provided they are in good and acceptable condition. Pipe in less than 2 M length shall be treated as scrap.

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

8.4 STEEL CONSUMPTION AND WASTAGE

8.4.1 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.

Surplus = UN tampered, unused, uncut quantity of steel and Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 1.8.3.1 above)" returned by the contractor to BHEL store along with relevant documents.

ii) Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

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

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

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

A) CONSUMPTION: -

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

i) Actual consumption = Issue – Surplus.

ii) Surplus = UN tampered, unused, uncut quantity of steel and Serviceable materials as stipulated under clause "Scrap and Serviceable Materials (Refer Clause 8.3.1 above)" returned by the contractor to BHEL store along with relevant documents.

ii) Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

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

S.No	CONSUMPTION OF STRUCTURAL STEEL (ROLLED SECTION, PLATES)	BASIS OF ISSUE
S-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
S-2	Wastage limited to plus Four percent (+4%) of the aforesaid theoreticalconsumption (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

8.4.3 RECONCILIATION OF MATERIALS

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

At the time of submission of bills, the contractor shall properly account for the material issued to him as specified herein to the satisfaction of BHEL certifying that the balance material are available in contractor's custody at site. Report of issue of material from BHEL store should be prepared by the contractor on monthly basis and should get it certified by BHEL store in-charge, the same will form a part of reconciliation statement.

At the time of submission of bills by the contractor, if it is noticed by BHEL that the wastage is high and calls recovery at the penal rate, then, BHEL will proceed for recovery for the excess wastage as per penal recovery rates as specified.

The reference drawings for actual material consumption to be used for the purpose of reconciliation shall be drawings prepared by the BHEL and drawings approved by BHEL for fabrication works and such other drawings approved by BHEL. This shall also include the bar bending schedule prepared by the contractor and approve by BHEL.

8.4.4 RECOVERY OF MATERIAL

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

8.4.5 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 – I CHAPTER - IX
PROGRESS OF WORK

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

9.0 PROGRESS AND MONITORING OF WORK

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

9.2 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.

9.3 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.

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

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.

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

9.6 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.

9.7 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.

9.8 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.

9.9 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 -X

BILL OF QUANTITY

10.1. Bidders shall only quote "Total amount" in the format given in of the price bid. Any other elsewhere in the price bid shall be treated as Null and Void.

10.2. The above mentioned "Total amount" is for the entire Bill of Quantity (BOQ) given in Part-C of the Price bid.

10.3. BHEL has the pre-fixed the weightages for the amount of individual items of Bill of Quantity with respect to the "Total amount" in Part-C.

10.4. Based on the pre-fixed weightages, the amount for the individual items of the Bill of Quantity shall be arrived at. This amount shall be rounded off to the nearest rupee.

10.5. Based on the quantities of individual item and the amount arrived in SI NO. 10.4 above, unit rate of individual items shall be derived. This unit rate shall be rounded off to four decimal places.

10.6. Bidder to note that this is an item rate contract. Payment shall be made for the actual quantities of work executed at the unit rate arrived at as per SI NO. 10.5 above.

10.7. The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). The derived item rates (as mentioned above) 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 (-) 15% of awarded contract value.

VOLUME-IA PART –I CHAPTER -XI

MATERIAL HANDLING

11.1 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.

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

11.3 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.

11.4 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. Requirement of such cement store shall be mutually finalized between contractor and BHEL site in-charge before commencement of work at site and after issuance of LOI.

11.5 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.

11.6 Clotting of cement and excessive rusting of steel must be avoided. In case, due to

any cause attributable to the contractor, rusting of steel for BHEL issued steel occur rendering the same unusable, then such quantity of cement steel shall be recovered from the interim payment at the penal rate specified in the tender.

11.7 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.

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

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

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

VOLUME-IA PART – I CHAPTER-XII

TAXES AND DUTIES

1.12.1 Goods and Service Tax (GST) & Cess

1.12.1.1 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.

1.12.1.2 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.

1.12.1.3 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 - 2X660MW UDANGUDI SUPERCRITICAL THERMAL POWER STATION, KALLAMOLI VILLAGE, THIRUCHENDUR TALUK, THOOTHUKUDI DISTRICT, TAMIL NADU- 628203

1.12.1.4 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.

1.12.1.5 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.

1.12.1.6 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.

1.12.1.7 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.

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

1.12.1.9 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.

1.12.1.10 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.

1.12.2 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.

1.12.3 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.

1.12.4 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.

1.12.5 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-XIII 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.)

1.13

1.13.1 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.

1.13.2 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.

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

1.13.3.1 **BOCW Act & BOCW Welfare Cess Act**

1.13.3.1.1 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.

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

1.13.3.1.3 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.

1.13.3.1.4 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.

1.13.3.1.5 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.

1.13.3.1.6 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

1.13.3.2 **PROVIDENT FUND**

1.13.3.2.1 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.

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

1.13.3.3 **OTHER STATUTORY REQUIREMENTS**

1.13.3.3.1 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.

1.13.3.3.2 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.

1.13.3.3.3 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.

1.13.3.3.4 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.

1.13.3.3.5 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.

1.13.3.3.6 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.

1.13.3.4 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.

1.13.3.5 **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 (l) of the Employee's Compensation Act, 1923."

1.13.4 **GENERAL**

1.13.4.1 **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.

1.13.4.2 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.

1.13.4.3 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.

1.13.4.4 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.

1.13.4.5 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.

1.13.4.6 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.

1.13.4.7 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.

1.13.4.8 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.

1.13.4.9 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.

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

1.13.4.11 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.

1.13.4.12 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.

1.13.4.13 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.

1.13.4.14 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.

1.13.4.15 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.

1.13.4.16 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.

1.13.4.17 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.

1.13.4.18 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.

1.13.4.19 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.

1.13.4.20 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.

1.13.4.21 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.

1.13.4.22 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.

1.13.4.23 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.

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

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

1.13.4.26 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.

1.13.4.27 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.

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

1.13.4.29 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.

1.13.4.30 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.

1.13.4.31 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.

1.13.4.32 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.

1.13.4.33 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.

1.13.4.34 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.

1.13.4.35 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.

1.13.4.36 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

1.13.4.37 SITE INSPECTION

1.13.4.37.1 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.

1.13.4.37.2 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.

1.13.4.37.3 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.

1.13.4.37.4 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.

1.13.4.37.5 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-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

Proforma of Bank Guarantee (in lieu of Earnest Money)- Form WAM 23 is enclosed with this Tender.

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

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

2.7.9.1 Penalty for Intermediate Milestones for each package

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

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

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

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

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

2.7.9.1.6 Amount required to be withheld on account of slippage of identified intermediate milestone(s) shall be withheld out of respective milestone payment and balance amount (if any) shall be withheld @10% of RA Bill amount from subsequent RA bills.

2.7.9.1.7 Final deduction towards LD (if applicable), on account of delay attributable to contractor shall be based on final delay analysis on completion / closure of contract. Withheld amount, if any due to slippage of intermediate milestones shall be adjusted against LD or released as the case may be.

2.7.9.1.8 In case of termination of contract due to any reason attributable to contractor before completion of work, the amount already withheld against slippage of intermediate milestones shall not be released and be converted in to

recovery.

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

Sl No.: 7

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.: 8

Procedure 2.3 that forms the part of Forms and Procedures is published as *Chapter 10 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- 09, 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).

Sl No.: 14

2.14 QUANTITY VARIATION

Clause 2.14 QUANTITY VARIATION published in General Conditions of Contract (Volume IC Book-II) is revised as under:

2.14 QUANTITY VARIATION

2.14.1 Variation in Final Executed Contract Value

The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). No compensation becomes payable in case the variation of the final executed contract value is within the limits of Minus (-) 15% of awarded contract value. Also, no compensation becomes payable in case the contract gets partially executed/ short closed/ terminated/ work withdrawn under Rights of BHEL mentioned in Clause 2.7 of GCC. In case of work terminated / short closed under clause 2.7.4 of GCC, compensation may be considered only if BHEL receives compensation from customer.

Compensation due to variation of final executed contract value in excess of the limits defined in clause above, shall be as follows:

i) In case the finally executed contract value reduces below the lower limit of awarded Contract Value due to quantity variation specified above, the Contractor will be eligible for compensation @ 15% of the difference between the lower limit of the awarded contract value and the actual executed contract value.

ii) In case the finally executed contract value increases above the awarded Contract Value due to quantity variation, the Contractor is not eligible for any compensation

2.14.2 Variation in Individual Quantities of BOQ Item(s)

The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). No compensation becomes payable in case the variation of the quantity of individual BOQ item(s) is within the limits of Plus (+) 100% of the quantity in the original price schedule.

In case executed quantity for a particular BOQ item(s) exceeds two times the quantity in the original price schedule (100% increase), then the revision in rates for such BOQ item(s) for the quantity in excess of two times the quantity in the original price schedule including any subsequent increase in quantity, may be considered based on request from the Contractor, however, BHEL decision in this regard shall be final. Revised rates for subject BOQ item (s) shall be worked out on the basis of prevailing market rates mutually agreed between BHEL and Contractor. PVC/ ORC will not be applicable for these revised rates.

BHEL, however, retains the right to arrange the excess quantity through any other source for expediting activities in the interest of the Project.

Note: (a) Revision in rates under clause 2.14.2 will remain admissible in those cases also, where, the Contractor is eligible for compensation under clause 2.14.1 i).

(b) The value of work executed at revised rates due to variation in Individual Quantities of BOQ Item(s) shall be included while calculating the finally executed contract value in clause no. 2.14.1 above

Sl No.: 15

Clause 2.22 RETENTION AMOUNT published in General Conditions of Contract (Volume IC Book-II) is revised as under

2.22 RETENTION AMOUNT:

2.22.1 Retention Amount shall be 5% of executed contract value and shall be recovered at the rate of 5% from each Running Bill admitted, including PVC Bills. Alternatively, BG, in line with clause 1.12 of GCC, equivalent to 5% of Contract Value against Retention Amount can also be submitted before payment of first RA Bill. The validity of the said BG shall be initially for the contract period & shall be extended, if so required, up to acceptance of final bill. In case of increase in contract value, additional BG for 5% of differential amount shall be submitted by Contractor before payment of next RA Bill due. In case, contractor opts cash deduction from RA bills in the beginning & subsequently offers to submit BG later on, then refund of deducted retention amount may be permitted against submission of equivalent BG only once during the contract period.

2.22.2 Refund of retention amount shall be as follows:

100% of Retention Amount/ BG against Retention Amount shall be released along with Final Bill after deduction all expenses/ other amounts due to BHEL under the contract/ other contracts entered into with them (contractor) by BHEL.

VOLUME-IA PART – II

CHAPTER 2 to 12

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TANGEDCO
UDANGUDI STPP STAGE I
2 X 660 MW

TECHNICAL SPECIFICATION
FOR
NATURAL DRAFT COOLING TOWER
(TOTAL 2 BOOKS)

Specification No. : PE-TS-435-165-N011 (REV. 01)

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

COOLING TOWER TECHNICAL SPECIFICATION COMPRISE 2 BOOKS:

CONTENTS

SECTION TITLE

BOOK – 1 of 2 – Mechanical Specifications

I Specific Technical Requirements

IA Specific Technical Requirements (Mechanical)
IB Specific Technical Requirements (Elec.)
IC Specific Technical Requirements (C&I)
ID Data Sheet – A

II Standard Technical Specifications

IIA Standard Technical Specifications (Mechanical)
IIB Standard Technical Specifications (Elec.)
IIC Standard Technical Specifications (C&I.)

III Documents to be submitted by Bidder

IIIA Guarantee Schedule (To be submitted along with the Bid by all Bidders)
IIIB Compliance Certificate (To be submitted along with the Bid by all Bidders)

BOOK – 2 of 2 – Civil Specification

5.0.0 SITE CONDITION

5.1.0 Location and existing Infrastructure

The plant location details are as follows:

Country	:	India
State	:	Tamil Nadu
Administrative district	:	Thoothukudi
Next big cities to site	:	Thoothukudi (approx.45 kms from site)
Road access	:	East Coast Road – State high way (176)
Nearest Railway Station	:	Thiruchendur (approx.12 kms from site)
Nearest Airport	:	Vagaikulam (approx.60 kms from site)
Nearest Harbour	:	Tuticorin (approx.45 kms from site)

The proposed power project will be located at Udangudi in Tamil Nadu. The proposed power project site is located at about 45km South of Thoothukudi. The proposed marine facilities for the power project will be built on the coast adjoining the power project. The site is accessible by well developed roads.

The town of Tuticorin has all infrastructural facilities and has number of Industries. Tuticorin is well connected by both state highways, National highways and has direct rail link with State Capital Chennai.

5.1.1 Soil Profile

A Preliminary soil investigation report and topographical survey has been carried out by Owner. The results are furnished in a separate annexure.

The Detailed geotechnical Investigation and Setting out survey will be performed by the EPC contractor, and will be the basis for the detailed engineering for the project. The geotechnical report shall contain recommendations for foundation design during detailed engineering.

5.1.2 Seismic intensity

Seismic Intensity	:	As per IS : 1893 Latest
Zone	:	II
Intensity	:	As per IS:1893-Latest

5.1.3 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

5.2.0 Meteorological conditions

Ambient Air Temperature

Maximum dry bulb temperature	:	41℃
Minimum dry bulb temperature	:	17℃

Relative humidity

Mean Maximum humidity (Summer)	:	84%
Mean Minimum humidity (Summer)	:	62%
Maximum humidity (Monsoon)	:	97%
Minimum humidity (Monsoon)	:	45%

Rainfall

Annual rainfall (Maximum)	:	718.2 mm
Annual Rain fall (Minimum)	:	384.1 mm
Twenty four (24) Hour max	:	138.2 mm

High Flood Level

High Flood Level for site	:	RL 2.450 m

Wind

Mean Wind Speed (max)	:	20.6 km/h
Wind direction	:	North, North East, North West, East

The details given are arbitrary and may vary. The contractor should collect the actual data from the Meteorological Department pertaining to the site location and design the plant accordingly.

Meteorological data corresponding to Tuticorin observatory station shall be adopted. These data can be collected from Regional Meteorological Centre, India Meteorological Dept, 50, College Road, Chennai – 600 006.

5.3.0 Design Requirements related to site conditions

5.3.1 Design Ambient Data

Rainfall data:

The maximum rainfall in a year to be considered for design is 718.2 mm. 24 hours maximum to be considered is 138.2 mm. Area drainage study as required is in Contractor's scope of work.

Wind data

Wind loads to be considered for design of structures shall be based on the design wind speeds arrived at based on IS : 875 (Part -3) – Latest Edition. The parameters for calculation of design wind speed as per IS : 875 (Part -3) – Latest Edition are elaborated under Volume II, Section 5 of Detailed Technical Specification - Civil.

5.3.2 Seismic Data

Seismic loads to be considered for design of structures shall be as per as per IS : 1893. Seismic design criteria are elaborated under Volume - II, Section 5 of Detailed Technical Specification- Civil.

1.00	**INTENT OF SPECIFICATION:**
1.01	This specification is intended to cover the vetting of thermal design undertaken by BHEL Consultant, manufacture, assembly, inspection and testing at manufacturer's and/or his sub-contractors works, proper packing, delivery at site, transportation, unloading/handling at site, storage at site, site fabrication, site painting, erection including all civil works/ testing/ commissioning at site and performance testing of Natural draft type cooling tower for 2X660MW UDANGUDI STPP STG I including complete Electrical, C&I and Civil Works as specified and as necessary. This specification is for Two (2) nos. Natural Draft Counter flow Cooling Towers for 2X660MW UDANGUDI STPP STG I. BHEL intends to get this NDCT's package executed by qualified contractors on an item rate basis. BHEL has done the thermal sizing of the NDCTs through its design Consultant and the same is approved by the owner. The owner approved thermal design is enclosed at Section IA along with the General Arrangement Drawing. The Cement, Structural and reinforced Steels for Cooling tower are excluded from Bidder's scope as they shall be free issue by BHEL. Terms and conditions for free issue items being given along with NIT. The NDCT contractor is required to own the owner approved thermal design and GA drawing such that the responsibility of cooling tower performance shall remain with the bidder in all manners. Any questions or clarifications regarding thermal design may be sought by the NDCT contractor to satisfy himself of its veracity. The tentative quantities for thermo-hydraulic components (Fills and distribution system) listed for S.Nos. 24 and 25 of BOQ as per BHEL's Design are indicated in Annexure-1 of section IA and the same is calculated based on the area inside the NDCT at respective levels shown in the GA drawing. If found necessary ''the NDCT contractor may suggest modifications to the thermo-hydraulic components (listed at S. Nos. 24 and 25 in the BOQ) with technical reasoning/analysis/calculations to justify the measures to improve the thermal performance of the NDCT which will be guaranteed by the bidder''. And as such the responsibility of cooling tower performance shall remain with the bidder in all manners. While suggesting justifiable reasons for changes as above the NDCT contractor shall abide by the following constraints. Also, the NDCT contractor shall guarantee the NDCT performance considering these constraints that are inviolable. 1) Civil Design of NDCT Shell, Shell Profile and Shell dimensions at various heights 2) Foundation of NDCT 3) Air Inlet Height 4) Basin & Internal Structure Column-Beam Grid Dimensions and Elevations 5) Water Distribution Ducts 6) Layout of CW Hot water inlet header to Cooling Tower 7) Height and Diameter of NDCT. Once the changes with justifiable reasons/analyses/calculations provided by the NDCT Contractor are accepted by BHEL/Consultant and duly incorporated, the NDCT contractor will vet the final thermal design & GA of NDCT and furnish the Performance guarantee. The thermal design and GA vetted by the NDCT contractor shall be furnished to Customer for approval. The NDCT contractor shall vet the thermal design as above within two weeks of award of contract, for further approval by BHEL/customer. The GA drawing already approved by owner may be required to be approved again depending on changes to the thermo-hydraulic components, if any and therefore the NDCT contractor shall furnish the relevant modifications agreed to by BHEL/Consultant to these items (only) keeping the other dimensions frozen for further approval from BHEL/Customer. The complete design and engineering of NDCT shall remain in the scope of BHEL's Consultant.

All Mechanical/Electrical/C&I drawings prepared by BHEL Consultant will be reviewed by the NDCT contractor before submission to customer for approval.

The NDCT contractor is required to estimate the “lump sum” cost of the thermo-hydraulic components based on his modified arrangement (if any) or as per Annexure-A. This lump sum cost shall be added to the cost of other BOQ items quoted by the NDCT contractor on item-rate basis to arrive at the total cost of evaluation.

No change in the quantities and cost of thermo-hydraulic components shall be allowed during execution due to any reason whatsoever from that quoted during tender stage.

SECTION - I

SPECIFIC TECHNICAL REQUIREMENTS

SUB-SECTION IA - Specific Technical Requirements (Mech.)
SUB-SECTION IB - Specific Technical Requirements (Electrical)
SUB-SECTION IC - Specific Technical Requirements (C & I)
SUB-SECTION ID – Datasheet-A

SUB-SECTION – IA

SPECIFIC TECHNICAL REQUIREMENTS (MECHANICAL)

1.00.00	**DELETED.**
2.00.00	**SCOPE OF EQUIPMENTS & WORKS UNDER THIS SPECIFICATION:**
2.01.01	**Scope (Mechanical):**
	a) Incoming hot water piping, including vertical run, Motorized Butterfly valves on hot water risers. Terminal point for hot water pipe shall be as per enclosed NDCT GA Drg. Welding at terminal point shall be in bidder's scope. Bidder shall also supply a Pressure Gauge & Temperature Gauge at the terminal point. Any reducer/ expander required at the terminal point shall also be in the bidder's scope. b) Tower fills & fill supports, drifts eliminators, including all supporting structures, fastening arrangements & accessories. c) Screens, along with handling arrangement and guides embedded in concrete shall be provided at the outlet of cold water channel. d) Sluice/ stop log gate with handling arrangement and guides in each of the cold water outlet channel connection from the cold water basin. e) Manually operated chain pulley blocks, together with the monorails and supporting frames for the handling of screen and gates. f) Knife-edge gate valve/sluice valve in each de-sludge connection and also De-sludge piping up to the disposal point at local storm water drain channels. g) Pipe spools to be embedded in sludge pit walls and terminated with flanged end at suitable distance from outer face of respective wall. h) Water Distribution system consisting of Pipes. Hangers & pipe supports & anchoring arrangement for all piping coming under the scope of supply. i) Two (2) Nos. (1+1) sludge pumps (submersible type) complete with electric motors, non-return valve, isolation valve, piping supports, hangers etc. for cold-water basin drainage. The bidder shall terminate pump discharge pipe work into Discharge Header of CW Blowdown pump at a distance of approx. 300 M from sludge pit. j) Counter flanges, bolts, nuts & gaskets for all piping connections in the scope of bidders and also at terminals.
2.01.02	**Scope (Electrical):**
	a) Complete electrical equipment as per specification/ details indicated in Section IIA shall be in bidders' scope. b) The scope of power & control cables & special cables shall be as per section IIA (electrical). c) Base plate, foundation plates, anchor bolts, sleeves, inserts in concrete work for electrical and mechanical equipment & accessories.
2.01.03	**Scope (C & I):**
	a) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test . b) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P.

	c) One no. of Anemometer for measurement of wind velocity. d) One no. of Psychrometer. e) Local Control Panel for Sump/Sludge Pumps (Submersible type). f) Level switches for sump/pit level high/normal/low/very low interlocks. g) Actuator for Motorized BFV at inlet of hot water pipes.
2.01.04	**Scope (Civil):**
	a) Complete civil works as detailed in Book 2 of 2 (Civil Specification) including excavation, shoring, dewatering, backfilling, concrete work including shuttering, sand filling, disposal of surplus soil outside plant boundary, formwork including automatic climb form, laser beam survey instruments, fabrication, galvanizing and erection of steel structures and inserts, finishing anchor bolts, RCC sump/duct, laying and testing of hot water pipe line, water proofing, providing PVC water stops and joint fillers, drainage and other ancillary items connected with cooling towers. All faces of concrete structures and steel structures coming directly in contact with water shall be coated with corrosion resistant coating system as approved. The surfaces that would include are inner face of hyperbolic shell, raker column faces, inner faces of cold water basin, fill support structures, hot water distribution ducts & channels, cold water channel etc. The scope of this work shall consist of , but not limited to, the construction of reinforced concrete double curvature hyperbolic shell, ring beams, foundations (including Piling, if required), cold water basins with partition walls, hot water ducts, drain sumps, external drain chamber with associated pipe work, cold water channels with sluice gate up to the terminal point as specified elsewhere, hoists and monorails, primary and secondary hot water distribution troughs, fill support system including columns and beams, drift eliminators, testing of cold water basin for water tightness, external stairs, sludge pit for each basin section, all other staircases/ladders as required, doors and their frames, walkways, platforms, steel fitting, fixture, inserts, including fabrication, hand railing, providing protective measures in concrete and steel materials against effect of water and other chemicals on the completed structure etc. b) Supply & application of painting at site including lettering on the outer wall of the cooling tower as per customer requirement.
2.01.05	The following are also included in bidder's scope: a) One set of special tools & tackles required for maintenance of equipment & accessories in the cooling towers. b) Various drawings, datasheets, calculations, test reports/ certificates, operation & maintenance manuals including "As built drawings" etc. as specified & as necessary. c) Supply of first fill of lubricants for all equipments under this package including second fill/ replenishments as necessary during & after commissioning till handing over of the plant. d) Supply of commissioning spares on as required basis. e) Scope of services shall include but not limited to erection/ testing/ commissioning/ trial run/ performance testing & handing over of cooling towers. Transportation of equipments, material to site, local clearance, storage at site etc. & supply of all labor including supervision personnel, materials, erection tools & tackles etc. as necessary for expeditious execution of works etc. are also included in bidder's scope. It shall be the responsibility of the bidder to arrange all T & P required for the execution of complete job including erection & civil works.
3.00.00	**Equipment & Services to be provided by Purchaser:**
	a. Supply and erection of incoming hot water piping up to bidder's terminal point.

	b. Supply & erection of sludge discharge piping beyond the bidder's terminal point, if applicable. c. Cold-water outlet channels for cooling tower beyond the bidder's terminal point. d. For Electrical, C&I and Civil works, refer Sections IB/IIB, IC/IIC and Book 2 of 2 respectively enclosed herein.
4.00.00	The cooling tower shall comply with standard technical specifications of cooling towers enclosed in section -'II'. In the event of any conflict between Section -'II' & section 'I', the section 'I' shall prevail. In case of any contradiction in different clauses/parts of Section-I or any other clause of specification, the most stringent requirement shall prevail.
5.00.00	DELETED
6.00.00	DELETED
7.00.00	DELETED
8.00.00	**PERFORMANCE TESTING AT SITE**
8.01.00	**Scope:**
	To ascertain the fulfillment of guarantees after completion of erection and commissioning of the cooling tower, contractor shall carry out performance test at site of CT in presence of employer / purchaser at site.
8.02.00	**Codes:**
	The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to between Owner, BHEL and bidder. a) Code ATC-105: Acceptance test code for water cooling towers. (latest Version). b) BS-4485: Specification for Water Cooling Tower. c) BS-1042: Methods for the measurement of fluid flow in pipes. d) BS-3435: Measurement of electrical power and energy in acceptance testing. e) ASME 19.5: Supplements on instruments and apparatus.
8.03.00	**Conductance of tests:**
	Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by the bidder for the design conditions of CW flow, range, ambient WBT as specified
8.03.01	The bidder shall submit cooling tower performance test procedure as per ATC 105 for approval & conduct the test as per the approved procedure, in the event of order.
8.03.02	The bidder shall be given permission to inspect the Cooling Tower in advance and ready it for the test.
8.03.03	**Cooling Tower performance shall be tested jointly by Contractor in presence of BHEL and Owner. All the representatives shall jointly record data of test**. a) The responsibility for conducting the test will be with the bidder. b) **All test instruments required for the PG test will be provided by contractor and meets the stipulations of the CTI ATC 105.** c) Calibration of instruments to be used in the test shall be carried out by an approved independent agency. Calibration of instruments should be carried out previous to, but not more than six months before the test. The calibration certificate of the instruments should be valid for the period of test. d) List of instruments to be arranged by the bidder along with the calibration certificates of the

	instruments to be used and psychometric charts and tables should be submitted to owner for approval.
8.03.04	PG test shall be carried out by the bidder after completion of the cooling tower and at a time when the atmospheric conditions are within limits of deviation from the design conditions as specified in this section preferably in the period from May to September.
8.03.05	Performance test shall be carried out based on ambient WBT. The performance curves of the towers showing variation in performance with change in ambient wet bulb temperature, cooling range, relative humidity water loading of the tower etc, required to ascertain the performance of the tower shall be furnished to the successful bidder. Performance curves applicable to 90%, 100% and 110% of the design water flow rate shall be furnished to the successful bidder.
8.03.06	The guaranteed performance of the equipments shall be demonstrated by the bidder after evaluating the P.G. test should the result of the test deviate from the guaranteed values the bidder shall be given an opportunity to modify/rectify/replace the fills and other materials associated with the performance of tower as required to enable it to meet the guarantees. In such cases the PG test shall be repeated within one month from the date on which the equipment is ready for retest and cost of modification, including labour, materials and cost of additional testing shall be borne by the Bidder. The chance for repeat testing will be given only twice during the contract period. All the modifications carried out by the bidder in the Cooling Tower to meet the contractual requirements shall be carried out free of cost to the Owner in other towers (if applicable for the package).
8.03.07	In case the test cold water temperature as determined from the PG test is higher than the predicated value (based on the performance curves). Purchaser reserves the right to accept all the towers after assessing the LD/ Penalty for performance as specified in cl no- 11.00.00.
9.00.00	The makes of all the equipments under this specification shall be subject to purchaser's approval in the event of order.
10.00.00	It is mandatory for the bidder's to furnish along with the bid the deviations if any, whether major or minor in the '**Schedule of Deviations**' only. In the absence of the deviations listed in the '**Schedule of Deviations**', the offer shall be deemed to be in full conformity with the specification not withstanding anything else stated elsewhere in the offer, data sheets etc. **The hidden deviations or stated/ implied deviations in the offer shall not be acceptable and binding on the purchaser**.
11.00.00	**PENALTY FOR PERFORMANCE:**
	Bidder is responsible for workmanship & material supplied for the cooling tower. a) Performance testing of cooling tower shall be done to demonstrate the guaranteed cooling water temperature at rated duty point. The cold-water temperature as specified in the specification shall be guaranteed by bidder for the design conditions of CW flow, range, ambient WBT as specified. In case the test cold-water temperature as determined from the PG test is higher than the predicted value. Owner reserves the right to reject/replace the fills and other materials associated with the performance of the tower. In the event of acceptance by purchaser, penalty of 5% of contract value shall be deducted. b) The successful bidder shall demonstrate the above guarantees during performance testing at site. The purchaser is, however, not bound to accept the equipment and reserves the right to out rightly reject it if the actual values exceed beyond the plant design limits.
12.00.00	**INSPECTION AND TESTING:**
	Purchaser/ Customer or their authorized representatives shall have the right to inspect at any stage of manufacture & construction, all materials, components & workmanship & testing of material. The

	bidder shall provide all facilities for inspection & testing without any extra cost to the purchaser/ Consultant.
12.01.00	The contractor/ manufacturer shall conduct the following minimum specific tests to ensure that the equipment shall conform to the requirements of this section and in full compliance with the requirements spelt out in applicable codes and standards.
12.02.00	Material identification and testing of regulating valve assemblies, screen assemblies, all supporting structural assemblies, fills, all nuts and bolts, sluice valves, nozzles and all other applicable components constituting each cooling tower.
12.03.00	Hydrostatic testing of hot water distribution piping regulating valves and all other pressure parts at a pressure and duration as spelt out in this specification.
12.04.00	Visual, dimensional checking of all components of each cooling tower.
12.05.00	Material testing of all components, hydrostatic testing of all pressure parts at a pressure and duration in compliance with this specification, static and dynamic balancing tests of all rotating components such as pump shaft, line shaft, impeller etc. and complete performance testing as minimum for each sludge pump in each cooling tower.
12.06.00	Tests for hoists, chain pulley blocks and all other lifting tackle shall be carried out as per relevant Indian/ equivalent international standards.
12.07.00	Any other tests deemed necessary for safe, reliable and satisfactory operation of the equipment.
13.00.00	**QUALITY PLAN:**
13.01.00	The inspection & testing of the cooling towers & its various components shall be as per quality plans approved by the purchaser/ Customer. Bidder shall submit the quality plans based on the guidelines given in specification & quality plans enclosed herein. The customer hold points of BHEL/ Customer/Customer nominated agency shall be marked in the QP at the contract stage, in the event of order & inspection/ testing shall be carried out as per same apart from various test certificates/ inspection records etc. Following standard QP are enclosed for bidder's guidance: • Cooling tower • Pipes, fittings & pipe work • BF Valves • Chain Pulley Blocks • Gate/ Globe Valves • Submersible Pumps
13.02.00	The quality plans for various electrical, C&I and Civil works are enclosed in respective sections for bidder's compliance.
13.03.00	For equipments not covered above, bidder shall submit QP's for same on the basis of similar guidelines & submit for approval in the event of order.
14.00.00	DELETED
15.00.00	**DRAWINGS, CURVES AND INFORMATION REQUIRED: DELETED**
16.00.00	**Successful bidder in the event of award of contract shall furnish the drawings/ documents for all temporary structures, all erection methodologies, bought items or self-manufactured and/or fabricated items.**

SECTION-B: MECHANICAL WORKS

1.0 GENERAL

The scope of Mechanical works and testing requirements are covered in this section. The specification gives a broad outline of the scope of work and services to be provided by the contractor and it is not the intent of this specification to cover all the granular details of the package. It shall be the responsibility of the contractor to provide all the necessary materials, works and services required to complete the project in all respects, even if the same are not explicitly mentioned in this specification.

All the detailed fabrication drawings shall be prepared by the contractor and got approved by the Engineer-in-Charge. All the latest revisions of relevant Indian and International standards are applicable in this contract.

1.1 MEASUREMENT & PAYMENT

For payment of work done under this section, the actual quantity erected in the NDCT as measured and approved by the Engineer-in-Charge shall be considered for payment. The quantities lost towards wastage, etc., shall be to the contractor's account and no bills toward wastages, etc. shall be entertained.

2.0 FILL

Fills are of PVC Splash type. Fills should be supported in Duplex SS grids with PP Clips in such a manner that movement in both horizontal & vertical directions are arrested. Additional Duplex SS or PP tie wire should also be used to ensure that the fills do not fall off position due to failure of clipping arrangement.

The fills should not sag with all the working, scaling and temperature loads envisaged, including the induced vibrations.

The fill shape, size and configuration shown in the GA drawing enclosed with this specification must be followed without deviation. No changes in these aspects will be permitted.

3.0 HOT WATER DISTRIBUTION SYSTEM

Hot water should flow into the RCC Primary Ducts through corrosion protected MS Riser pipes that enter the NDCTs through the air inlet as shown in the enclosed GA drawing. It is preferred that the water discharges into the duct from the bottom.

A RCC Secondary Duct shall receive hot water from the Primary Duct for distribution into specific segments as per design.

The lateral distribution pipes embedded in the Primary and Secondary Ducts are fitted with down-spray type nozzles, which spray water uniformly over the fill. Spray pattern over the fill should be

circular or square, but solid in either case to ensure equal and uniform distribution of water over the fill without resulting in dry spots at all plant loads.

The complete water distribution system should be rigidly secured to the supporting structure as shown in the drawings.

3.1 PRIMARY DUCT

Primary duct is designed as a RCC channel with cast in-situ slab on top (i.e. closed on top). Each primary duct has 2 Nos. of 1000 mm (W) x 1000 mm (B) x 1000 mm (D) min. open surge shafts cum manholes with rungs to access duct bottom. Each primary duct also has a 100 NB drain plug with dummy nut.

The primary duct also acts as a walk way across the tower. Hence, handrails are provided on both sides along the duct.

3.2 SECONDARY DUCT

A Secondary duct is required to distribute hot water over small segments of the circular area which cannot be catered to by the Primary duct. This duct too is designed as a RCC channel but with a cast-in-situ slab on top.

The secondary duct too acts as a walk way. Hence, handrails are provided on both sides along the duct.

3.3 LATERAL PIPES

Lateral pipes are of GRP material or as shown in the drawings. The pipes should be with Spigot ends so that couplers for jointing are avoided to the extent possible. Reducers, End plugs, etc. needed for the operation of the distribution system and as shown in the drawings shall be provided by the contractor. All the accessories shall be of the same rating as of the pipe (Class 3 to IS: 4985).

Lateral pipes shall have pre-fabricated holes at desired intervals (as shown in the drawing) for fixing of nozzles. No drilling will be permitted in pipes after these are installed/embedded in HW ducts.

Maximum diametrical tolerance of (+) 1 mm is allowed for the holes. And alignment of holes shall be within + 10 mm tolerance limit. Hence, it is suggested that the contractor make a suitable jig arrangement at ground level to achieve this requirement.

Nozzles should be fixed to the lateral pipes by bolting and tying with Polypropylene (PP) straps as shown in the drawings. In case of additional fastening with PP straps, the straps shall be capable of taking a minimum load of 30 Kg. Necessary accessories for fastening shall be of same material as of the strap. Bolts shall be of Duplex SS material.

Pipe joints shall be rendered leak proof by proper application of adhesive (supplied by manufacturer) as shown in the drawings.

Alignment of lateral pipes shall be within the tolerance limits specified above for the pre-fabricated holes. All the nozzles shall be aligned to the direction of gravity. The levels of the pipes and nozzles shall be maintained to result in uniform distribution.

3.4 NOZZLES

The nozzles shall be of down-spray type in PP construction. The spray pattern shall be either circular or square with a minimum diameter of 900 mm.

The contractor shall offer a nozzle that achieves the spray pattern and diameter specified at a static head shown in thermal design calculations. The final choice of the nozzle shall be subject to acceptance by the Engineer-in-Charge.

The tolerance on nozzle opening size for discharge shall be limited to ±1% of that shown in the drawings. Contractor shall demonstrate the performance at 80%, 100% and 120% water loads at nozzle vendor premises using a properly designed test rig. The contractor shall submit testing facility details along with test procedure for review and acceptance before under taking the performance test and procurement or supply of nozzles.

Owner reserves the right to witness the nozzle testing at vendor works. Contractor shall submit the nozzle performance curves to the Owner for review and final acceptance of the proposed nozzle type to achieve the performance envisaged in designs and drawings.

In case of any deficiency is found in nozzle performance at a later stage, the Contractor shall provide additional nozzles or nozzles of a better type without any additional cost to the Owner to meet the design requirements.

In case nozzles comprise of two or more parts, assembly of the same shall be either by threaded connection or Duplex SS bolting. The Contractor shall submit a sketch/drawing of the nozzle and its fixing arrangement, including two sample pieces along with his offer.

3.5 HOT WATER PIPING

The MS hot water riser piping shall be connected to the Owner's hot water header pipe at the Terminal Point as shown in the drawing. The end connection shall be of welded type. If the terminal points of owner's header pipes are not ready, all the open ends of the pipes shall be covered with polythene sheets to prevent corrosion.

Steel pipes shall be made either by ERW/SAW methods. Steel pipes shall conform to IS: 1239 (Medium grade) and IS: 3589 (Fe 410 grade) as the case may be. Steel plates for pipes shall conform to IS: 2062. For pipe sizes up to 300 NB, seamless long radius elbows shall be used unless otherwise specified. For pipe sizes above 300 NB, mitre bends shall be used.

The Contractor shall provide the necessary civil & structural works, if required for all the independent foundations, thrust blocks, etc supporting the hot water pipe. Painting shall be as specified elsewhere in these documents.

3.5.1 Butterfly Valves

Butterfly Valves shall be electrically operated Double flanged type meeting the requirements of AWWA C – 504 or BS: 5155. Necessary cabling for actuators and limit switches, etc shall be provided by the Contractor up to a common Junction Box located near the Staircase.

POD (Proof of Design) Test	: AWWA C – 504
Operating Fluid	: Water at 45 to 50 deg. C
Design Pressure	: 5.7 Kg./Sq.cm
Max. Differential Pressure	: 5.7 Kg./Sq.cm.
Head loss coefficient	: Max. 0.25
Body & Disc	: Cast Iron to IS: 210 Grade FG 260 or Fabricated steel to IS:2062 / IS:2002 with Rubber or Ebonite Lining
Shaft	: Duplex SS
Bearing type	: Self-lubricated type
Disc seat	: EPDM
Body Seat	: Duplex SS
Internal Hardware	: Duplex SS
External Hardware	: SS 316L
Wetted Fasteners	: Duplex SS
other Fasteners	: SS 316L
Gland Packing	: Teflon
Gaskets, Rings, etc.	: Nitrile Rubber
Accessories	: 2 Nos. of 2NO + 2NC Limit Switches 'OPEN' & 'CLOSE' or as per Actuator data sheet enclosed with Electrical Specifications

All the butterfly valves shall be complete with graduated position indicator, arrow indicating the flow direction, actuators, limit switches, etc. The valves shall be suitable for erection in any position (Horizontal / Vertical, etc.). The operating mechanism shall be mounted directly on or supported from valve body. Actuator specifications shall be as specified elsewhere in this document.

All the butterfly valves shall be provided with hand wheel. Butterfly valves of size 350 NB and above shall be provided with reduction gear units. Valves shall close in clockwise direction. The hand controls shall be dimensioned to guarantee an easy manoeuvre under most severe conditions. The hand controls shall be provided with locking systems to avoid the disk assuming a not desired

position during operation. The pulling force required on the hand wheel-rim shall not exceed 30 Kg. when operating the valve under full flow and operating pressure, in case of failure of actuator. The reduction units shall be watertight, complete with lubrication and position indicator.

3.5.1.1 Flanges

For valves designed as per AWWA C-504, flanges shall conform to ANSI B16.1 Class 150 for CI valves and AWWA C-207 Class D for fabricated steel valves. The counter flanges shall conform to AWWA C-207 Class D.

For valves designed as per BS: 5155 the flanges shall be as per BS: 4504. All the flanges shall be of slip-on and flat-face type. Flanges shall be fabricated from steel plates conforming to IS: 2062.

3.5.2 Ball Valves:

Ball valves are envisaged mainly for flow measurement ports. These valves shall conform to IS: 9890 and are of threaded type.

Pattern and Construction : Full bore in single piece

Nominal size : 150 NB

Design pressure : 6 kg/sq.cm

Material of construction : Duplex SS

3.5.3 Sluice Gate (if applicable)

The sluice gate shall be of circular opening conforming to IS: 3042 Class – 1, with rising spindle. The materials of construction of the gates shall be as follows:

Frame and Door : SS 316L

Face, seat rings, trim and Spindle Nut : SS 316L

Spindles, bolts and nuts : SS 316L

Each sluice gate shall be furnished complete with extension spindle through extra-strong pipe of required length connected to the floor-stand through stem coupling. The floor-stand shall be provided on concrete floor of the drain box. Each gate shall be furnished with bell-bottom base and shall 815 mm high, provided with an indicator and open/close positions clearly marked on the stand. The floor-stand shall be furnished with 450 mm diameter hand wheel and wheel-stem coupling to suit the sluice extension pipe.

3.5.4 Miscellaneous

Each hot water header shall have 3 Nos. of 150 NB, 200 mm long MS stubs internally and externally coated with Corrocoat or Polyurea or Glass Flakes. The stubs can have threaded or flanged ends (depending on valve ends) for measurement of water flow with Pitot tube. The location of these stubs shall be at a location on the header piping where at least a straight length of 10D on upstream side and 5D on downstream side is available.

Each stub shall be fitted with 150 NB Ball Valve in Duplex SS for isolation purpose. All necessary bolts, washers, nuts shall be of Duplex SS.

Each hot water header shall have one number stub for pressure gauge with isolation valve and one thermowel for temperature measurement.

3.6 CONSTRUCTION FEATURES OF M.S. PIPING:

3.6.1 End Preparation, Cutting, etc.

For steel pipes, end preparation for butt-welding shall be done by machining/flame cutting. Socket weld preparation shall be saw/machine cut. All the welding electrodes and other requirements for welding, including any special material, shall be arranged by the contractor.

For tees, laterals, mitre bends and other irregular details, template shall be used for accurate cutting.

3.6.2 General Instructions for Piping Construction

While erecting the field run pipes, the contractor shall check the accessibility of valves, instrument tapping points and maintain minimum head room requirement and other necessary clearances from the adjoining work areas. Irrespective of whether mentioned in the drawings or not, all pipelines shall be given proper slope towards the drain point.

3.6.3 Welding:

a. Before welding the ends shall be cleaned by wire-brushing, filing or grinding.
b. Welding of piping shall be done by certified welders. Welders' qualification shall be as required by ASME Section-IX. Welding at any joint should be completed in one go.
c. Welding under this specification shall be done by a process approved by the Engineer-in-Charge.
d. Automatic or semi-automatic welding shall be done only with the specific approval of the Engineer-in-Charge.
e. As far as possible welding shall be carried out in flat position. In case that is not possible, welding shall be done in a position as close as to the flat position as possible.
f. Downward technique is not allowed in the welding of pipes in horizontal position, unless permitted by the Engineer-in-Charge.
g. Combination of welding processes or usage of electrode of different classes or 'makes' in a particular joint shall be done after the welding procedure has been duly qualified and approved by the Engineer-in-Charge.

h. Welding carried out in ambient temperature of 50°C or below shall be heat-treated.

3.6.4 Alignment & Spacing

a. The pipes joined by welding shall be aligned correctly within the existing tolerance on diameters, wall thickness & out of roundness, which shall be preserved during welding. All flange facings shall be true and perpendicular to the axis of the pipe with bolt holes being off centre, unless different orientations are shown in drawing to match some equipment connections.
b. Components to be welded shall be aligned and spaced.
c. Root opening shall be 1 mm to 2 mm for wall thickness of 2.4 mm or under and for all thicknesses in oxy-acetylene welding. For 2.4 mm and above, root opening shall be 2 mm to 3 mm.
d. Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds form a part of final welding these shall be executed carefully and shall be free from defects. Defective welds shall be removed prior to the welding of joints.
e. Electrode size for tack welding shall be selected depending upon the root opening.
f. Tack welding should be equally spaced as follows:

For 65 NB pipe and smaller	: 2 tacks
For 80 NB to 300 NB pipe	: 4 tacks
For 350 NB & larger pipes	: 6 tacks

3.6.5 Welding Technique

a. Root pass shall be made with respective electrodes/filler wires. The size of the electrodes shall not be greater than 3.25 mm (10 SWG). Welding shall be done with direct current values recommended by the electrode manufacturers.
b. Upward technique shall be adopted for welding pipes in horizontally fixed position. For pipes with wall thickness less than 3 mm, oxy-acetylene welding is recommended.
c. The route pass of butt-joints shall be so as to achieve full penetration with the complete fusion of root edges. The weld projection shall not exceed 3 mm inside the pipe.
d. Each pass shall be cleared to be made free of slag before the next pass is deposited.
e. In case of deviation from the welding process and electrodes as specified, the contractor shall seek the approval of Engineer-in-Charge before implementing the change.
f. On completion of each run, craters, weld irregularities, slag, etc. shall be removed by grinding or chipping.
g. During the process of welding, all movements, shocks, vibrations or stresses shall be carefully avoided in order to prevent weld cracks.
h. Fillet welds shall be made by shielded metal arc process regardless of thickness and class of piping. Electrode size shall not exceed 10 SWG (3.25 mm). At least two passes shall be made on socket weld.

4.0 BASIN

Basin is divided into two equal parts by a diametrical partition wall. Each NDCT basin compartment shall be provided with a cold water outlet and a drain sump at the opposite ends. A peripheral drain shall be provided with a minimum floor slope of 1:400 towards the drain sump for easy cleaning of the basin. The basin floor itself, in turn will be provided with a slope of 1:500 towards the peripheral drain.

Sludge will be removed using portable pumps, which shall be supplied by the contractor. The Contractor shall make all provisions such as platforms with handrails, discharge piping up to terminal point, etc. for smooth operation of these pumps. Rungs shall be provided up to the bottom of sump in each compartment for maintenance of valves and pumps.

5.0 COLD WATER CHANNEL

Cold water outlet near cooling tower is partitioned into two parts. Each part of cold water outlet shall have Screens and Stop Log Gates as shown in the drawings. Guide frames of Screens and Gates shall be interchangeable.

To obtain proper alignment of the guide channels, a bigger slot will be left in the concrete and after fixing the channels in position the grouting of these channels will be done by secondary grout/concrete so that fixtures do not get disturbed.

Monorails with push trolleys, chain pulley blocks and hooks shall be provided for handling of gates and screens,. The structural arrangement required for the monorails shall also be provided by the contractor as per the approved drawings.

A walkway with handrails shall be provided across the outlet for easy operation of gates and screens. Both the compartments of cold water outlet shall be combined into a gravity channel at the end of the partition wall as shown in the drawings. The combined cold water outlet shall be covered with RCC cast-in-situ slab up to terminal point. Termination of cold water outlet shall be done with PVC water stopper.

5.1 SCREEN

Mesh	: SS 316 L
Mesh Size	: 10 mm x 10 mm to IS: 2405, Part 1
Supporting Frame	: SS316 L
Guide Frame (Embedded in Concrete)	: SS 316 L
Trash Tray	: SS316 L
Fasteners	: SS 316 L

Screens shall freely move inside the structural framework embedded in the concrete walls of the open channel. Screens provided in the outlet channel shall have a trash tray incorporated on the

upstream side of the bottom edge of the screen to catch any debris falling down the screen during removal.

5.2 STOP LOG GATE

Standard	: IS: 5620
Guide frame (Embedded in Concrete)	: SS 316L
Gate (including supporting frame)	: SS 316L
Slide plates of gate	: SS 316L
Slide Seal	: EPDM Musical note to IS: 11855
Bottom Seal	: EPDM to IS: 11855
Painting	: Specified elsewhere
Fasteners	: SS 316L

Slide gate constructed in hot double-dip galvanized structural steel sections shall be furnished as per the drawings to be given during execution. The gate shall move freely inside a structural framework embedded in the concrete walls of the open channel. The gates shall have a continuous bearing under compression all around the opening ensuring no leakage.

6.0 ACCESS

6.1 STAIR CASE

All stair cases shall be 'Dog Legged'. The minimum clear width of the stairways and platforms shall be 1000 mm. Minimum clear headroom of 2.5 m shall be maintained over platforms and walkways.

6.2 ACCESS DOORS

The doors shall be of single leaf – double skin type and of 2.1 m (H) x 1.2 m (W) size fabricated from min. 6 mm thick FRP sheet in ribbed construction.

6.3 CAGE LADDER

The cage ladder shall conform to IS: 3696. The ladders shall be min. 600 mm wide and made of hot double dip galvanized 75 mm x 6 mm thick flats with 20 mm diameter rungs at 300 mm centres with stays at every 1.75 m connected to the wall. The ladder shall be provided with a hot double dip galvanized MS cage consisting of 50 mm x 6 mm straps at 800 mm centres with min. five (5) Nos. 50

mm x 6 mm vertical cage flats throughout the complete length of the ladders. Intermediate landing platforms with handrails, as required and/or as shown in the drawings shall be provided.

6.4 WALKWAYS

Walkways shall be min. 1000 mm wide and shall have min. 2.1 m headroom, unless otherwise specified. All walkways shall have safety handrail of min. 1.2 m height on both sides.

6.5 RUNGS

SS 316 rungs of 12 mm diameter shall be embedded in CW Channel RCC wall. Each rung shall be 450 mm wide x 150 mm beyond the wall face unless otherwise specified.

7.0 MATERIAL HANDLING FACILITIES

7.1 AT TOP OF SHELL

During maintenance of the tower, to lift the materials like lighting poles, aviation lights, welding machine etc., from ground to the top of the tower, material handling provision to be made at the top of the tower. MSHDG plates of size 300 x 300 x 20 mm shall be embedded in the wall, flush with the outside concrete surface at 1 m C/C on the shell circumference at the top most platform level. Each plate shall have four tapped holes with nuts welded to the back of each hole (for having extra-long thread engagement) for fixing bolts later. The drilled and tapped holes and nuts shall be suitable for 20 mm diameter bolts. Care shall be taken to prevent entry of concrete into the nut and tapped holes. This arrangement is to support a swivelling lifting arm to hoist a load of 1000 kg.

7.1.1 PORTABLE ROTATING TYPE LIFTING ARM

Lifting arms including swivelling brackets, pins, etc. complete shall be provided along with 250 mm diameter CS pulleys. It shall be possible to easily erect/dismantle this arrangement as and when required. All structural steel sections, brackets and inserts such as bolts, nuts, plates, etc., shall be of MS hot dip galvanized.

7.2 FOR SCREEN AND SLIDE GATE IN COLD WATER CHANNEL

Monorail beam at sufficient height shall be provided. A hand operated chain pulley block with traveling trolley of capacity not less than 125% weight of slide gate shall be provided. All other accessories for this system shall also be designed for the same load. Monorails shall be extended outside the cold water channel to lift/lower the equipment from/to the ground level.

Life	: Not less than 20 years
All parts	: SS 316L or better
Chain pulley blocks	: IS: 3832, Class 2 duty
Hand operating chain	: SS 316L
Load Chain	: SS 316L

Hook	: IS: 7847
MOC of hook	: High tensile steel and heat treated or better as per Clause 7.1 (b) of IS: 3815 suitable for highly corrosive environment
Wire ropes/slings	: IS: 2266

8.0 HARDWARE

All the hardware immersed in water or in direct contact with water/water spray shall be of Duplex SS, unless otherwise specified. The hardware not in contact with water or moisture shall be of SS 316L, unless otherwise specified. However, all hardware for handrails and cage ladders, etc external to the tower shall be of hot double dip galvanized MS.

10.0 TESTS:

The contractor shall submit detailed QAPs for approval. Typical QAPs are given elsewhere in this document.

10.1 FILL

10.1.1 Material Test

For plastic fills and drift eliminators impact tests shall be done as per ASTM-D-256 and flammability tests as per ASTM-D-635. Density and Vicat softening tests shall also be done. The contractor shall submit test certificates from approved third party laboratories for approval by the owner. All tests on Fills & Drift Eliminators shall conform to CTI STD-136.

10.1.1.1 UV Test for Plastic fills

UV test shall be done as per ISO-4892. Impact test shall be done before and after UV test. Test certificate from approved third party laboratories shall be submitted for approval by the owner.

10.1.2 Dimensional Test & Load Test on Fill

Dimensional accuracy and material thickness will be checked randomly at site. Load Test shall be done on a mock fill assembly. Both the tests will be done in presence of Engineer-in-Charge.

10.2 BUTTERFLY VALVES

Butterfly valves shall meet the proof of Design test and Disc strength test confirm to AWWA-C-504. Seat leak test shall be done in both directions. In case of fabricated valves, UV test on plates 20 mm or above thickness for body, disc and shaft shall be done. Radiography test on 100% butt welds and 10% DPT on fillet welds shall be done in presence of Engineer-in-Charge.

10.3 GATE/BALL VALVES

Material test, DPT for 100% butt welds and 10% fillet welds, assembly fit up and hydraulic test shall be done and certificates of same to be submitted for approval.

10.4 SLIDE/STOP LOG GATE

Material and DPT for 100% butt welds and 10% fillet welds shall be done and certificates of the same shall be submitted for approval. Assembly fit up, Dimensional accuracy and Leak tight test shall be done at site.

10.5 CHAIN PULLEY BLOCKS

Test certificates of material and DTP shall be submitted for approval. Full load test and 25% overload test shall be carried out with all motions and safety features at site.

10.6 HOT WATER PIPES

Certificates of material and welder qualification shall be submitted for approval. Assembly fit up, dimensional accuracy, DPT and NDT (if required) shall be done at site.

10.7 SCREENS

Certificates of material and DPT shall be submitted for approval. Assembly fit-up test and dimensional accuracy shall be done at site.

11.0 VENDORS LIST

S. No	DESCRIPTION	VENDORS
1.	Testing Agency for Fills & D/E	Shriram Labs, New Delhi / CIPET, CHENNAI
2.	Butterfly Valves	AUDCO / FOURESS / KEYSTONE / IL / INTER VALVE/ KIRLOSKAR / DYNAMIC
3.	Structural Steel	SAIL / TATA / JINDAL / VIZAG STEEL
4.	PVC Pipes	SUPREME / FINOLEX / PRINCE
5.	Push Trolley, Chain Pulley Block, Hook & Chain	WMI / INDEF
6.	Red Oxide Zinc Chromate Primer	'APCOMIN' OF ASIAN PAINTS / BISON UNIVERSAL OF BRITISH

		PAINTS / '3100' OF JANSON & NICHOLSON / SYNTHETIC ZINC CHROMATE OF SHALIMAR PAINTS
7.	Epoxy Primer	HINDUSTAN CIBA GEIGY / Dr. BECK & Co / CHEM.E.LEEK
8.	Epoxy Paint	HINDUSTAN CIBA GEIGY / Dr. BECK & Co / CHEM.E.LEEK
9.	Aviation Obstruction Lights	BINOY / INSTAPOWER / AVAIDS
10.	PVC Fills & D/Es	CONTRACTOR'S OWN MAKE / MM AQUA
11.	SS Weld / FRP Mesh	CONTRACTOR'S OWN MAKE / WIRE NETTING INDUSTRIES / JEETMUL JAICHANDLAL / NBC Weld Mesh
12.	Nozzles	CONTRACTOR'S OWN MAKE / VULQUA
13.	GRP Pipes	EPP Composites / Fibre Tech Composites / BSF FRP Industries / Other Reputed

This vendor list is tentative and shall be subject to CUSTOMER approval during detailed engineering.

SECTION-C: ELECTRICAL & INSTRUMENTATION

1.0 AVIATION OBSTRUCTION LIGHTING SYSTEM (AOLS)

The aviation obstruction lights shall meet the recommendations of ICAO and all the requirement of Director General of Civil Aviation, India and FAA guidelines in general.

Aviation lights shall be fixed on the top of NDCTs. Type of fixtures shall be as listed below.

Tower height	Type of Light	Description
<= 150m	Type B, Medium Intensity	Red flashing light with directional intensity of 2000cd ± 25%. Flash frequency shall be in the range of 20 to 60 per minute
> 150m	Type A, High Intensity	White flashing light with directional intensity of 200000cd ± 25%. Flash frequency shall be in the range of 40 to 60 per minute

The number of fixtures shall be as given under.

Top diameter	No. of fixtures
<=20 ft	3
20 ft < >= 100ft	4
100 ft < >= 200ft	6
> 200 ft	8

All flashing lights shall flash simultaneously. Low and Medium intensity lights, if applicable should be operated only in night times. High intensity lights should be operated in day time with full intensity (2,00,000 Cd), during twilight times with 20,000 Cd and in night times operates with 2,000Cd intensity. Installation and setting angles for high intensity lights shall conform to table no.6.2 of ICAO / FAA guidelines.

1.1 AVIATION OBSTRUCTION LIGHTS (AOL)

Each AOL fixture shall have 100% standby light i.e. twin type. In case of failure of any operating light, the standby should be activated automatically with auto changeover facility giving hooter feedback. AOL shall be LED type conforming to IP-65 grade protection class. High intensity lights shall have

intensity step changers. The control panel for the AOLs shall be mounted near the main distribution board under the staircase.

1.2 Photoelectric light detectors shall be furnished and installed near NDCTs to monitor the north sky. The detector shall cause the control unit to energize the aviation lighting system with the north sky illuminance. The lighting system may be energized during short periods of decreasing illumination due to abrupt periods of shadow during daylight hours, but shall not be de-energized as the result of short periods of increasing illumination levels due to lighting flashes or stray light sources when overall illumination level is such that the system is operating.

1.3 Temporary warning lights shall be installed during construction and these shall be located above the top most point of the obstruction and shall be shifted as construction progresses. These lights need to be installed only after the level of obstruction is greater than 50 m above ground. Temporary warning lights shall be of four fixtures each with not less than 10 candelas of red light. Power for operation of the temporary lights shall be obtained from the construction power system. Electrical circuits and cables for these lights shall be furnished, installed and maintained by the Contractor during the construction / erection period. These lights shall be operated right from sunset to sunrise.

1.4 The contractor shall provide hand railing around the beacon platforms, if applicable for attending to any maintenance work.

1.5 The AOLs shall be adequately secured to the handrails / parapet wall of the top platform against wind forces.

1.6 All cables shall be supplied and fixed as per relevant IS codes, clamped at intervals of 1000 mm by the side of the ladder. The cables shall be PVC insulated and PVC sheathed / armoured copper conductor of 650/1100V grade heavy duty conforming to IS: 1554 Part – I (latest revision). The cable shall be subject to Owner's approval.

1.7 The contractor shall install weatherproof terminal boxes with cable glands on top of the NDCTs at a location close to the AOLs. Suitable pull boxes shall be provided at convenient locations.

1.8 There will be two incomers – one main and the other stand-by. Automatic changeover facility with manual option shall be provided in case of failure of main incomer. Standby incomer will be disconnected once the main incomer is restored with suitable delay. A 0-30 second delay timer should be provided to prevent change over taking place for very short-term failure. A16 ampere or higher rating circuit for AOLs shall be provided. The aviation warning lights shall be controlled by photoelectric cell facing north sky through contractor. Auto manual operation selector switch shall be provided for 'ON' and 'OFF' operations. A wall mounted, sheet steel enclosed type Distribution Board (DB) shall be supplied and installed at the ground level for below the staircase. It shall have arrangement to receive Owner's PVC cable (size to be intimated later) and shall have an isolating switch and separate switch fuse circuits for feeding the aviation lights. The DB shall be outdoor type dust and vermin proof and shall have a sheet steel thickness of not less than 2 mm and shall have a proper gasket with removable gland plates at top and bottom. The DB shall also house the automatic switching arrangement described above. The board shall be dead front type; all equipment shall be mounted on auxiliary door. The DB shall be provided with two separate and distinct Grounding terminals. The cables and cabling between distribution board, flashing control unit and AOL fixtures shall be in Contractor's scope.

1.9 Lighting fixtures, conduits, junction boxes, etc., shall be properly earthed using GI wire of 14 SWG. Earth wire will run along the entire length of the cable between the fixtures and DB where it will be connected to the earth.

1.10 Contractor's scope includes supply, installation, commissioning and maintenance of the complete AOL system and its cabling until the NDCTs are taken over by the Owner. The scope shall also include the associated civil works.

1.11 AOL system shall be test operated by the Contractor for not less than 12 months from the date of trial commissioning. Equipment and work that fails during the test period shall be repaired or replaced at the option of the Engineer-in-Charge. Upon any failure in this system during the test period, a new test period of 12 months will be required after repair or replacement of the equipment that has failed.

1.12 POWER RECEPTACLES

32A TPNE industrial type switch-socket outlet(s) shall be provided on the top peripheral platform and on landing platforms, if applicable as specified elsewhere.

2.0 EARTHING AND LIGHTNING PROTECTION

The Contractor's scope of supply for lightning protection includes complete system required as per IS: 2309 from air termination rods to earth mat and electrodes, whether specifically mentioned herein or not.

Grounding system shall confirm to IS: 3043. Each air terminator shall be connected to individual earth-pits through individual down conductors and earth conductors. Apart from the above, a coronal band and an earth mat shall be provided for each NDCT. Depending on the number of earth pits, four shall have test links and two shall have pigtails for connecting to main plant earth grid. All structures and equipment (even the one which are not supplied by the contractor but are in the cooling tower area) shall be connected by minimum two parallel conductors to nearest down/earth conductors.

2.1 Material of Construction

Material of conductors used above Ground level shall be of GI with zinc deposition of minimum 900 gm/m^2. All buried conductors are of MS round bars of min. 40 mm diameter.

a.	Air terminator	: 2 m long, 20 dia. Copper rod with pointed tip
b.	Coronal Band	: 75 x 10 thk GI flat
c.	Down Conductor	: 75 x 10 thk GI flat
d.	Earth Conductor	: 40 dia MS rod
e.	Earth Mat	: 40 dia MS rod
f.	Earth Electrode	: 3 m long, 40 dia MS rod
g.	Grounding for Columns & Structures	: 50 x 6 thk. GI flat
h.	Handrails & Steel structures	: 40 x 3 thk. GI flat

i. Grounding for Distribution boards & Control Panels, etc. : 40 x 3 thk. GI flat
j. & Grounding for Power outlets Lighting Fixtures : 14 SWG GI wire

2.2 AIR TERMINATOR

Tip of air terminator shall be pointed and at least 1.2 m above top of cooling tower. Air terminator shall be clamped with heavy-duty GI clamps at a minimum of 3 points to the structure. Air terminators shall be connected to down conductor and coronal band by use of pressure type fittings.

2.3 CORONAL BAND

Cooling tower shall have a coronal band connecting all air terminators provided at the top of the cooling tower. It shall be clamped to structure at 1000 C/C intervals all around.

2.4 DOWN CONDUCTOR

Down conductors shall be connected to Air terminators via the Coronal band at the top of the cooling tower and to the earth conductor at 300 mm above FGL through a test point at 1.2 m above grade. These conductors shall be continuous as far as possible. Intermediate breaks if any, shall be welded to form continuous circuit from top to bottom. Lapping of down conductor by bolting is not acceptable. These conductors shall be embedded in the outer surface of the concrete shell and diagonal columns with a minimum cover of 50 mm. These shall come out of the shell at the top of the cooling tower and at the ring beam level.

Ladders shall be electrically connected to the down conductors at top, middle and bottom by bolted connections.

2.4. TEST LINK

Test link shall be of 50 x 6 thk GI flat with electroplated bolts, nuts and washers. Test link shall be installed in a GI box fixed on the outside surface of the raker column.

2.5 EARTH CONDUCTOR

Earth Conductor shall be connected to down conductor, earth mat and earth pit by welding. Earth conductor shall be taken through approx. 1.3 m long, 100 NB AC pipe filled with PCC (1:3:6).

2.6 EARTH MAT

Cooling tower shall have a circular earth mat of diameter at least 12 m more than the cooling tower sill diameter and laid at 1000 mm below the ground. All the joints shall be of welded type.

2.7 EARTH PIT

Earth Pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600 mm. Earth Pits shall be treated with salt and charcoal, in case average resistance of soil is more than 20 ohm-meters.

2.8 CLAMPS & ANCHORS:

All connections, clamps, anchors, etc. of the lightning protection system shall be made of GI fittings. All joints, unless otherwise specified shall be clamped or bolted (min. 2 Nos. of bolts) to form high pressure contact for a connection of adequate current carrying capacity and mechanical strength.

2.9 VERTICAL AND HORIZONTAL REINFORCING BARS

All vertical reinforcing bars at the top and the bottom portion of the cooling tower shall be electrically connected to the nearest horizontal reinforcing bar and these bars shall in turn be connected to the down conductors. At locations where vertical reinforcing bar is spliced, each of the spliced bar shall be electrically connected to at least one horizontal reinforcing bar which in turn shall be electrically connected to the down conductor. These electrical connections shall be made by winding tightly with not less than five (5) wrapped turns of 14 SWG GI wire.

2.10 TEMPORARY LIGHTNING PROTECTION

Temporary arrangement for lightning protection during construction shall be maintained by connecting the reinforcement bars to two Grounding conductors of minimum size 50 x 6 thk. Temporary protection shall be provided even after the completion of the tower till such time that the permanent air termination rods and various conductors, etc. are installed.

3.0 INSTRUMENTATION
3.1 PRIMARY INSTRUMENTS

a. Thermowel

Thermowel shall be of one piece solid bore type in SS 316 and of step-less tapered design as per ASME PTC 19.3.

b. Temperature Gauge

Range	: 0^{o} C – 50^{o} C (linear 270^{o} arc in metric units)
Accuracy	: + 1% of span
Dial size	: 150 mm
Sensing element	: Mercury in steel with SS Bulb and Capillary
Body material	: Die-cast aluminium
Protection	: IP55
Zero / Span adjustment	: Required
Accessories	: SS Thermowel

c. Pressure Gauge

Range : 0 – 5 kg/sq.cm (linear 270^{o} arc in metric units)

Accuracy : + 1% of span

Dial size : 150 mm

Sensing element : Bourdon/Diaphragm/Bellow of SS 316

Body material : Die-cast aluminium

Protection : IP55

Zero / Span adjustment : Required

Accessories : Blow out disc, Siphon, Snubber, Pulsation Dampener, Isolation Valve

3.2 SECONDARY INSTRUMENTS

RTD

Range : 0^{o} C – 50^{o} C

Characteristic : Linear with temperature (within + ½ % of top range value)

Type : Metal sheathed, ceramic packed

Standard : DIN 43670

No. of Elements : Duplex – 4 wire

Housing : IP 55 / Die-cast Aluminium

Calibration and accuracy: As per Class A of DIN 43760

Accessories : Spring loaded for positive contact with the well

SCHEDULE – II: PROCEDURE FOR PERFORMANCE TEST

The Contractor is required to comply with the Thermal Design Calculations, GA Drawing and Design Basis Report enclosed with this specification and stand guarantee for thermal performance of the NDCTs as per the specification requirements.

Once the construction and erection works are completed by the Contractor, he shall undertake trial commissioning of the NDCTs after notifying the Owner/Purchaser. The Owner shall provide the necessary water flow / heat load to the NDCTs for trial commissioning.

After successful trial commissioning to the satisfaction of the Owner/Purchaser, the Contractor shall carry out Performance Guarantee Test on the NDCTs as per the schedule agreed to demonstrate the thermal performance during conditions close to the design.

1.0 SCOPE AND PURPOSE

1.1 Scope

This Performance Test Procedure covers the determination of the water-cooling capacity of the Natural Draught Cooling Tower.

1.2 Purpose

This note gives an outline of procedure for the performance test. For full details, the tender documents and other associated documents as well as codes mentioned below may be referred.

1.3 Flexibility

It is recognized that the data limitations specified throughout this test procedure represent ideal conditions, which are not available most of the times the tests are performed. In such cases actual conditions may be used provided written consent is obtained from the official representative of the manufacturer and the Engineer-in-Charge.

1.4 Scope of Test

Acceptance test shall cover the determination of the thermal capability and verification of the guarantee parameters of the cooling tower constructed for the project.

1.5 Conduct of the Test

a. Test shall be conducted by accredited representatives of the Contractor in the presence of the Owner/Purchaser. The Contractor shall be given permission to inspect the tower in advance. Owner's/Purchaser's representatives shall witness all phases of the test and record the data jointly with the Contractor.

b. The responsibility for conducting the test will be with the Contractor.

c. All instruments required for the Performance test and their calibration as per codes will be the responsibility of the Contractor.

d. Calibration of the test instruments will be carried out by an approved independent Govt. agency. The calibration of the equipment should not be older than six months before the test and should be valid at the time of the test.

e. Performance curves

Performance curves for 80%, 90%, 100%, 110% and 120% of design water flow are enclosed. The performance of cooling tower during the test shall be compared with the performance possible/expected on the basis of these curves.

1.6 Codes

The performance test will be generally as per CTI Code ATC-105 or BS4485 Part-II. The following checks should be done before the test.

a. Water distribution system shall be essentially clear and free of foreign materials, which may impede the normal water flow. All the nozzles should be in place and clean so that the water distribution is good and as per design.
b. Fill shall be essentially free of foreign materials such as oil, tar, scale, silt or algae.
c. Water level in cold-water basin shall be as close as possible to normal operating level and should be maintained substantially constant.
d. Make up water and blow down should be stopped during the test period. In case it is not possible to stop the make-up water, the correction for the same will be applied as per code.

2.0 CONDITIONS OF THE TEST

Every effort should be made to conduct the test when the conditions are very close to the design. At the time of the test, the tower shall be in good operating condition. During the test, steady state and calm conditions shall prevail for the various parameters involved. Tentatively, the duration of the test shall be 4 hours. During this period, to avoid uncertainties introduced by make-up water and purge water, these will be shut off and the duration modified accordingly to maintain the concentrations of dissolved solids, etc. The station power load should be maintained at its near maximum.

The design parameters of the cooling tower are as follows:

Parameter	Unit	Design Point	Performance Range
Circulating water flow rate	m^3/hr		±20%
Cooling Range	^oC		±20%
Ambient Wet-bulb Temp.	^oC		±8.5
Ambient Relative Humidity	%		40% to 100%
Re-cooled Water Temp.	^oC		To be checked with the Performance Curves
Wind Velocity	km/hr		0 to 5

3.0 VARIATION IN THE RANGE OF PARAMETERS

During the test, the water-flow, range and heat load shall not vary by more than 5%, and shall generally remain within the limits specified in the table above.

The total dissolved solids in circulating water shall remain within design limits. Instantaneous air temperature readings may fluctuate, but variation in averages during the test period shall not exceed the following:

a. Wet bulb temperature : 1°C
b. Dry bulb temperature : 2.5°C

4.0 INSTRUMENTS FOR MEASUREMENT

All the Instruments to be used shall be calibrated.

a. Water flow: The circulating water flow should be measured using a Pitot Tube - Manometer assembly. The flow through the tower should be measured in the hot water header/riser(s) based on

the provisions made by taking either two traverses at 90° if sufficient straight length is available or three traverses at 120° if adequate straight length is not available.

b. Hot Water Temp: The hot water temperatures should be measured by using RTDs with 0.05°C least count. The measurement should be done in the hot water header / riser based on the provisions made.

c. Cold Water Temp: The cold water temperature should be measured by using RTDs with 0.05°C least count. The measurement should be done in the cold-water outlet.

d. Relative Humidity: The Relative Humidity should be derived from the measurement of wet bulb and dry bulb temperatures.

Wet Bulb Temperature (WBT): WBT should be measured using a Mechanically Aspirated Psychrometer with its bulb continuously kept wet by a wick. The air velocity over the temperature sensitive element should be maintained between 3 and 5.4 meters/sec. The thermometers for wet bulb and dry bulb shall be Mercury in glass type with a least count of 0.05°C. The measurement of WBT should be made at about 1.5 to 2.0 m above the sill level and between 15 and 100 meters to wind ward of the tower and equally spread along a line substantially bracketing the flow to the tower.

Readings should be taken at about 5 minute intervals consecutively at various stations. Both the temperatures should be measured in the shade.

The ambient wind velocity should be measured using a rotating cup / vane type anemometer. Calibration of the instrument before the test is necessary. Measurement should be made in an open and unobstructed location upwind of the tower and beyond the influence of inlet air approach velocity.

Location may be selected within 30 m of and to the windward direction of the tower at a point 1.5 to 2 m above the basin curb elevation. This location shall be subject to mutual agreement. Care shall be taken that the wind velocities and direction recorded are the true reflection of the conditions affecting the tower. Wind direction should be recorded with the help of the compass and the tower orientation.

5.0 PROCEDURE FOR THE PERFORMANCE TEST

Tentatively, the test should be conducted for a 4 hour duration and out of this, an hour will be selected which is considered to be of most stable conditions (The test may be terminated earlier in case it is found that the conditions are quite stable for at least one hour duration before the 4 hour period). The average readings will be taken at 10 min. intervals.

The hour when the conditions are most stable shall be considered for the test readings. The measurement tolerance shall be as per codes. As already mentioned the make-up water and purge water will be stopped during the test to avoid uncertainties. However if it is not possible to stop the make-up and purge water, suitable correction shall be applied as per CTI / BS codes.

6.0 FREQUENCY OF OBSERVATIONS

Readings shall be taken at the regular intervals and recorded in the units and to the number of significant digits as shown in the following table:

Measurement	Unit	Min. nos. per hour	Record to nearest
WBT	°C	12	0.1
CWT	°C	12	0.1
HWT	°C	12	0.1
Wind Velocity	km/hr	6	0.1
Water Flow	m^3/hr	3	1

One full Pitot tube traverse readings will be taken prior to conducting the actual test. During the test a minimum of three centre point readings will be taken to verify the flow.

7.0 COMPUTATION OF THE RESULTS

7.1 Computation of Water Flow

The water flow of each diameter traversed shall be determined separately by graphical integration method. The curves shall be plotted with radius against velocity on millimetre graph paper on large scale (not less than 1:5) to minimize computational error. The water flow calculation shall be as per formulae given in CTI Code ATC-105.

The average flow through all the diameters is the calculated flow through the pipe.

7.2 Calculations of the Tower Performance

7.2.1 Determination of predicted cold water temperature

The predicted cold-water temperatures (CWTs) shall be read from the performance curves for 80% to 120% of the rated flow (as the case may be) at the test wet-bulb temperature with range and relative humidity as varying parameters. A first cross-plot is drawn at each of the flow rates and a set of curves are drawn between predicted CWT and relative humidity with range as a parameter.

Scribe the test RH on the above cross-plot to read various predicted CWTs at different ranges for each of the water flow rates. Draw a second plot with between predicted CWTs and different ranges for each of the water flow rates.

Scribe the test range on the above cross-plot to read various predicted CWTs for each of the water flow rates. Draw a third cross-plot between predicted CWTs and water flow rates at the test WBT, range and relative humidity.

Enter the test CWT on the above cross-plot to read the predicted water flow rate.

7.2.2 Determination of Tower Capability

Tower capability should be calculated using the following formula, which is as per ATC-105:

$$\text{Capability} = \frac{\text{Test Water Flow Rate (measured using the Pitot Tube)}}{\text{Predicted Water Flow Rate (determined from the cross-plots)}}$$

7.2.3 Deviation in Guaranteed CWT

The tower capability calculated as above shall be used for determining the deviation in design CWT as per the procedure given in Appendix-M of CTI Code ATC-105.

The allowable tolerance in design CWT shall be subtracted from the above deviation determined as per ATC-105 to arrive at the deviation in guaranteed CWT.

7.2.3 Acceptance Criteria

If the deviation in guaranteed CWT equals zero (after subtracting the allowable tolerance), the tower is deemed to have met the guaranteed conditions.

7.3 Accuracy

To account for the errors in measurements, a tolerance of 0.3°C shall be allowed while determining the deviation in guaranteed CWT as above.

8.0 ARRANGEMENTS TO BE MADE AT SITE

a. By OWNER / PURCHASER

The plant heat load will be maintained as per steady state conditions explained above within the permissible limits of variation.

The circulating water flow, HWT and the dissolved solids concentration will be within the permissible range of variations.

The Condenser, Turbine and the Water Treatment System, if applicable will be maintained in clean condition to ensure that thermal parameters stay within the permissible limits of cooling tower testing.

b. By CONTARCTOR

A working platform shall be erected on each hot water riser or a pit provided across the header (buried), as the case may be, to facilitate flow measurement using pitot tube.

Pitot stubs shall be connected to the HW piping (riser or header, as applicable) along with isolation valves to facilitate insertion of pitot tube for flow measurement.

All the necessary measuring instruments, props, scaffolding, necessary manpower, etc. shall be arranged by the Contractor for the purpose of PG testing.

All such instruments and other appurtenances shall be taken back by the Contractor after successful PG testing of the cooling towers.

SUB-SECTION – IB

SPECIFIC TECHNICAL REQUIREMENTS (ELECTRICAL)

CONTENTS

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C	ELECTRICAL LOAD DATA FORMAT (ANNEXURE-II)	1
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D	REFERENCE QUALITY PLAN	
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	CABLE TRAY & ACCESSORIES	5
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Total Sheet including cover & content sheet = 191

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

SECTION-C

(ELECTRICAL PORTION)

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.

c) Supply of mandatory spares as specified in the specifications of mechanical equipments.

d) Electrical load requirement for Natural draft cooling Tower.

e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer/BHEL approval without any commercial and delivery implications to BHEL

g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.

h) Motor shall meet minimum requirement of motor specification.

i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.

j) Cable BOQ worked out based on routing of cable listing provided by the vendor for " both end equipment in vendor's scope"shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

k) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.

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

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.

3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

PACKAGE: COOLING TOWER (NATURAL DRAFT) Annexure-I
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT **SECTION-C**
PROJECT: UDANGUDI STPP STAGE-I (2x660 MW)

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, fibre Optic cables etc.	Vendor	Vendor	Refer scope/ C&I portion of specification for scope of fibre Optic cables if used between PLC/ microprocessor & DCS.
6	Cabling material (Cable trays, accessories & cable tray supporting system)	Vendor	Vendor	1. Layout details between vendors supplied equipment & installation dwgs by vendor. 2. BHEL will provide cable trench/cable racks/cable pedestals along with cabling material up to the terminal point approx. 10 m away from cooling tower. Further cabling (supply and E&C) shall be in vendor's scope.
7	Cable glands ,lugs, and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
8	Equipment grounding (including electronic earthing) & lightning protection	Vendor	Vendor	Material and sizes shall be as per specification and subject to BHEL approval during detailed engineering stage. Refer note no. 4 for electronic earthing.
9	Below grade grounding	BHEL	Vendor	MS Rod material shall be provided by BHEL. All other materials/ consumables are in vendor's scope.
10	LV Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.

PACKAGE: COOLING TOWER (NATURAL DRAFT) Annexure-I
SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT **SECTION-C**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
11	Lighting System	Vendor	Vendor	In addition to other lighting system items, vendor shall consider aviation lights & their control as per statutory requirement and Lighting panels (LP) & timer control as per requirement. Further wires, any other material required for lighting system shall also be considered by vendor in their scope. **BHEL will provide the power supply along with LDB at one location near Cooling Tower for feeding cooling tower vendor LPs/other lighting loads. Further distribution including material is in vendor scope.**
12	Aviation Lighting	Vendor	Vendor	
13	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
14	**Engineering activities** during detailed engineering stage, including those listed below: a. Electrical load data submission in PEM format b. Electrical equipment GA drawings and layout drawings c. Cable trench/ tray layout drawings d. Control & Instrumentation cable schedules showing routing details [including electronic earthing cable & cables supplied by PEM for CT equipment]. e. Grounding and lightning protection system layouts f. Cable termination/ interconnection details (diagram)/ Cable block diagram	Vendor	--	1. Documentation shall be submitted as per project schedule for BHEL/ customer approval. 2. Vendor shall be responsible for necessary coordination with BHEL for required engineering interfacing during contract stage. 3. Any approval required from electrical inspection authority for electrical equipment shall be arranged by vendor.

NOTES:

PACKAGE: COOLING TOWER (NATURAL DRAFT) Annexure-I

SCOPE OF VENDOR: SUPPLY, CIVIL WORKS, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT **SECTION-C**

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their civil assignment drawing.

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.	VERIFICATION FROM MOTOR DATASHEET (Y/N)	KKS NO
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

ANNEXURE-II

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)/ CUSTOMER

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	435	ORIGINATING AGENCY		PEM (ELECTRICAL)	
	PROJECT TITLE	2X660 MW UDANGUDI STPP	NAME		DATA FILLED UP ON	
	SYSTEM	NATURAL DRAFT COOLING TOWER	SIGN.		DATA ENTERED ON	
	DEPTT. / SECTION	ELECTRICAL	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE	

CABLE SCHEDULE FORMAT

ANNEXURE III

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.

2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.

3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.

4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).

5. The cables shall be described as per the scheme listed below:

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

please refer below examples:

i) 3C x 120 sq. mm. (1.1kV) PVC FRLS, Unarmoured Aluminium cable, the voltage code shall be D03G120
ii) 3C x 2.5 sq. mm. (1.1kV) PVC FRLS, Unarmoured Copper cable, the voltage code shall be D03C2.5
iii) 3.5C x 120 sq. mm. (1.1kV) PVC non-FRLS, Armoured Aluminium cable, the voltage code shall be D3HF120

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)
B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable,

the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

7. For any assistance or clarifications, please contact mailto:praveendutta@bhelpem.co.in

SECTION–3.16: MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT motors, LT Motors and DC motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

a)	IS: 325	Three phase induction motors
b)	IS: 12615	Energy efficient induction motors
c)	IS: 900	Code of practice for installation and maintenance of induction motors
d)	IS: 996	Single-phase AC induction motor for general purpose
e)	IS: 1231	Dimensions of three-phase foot-mounted induction motors
f)	IS: 2223	Dimensions of flange mounted AC induction motors
g)	IS: 4029	Guide for testing three-phase induction motors
h)	IS: 8789	Values of performance characteristics for three-phase induction motors
i)	IS: 13555	Guide for selection and application of 3-phase AC induction motors for different types of driven equipment
j)	IS: 5571	Guide for selection of electrical equipment for hazardous areas
k)	IS: 12065	Permissible limits of noise level for rotating electrical machines
l)	IS: 12075	Mechanical vibration of rotating electrical machines
m)	IS 60034-5	Degree of protection provided by Integral design of rotating electrical machines
n)	IS 60034-8	Terminal marking and direction of rotation
o)	IS 60079-1	Equipment protection by flame proof enclosure
p)	IS 60034-1	Rotating electrical machines.
q)	IS 60079	Explosive atmospheres
r)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
s)	IEC 60034	Rotating electrical machines.
t)	IS 3177	Code of practice for Design, Manufacture, Erection and testing of Cranes and Hoists

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2.0 Supply voltage

Motors rated up to and including 415 V are termed as LT motors and the motors rated higher than 415 V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 6%
- Combined variation of voltage and frequency : 10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

3.3.0 System Parameters

Sl. No.	Description	11 kV and 6.6 kV System	LT System
1.	Voltage level	6.6 kV : Above 200 kW and upto 2000 kW 11 kV: Above 2000 kW	240 V : up to 0.2 kW 415 V: >0.2 kW and up to 200 kW.
2.	System earthing	Earthed through resistance, limiting earth fault current to 300 Amps	415 V system solidly grounded.
3.	Fault withstand rating of motor terminal box (Breaker operated)	50 kA for 0.2 sec for 11 kV and 31.5 kA for 0.2 sec for 6.6 kV	415 V system : 50/65 kA for 0.2 second

3.4.0 Type

AC Motors shall be squirrel cage induction type unless otherwise it is specified.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- All the motors shall be rated for S1 duty for continuous operation. Motors of crane and hoist application shall be intermittent duty.
- DC motor shall generally be of shunt wound type rated for 220 V DC.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.
- The motors shall be suitable for bus transfer schemes provided on the 11 kV/6.6 kV/415 V systems without any injurious effect on its life.

3.6.0 Design margin

Whenever the basis for motor rating are not specified in the corresponding mechanical specification section maximum continuous motor rating shall be atleast 10% above the maximum load derived of the driven equipment under entire operating range including voltage & frequency variation.

The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.

Service shall be considered as 1.0 only.

3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load. Where variable voltage and variable frequency (VVFD) operation is envisaged through VVFD drives, motors shall be specially designed for such application.
- LT motors rated up to 125 kW shall be controlled through MPCB/MCCB and contactor. LT motors rated more than 125 kW shall be controlled through air circuit breaker.
- HT Motors shall be controlled through vacuum circuit breaker.

3.8.0 Efficiency

All the duty motors shall be energy efficient type. 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.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of air cooled motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.
- Temperature rise of water cooled motors shall not exceed 80°C over inlet cooling water temperature by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on-line starting, without exceeding specified winding temperatures.

- HT Motors (up to 1000 kW) : 85% of rated voltage
- HT Motors (> 1000 kW up to 4000 kW) : 80% of rated voltage
- HT Motors (> 4000 kW) : 75% of rated voltage
- LT motors : 80% of rated voltage

b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage shall be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.

c) The motor shall be capable of operating at full load at a supply voltage of 75% of the rated voltage for 5 minutes.

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
- No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
- For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).

3.12.0 Starting current

- Locked rotor current of HT motors for applications other than listed below shall be limited to 600% of the full load current, and is subject to IS tolerance.
- For energy efficient LT motors, locked rotor current shall be as per IS: 12615.
- Locked rotor current of the VFD controlled AC motors shall be limited to 300% of the full load current, and is subject to IS tolerance.
- Locked rotor current of the BFP motors shall be limited to 450% of the full load current of the motor, and is subject to IS tolerance.

3.13.0 Locked rotor withstand time

- 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 atleast 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 speed switch is required, it shall be indicated by the bidder in his offer
- For the LT motors having starting time up to 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- When a speed switch is mounted on the motor shaft, the same shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% over speed in either direction of rotation.

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.

3.15.0 Enclosure

a) Motors shall have IP 55 degree of protection.

b) For hazardous location, the enclosure of motors shall following have flame proof construction conforming to applicable standard.
   - Fuel oil area Group – IIB
   - Hydrogen generation plant area : Group – IIC)

3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self-driven bi-directional centrifugal fan protected by fan cover.
- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA-IC6A1A1) type.
- Motors rated >3000 kW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:

  -Hot and cold air temperatures of the closed air circuit for CACA motors.

  -Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high DV/DT. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240 V AC, 50 Hz supply shall be provided for motors rated 30 kW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand one minute power frequency voltage test or 1.2/50 micro sec lightning impulse Voltage wave of 4U+5 kV (U=Line voltage in kV) test on main insulation as per IEC 600034-15. The coil inter-turn insulation shall withstand steep front impulse withstand voltage as per IEC 600034-15.
- For HT motors, 12 nos. simplex or 6 nos. duplex RTDs (two per phase), each having D.C. resistance of 100 ohms at 0℃, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the ETD's shall be platinum.

3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes. For sleeve bearings, the bearing housing shall be preferably in end shield itself.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.

- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30 kW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10 A at 230 V AC.
- 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.
- For all VFD operated motors shall have insulated bearings to prevent flow of shaft currents.
- For motors rated above 1000 KW having shaft length more than 1.5 M shall have insulated bearings to prevent flow of shaft currents.
- All the motors rated <15 kW shall be provided with sealed ZZ bearings.
- 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.

3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box of HT motors shall be capable of being turned 360° in steps of 180°. Terminal box of LT motors shall be capable of being turned 360° in steps of 90°. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.2 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.
- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fiber glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.
- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motors rated >1000 kW shall be provided with neutral current transformers of PS class on each phase for differential protection in neutral side terminal box. The three phases shall be connected to form the star point after passing through the CTs. The CT details shall be

finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.

- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

In addition to the minimum information required by IEC/IS, the following information shall be shown on motor rating plate:

- Temperature rise in ºC under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Canopy

Canopy shall be provided for all the motors located outdoor. For details, please refer Civil section.

4.0.0 DC MOTORS

DC motors shall be provided where specified/required. DC Motors shall be sized for operation with fixed resistance starting for reliability. DC motors shall be shunt wound type. Motors shall be capable of delivering the rated output at 220 V DC with (+) 10% and (-) 15% variations without exceeding its guaranteed temperature limits. 220 V DC system shall be unearthed. Starting current of the DC motors shall be limited to 200% of the full load current of the motor, and is subject to IS tolerance. DC Motors shall be similar to AC Motors with respect to other features like enclosure type, cooling and class of insulation.

5.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

6.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and

outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be 631 of IS: 5 (smoke grey).

7.0.0 TESTING AND INSPECTION

7.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished for the motors rated 30 kW and above.

7.2.0 The following type tests shall be conducted on LT motors.

- Measurement of resistance of windings of stator and wound rotor.
- No load test at rated voltage to determine input current power and speed
- Full load test to determine efficiency power factor and slip.
- Temperature rise test.
- Momentary excess torque test.
- High voltage test.
- Test for vibration severity of motor.
- Test for noise levels of motor
- Test for degree of protection
- Over speed test.

7.3.0 The following additional type tests shall be conducted on HT motors.

- No load saturation and loss curves up to approximately 115% of rated voltage
- Measurement of noise at no load.
- Momentary excess torque test
- Full load test
- Temperature rise test at rated conditions.
- Lightning Impulse withstand test on the sample coil shall be as per IEC-60034, part-15
- Surge-withstand test on interturn insulation shall be as per clause no. 5.1.2 of IEC 60034, part-15
- Degree of protection test for the enclosure followed by IR, HV and no load run test.
- Terminal box-fault level withstand test for each type of terminal box.

7.4.0 The following routine tests shall be carried out for the motors as per applicable standards.

- IR of Winding before and after HV tests
- HV test on main winding space heater, RTD, BTD
- Resistance measurement
- No load run test Major Electrical
- Phase sequence and direction of rotation
- Vibration check Major Electrical
- Reduced voltage running test
- Locked rotor test at reduced voltage
- Record of RTD & BTD resistance at the end of no load test
- Test on space heater & RTD
- Visual Control of terminal box and verification of construction with respect to short tested terminal box

7.5.0 The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out

- Measurement of vibration.
- Measurement of insulation resistance and polarization index.
- Measurement of full load current.
- Test running of the motors, checking the temperature rise and identifying the hot spot etc.

8.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Motor sizing calculation
- Technical particulars
- General arrangement drawings
- Performance curves (Efficiency, power factor, starting current)
- Characteristic curves (Speed torque, Hot/cold with stand time, Negative sequence current)
- Terminal box details
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SECTION–3.25: CABLE TRAYS, SUPPORTS & ACCESSORIES

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Cable trays & accessories.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

a) Ladder type Cable trays
b) Perforated type Cable trays
c) Cable troughs
d) Cable Tray bends, Tees, Cross, Coupler plates, etc.
e) Cable tray covers
f) Bolted (Unistrut type) cable tray support system
g) Erection hardware
h) Consumables
i) Tools & tackles
j) Any other equipment required for the system

3.0.0 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 following Indian Standards, except where modified and /or supplemented by this specification.

a) IEC: 61537 Cable tray systems.
b) IS: 1079 Specification for hot rolled carbon steel sheet and strip.
c) IS: 1730 Dimensions for steel plates, sheet strips and flats for general engineering purposes.
d) IS: 1363 Hexagon head bolts, screws and nuts.
e) IS: 6005 Code of practice for phosphating iron & steel.
f) IS: 2629 Recommended practice for hot dip galvanising on iron and steel.
g) IS: 2633 Methods for testing uniformity of coating on zinc coated articles.
h) IS: 6745 Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
i) IS: 816 Code of practice for use of metal arc welding for general construction of mild steel.
j) IS:4759 Specification for hot-dip zinc coatings on structural steel and allied products

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Cable Trays

4.1.1 Cable trays shall be ladder type for power and electrical control cables and perforated type for signal cables, prefabricated, made out of hot / cold rolled mild steel sheets complete with matching fittings, accessories and hardware as required. Cable trays shall be with standard width of 150 mm, 300 mm, 450 mm, 600 mm, 750 mm and 900 mm and standard lengths of 2.5 metre or more. Minimum thickness of mild steel sheets used for fabrication of cable trays and fittings shall be 2 mm. For ladder trays, rung spacing shall be 250 mm maximum. The thickness of side coupler plates shall be minimum 2 mm and of tray covers shall be minimum 1.6 mm.

4.1.2 In corrosive areas, FRP cable trays shall be provided in general.

4.1.3 FRP cable trays also shall be provided for the following areas

- Water Treatment Plant
- Coal Handling Plant
- Sea Water intake system
- Interplant cable trays

4.1.4 Separate cable trays shall be provided for the following cables:

- HT Cables
- LT power cables
- Electrical Control cables
- Signal cables
- Fiber optic cables

Cable trays shall be designed to cater to a load of minimum 75 kg/m.

4.1.5 Cable trays shall be complete with matching fittings and accessories (like elbows, bends, reducers, tees, crosses, side coupler plates, etc.) and hardware (like bolts, nuts, washers, etc.) as required. At both the ends of cable trays, four holes shall be provided for fixing side coupler plates. All the slots and coupler holes shall be machine punched.

4.1.6 Cable trays, fittings and accessories and covers shall be hot dip galvanized. Thickness of galvanizing shall be not less than 610 grams/sq.m. Fasteners like bolts, nuts; screws washers etc. shall also be hot dip galvanized.

4.1.7 For branch cabling routes involving fewer cables, sheet steel galvanized cable trough of size 50/75/100 mm shall be provided.

4.1.8 Cable tray covers shall be provided for horizontally laid outdoor trays, on top most trays. It shall be prefabricated made out of hot/cold rolled mild steel sheets, complete with hardware as required. Special clamps shall be provided for fixing tray covers without drilling holes on trays.

4.2.0 Cable Tray Support System

4.2.1 Cable tray supports shall be of prefabricated preformed sections of sheet steel, bolted type and shall be hot dip galvanized.

4.2.2 Cable tray support system shall be similar or equivalent to "Unistrut make". Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of following two types:

- Single channel strut support for supporting cable trays on one side
- Double channel strut support for supporting cable trays on both sides

4.2.3 Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

4.2.4 The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware fittings and accessories shall be prefabricated factory galvanised.

4.2.5 The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc. of the components shall not be allowed.

4.2.6 All steel components, accessories, fittings and hardware shall be hot dip galvanised after completing welding, cutting, drilling and other machining operation.

4.2.7 The typical arrangement of flexible support system shall comprise the following:

4.2.8 The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets conforming to IS.

- Cantilever arms of required length to match cable tray width. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
- The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only.
- Main support channels may be supplied in any suitable lengths to minimize the wastage. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified.

4.2.9 Thickness of galvanizing on steel sections shall be not less than 610 gm/sq.m on all steel sections.

4.2.10 Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval of 1500 mm for outdoor and 2000 mm for indoor locations. Vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000 mm.

4.2.11 The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm.

5.0.0 TESTS

Equipment offered shall be type tested and proven type. Tests shall be carried out for galvanizing thickness of trays and supports. Load test shall be carried out for trays and supports.

Load Test for Cable trays shall be carried out as follows:

A 2.5 metre straight section of each type of cable tray shall be simply supported at the two ends. A uniformly distributed load of 100 kg per meter shall be applied along the length of tray. The maximum deflection at mid span shall not exceed 7 mm.

6.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- General arrangement drawings for trays and fittings
- General arrangement drawings for support system
- Technical data sheet
- Test reports
- Installation details
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SECTION–3.26: CABLING ACCESSORIES

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cabling accessories.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

a) Cable joints & terminations
b) Cable glands
c) Cable lugs
d) Camps
e) Tags
f) Conduits & Pipes
g) Junction boxes
h) Consumables
i) Tools & tackles
j) Any other equipment required for the system

3.0.0 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 following Standards except where modified and /or supplemented by this specification.

a) VDE 0278 Joints and Terminations
b) IS: 13573 Joints and Terminations for polymeric cables for working voltages from 6.6 kV up to and including 33 kV-Performance requirements and type tests.
c) BS:6121 Mechanical cable glands (Part 1 -Specification for metallic glands)
d) IS: 12943 Brass Glands for PVC Cables
e) IS: 8309 Specification for compression type tubular terminal ends for aluminium conductors of insulated cables.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Joints & terminations

4.1.1 Termination and jointing kits shall be of proven design and make which have already been extensively used and fully type tested. Kits shall be complete with all accessories and consumables required for complete termination or jointing. Copper cable lugs & jointing ferrules for straight through joints shall form part of the kit.

4.1.2 Termination and jointing kits shall be suitable for the following types of cables as per IS.

- 19/33 kV earthed grade cable
- 11/11 kV unearthed grade cable
- 6.6/6.6 kV unearthed grade cable
- 1.1 kV grade power cables

4.1.3 Termination kits shall be ‘elastimold’ or ‘Push on type’ or ‘heat shrinkable type’.

4.1.4 Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length. Jointing kits shall be ‘heat shrinkable type’.

4.1.5 Straight through joint and termination shall be capable of withstanding the fault level of 50 kA for 11/11 kV cables and 31.5 kA for 6.6/6.6 kV Cables and 25 kA for 33 kV cables.

4.1.6 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.

4.2.0 Cable glands

Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. Cable glands shall be double compression, weather proof type for armoured cables. For flame proof equipment cable glands shall be of flame proof type

4.3.0 Cable lugs

4.3.1 Cable lugs shall be of aluminium for aluminium cables and tinned copper for copper cables. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solder less crimping type.

4.3.2 Cable lugs for conductors of power cables shall be "heavy duty" long barrel type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.

4.3.3 Solder less crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ ring type/U Type to suit the terminals provided in the panels.

4.3.4 Type of cable lugs shall be as follows:

- Power cables with aluminium conductor : Aluminium crimping type.
- Power cables with copper conductor : Copper crimping type.
- Control Cables : Copper pin type /Copper screw type
- Special cables : pin type / maxi-termi type

4.4.0 Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.
- Clamps shall be of suitable sizes to firmly hold the cables of various outer diameters including tolerance in OD.
- Clamps should have been type tested for Short Circuit Withstand Test.
- For Trefoil clamps run spacing shall be 2000 mm and axial spacing shall be double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

4.5.0 Omega Cable clamps

- Omega clamps shall be of galvanized mild steel and shall be used to fasten the individual multi-core cables.
- Clamps shall be of simple construction, made of 2 mm thick, 25 mm wide strip of omega shape and suitable for clamping on the rungs / perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different outer diameters of cables. Omega cable clamps shall be used for individual cables above 35 mm outer diameter.

- Steel clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre
- For cables of above 35 mm OD, cables shall be individually clamped at 5000 mm interval for Horizontal runs and shall be individually clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

4.6.0 Strip Cable Clamps

- Strip clamps shall be of galvanized mild steel and shall be used to fasten the group of multi-core cables up to 35 mm diameter only on a full or part of the tray width.
- Clamps shall be of simple construction, made of 3 mm thick Steel, 25 mm wide strip to cover the entire width up to 300 mm wide tray and part of the tray for more than 300 mm wide trays. Strip shall have two right angle bends at each end for fixing on to the rung/ perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different sizes of tray width. However, the maximum size of clamp shall be 300 mm and for cable trays of greater width, two clamps shall be used.
- Clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre

4.7.0 Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Type test certificates to ascertain the strength of clamps shall be submitted for Owner's approval.
- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.
- Clamp length shall be selected such that not more than 80% of lockable length is utilised for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35 mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 35 mm OD up to 55 mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 55 mm OD) shall be 7 mm having Tensile strength 60 kg.

4.8.0 Tags

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of aluminium.
- Cable numbers shall be engraved type
- Tags shall be of durable quality of size 60 mm x 12 mm with a tie hole at each end.
- Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

4.9.0 Junction Boxes

4.9.1 Junction box with IP 55 degree of protection shall comprise of a case with hinged door constructed from FRP material. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.

4.9.2 Terminal blocks shall be of 650 Volt grade, rated for 10 A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2Cx2.5mm^2 cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.

4.9.3 The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.

5.0.0 TESTS

Equipment offered shall be type tested and proven type. Test reports shall be submitted for review. For junction boxes degree of protection test shall be carried out.

6.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- General arrangement drawings
- Technical data sheet
- Test reports
- Installation details for junction boxes
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SECTION - 3.24: CABLES

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of cables.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

a) 19/33 kV grade XLPE insulated armoured FRLS power cables
b) 11/11 kV grade XLPE insulated armoured FRLS power cables
c) 6.6/6.6 kV grade XLPE insulated armoured FRLS cables
d) 1.1 kV grade XLPE insulated armoured FRLS cables
e) 1.1 kV grade XLPE insulated armoured FRLS control cables
f) Trailing cables
g) Shielded cables
h) Telephone cables
i) Fiber optic cables

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and / or supplemented by this specification.

a)	IS: 3975	Mild steel wires formed wires and tapes for armouring of cables.
b)	IS: 4905	Methods for random sampling.
c)	IS: 5831	PVC insulation and sheath of electric cables.
d)	IS: 7098 Part-I	Cross-linked polyethylene insulated PVC sheathed cables (LV)
e)	IS: 7098 Part-II	Cross-linked polyethylene insulated PVC sheathed cables (HV)
f)	IS: 8130	Conductors for insulated electric cables and flexible cords.
g)	IS: 10418	Drums for electric cables.
h)	IS: 10810	Methods of tests for cables.
i)	IS: 3961	Recommended current ratings for cables

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Power cables shall be provided for the following systems:

- 33 kV earthed system having phase fault current and earth fault current of 25 kA.
- 11 kV unearthed system having phase fault current of 50 kA and earth fault current of 300 A.
- 6.6 kV unearthed system having phase fault current of 31.5 kA and earth fault current of 300 A.
- 415 V earthed system having phase fault current and earth fault current of 65/50 kA.
- 220 V DC unearthed system having fault current of not less than 25 kA.

4.2.0 Power cables shall be sized to withstand the system fault current for the fault clearing time indicated below:

- Breaker operated Motor feeders and transformer feeders: 0.16 second.
- Breaker operated outgoing feeders: 0.5 second.
- Tie between two switchgear: 0.5 second.
- Incomers: 1 second.

4.3.0 Power cables shall be sized to satisfy the following Criteria:

- To withstand specified system short circuit current for the specified fault clearing time.
- To carry full load current under applicable installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
- To limit the voltage drop under steady state/transient state conditions to permissible values.

4.4.0 Cables shall be armoured type only.

4.5.0 Power cables shall be XLPE insulated. Control cables shall be PVC / XLPE insulated.

4.6.0 PVC insulation shall be suitable for continuous conductor temperature of 70°C and short circuit conductor temperature of 160°C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.

4.7.0 Cables for 33 kV system shall be rated for 19/33 kV earthed grade, cables for 11 kV system shall be rated for 11/11 kV unearthed grade and Cables for 6.6 kV system shall be rated for 6.6/6.6 kV unearthed grade. Cables for 415/230 V AC and 220 V DC shall be rated for 1.1 kV grade.

4.8.0 To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have non-propagating, and self-extinguishing flame retardant, low smoke (FRLS) characteristics. Outer sheath shall be of PVC black in colour. These cables shall meet the following test requirements.

- Oxygen index of minimum 29 when tested as per IS 10810 Part-58
- Temperature index of minimum 250°C when tested as per IS 10810 Part-64
- Acid gas emission of maximum 20% when tested as per IS 10810 Part-59 Average light transmission of 40% minimum when tested as per IS 10810 Part-63 (average smoke density is maximum 60%)
- Flame test requirements as per IS 10810 Parts-53 and 62
- Flame retardant test requirements as per IS 10810 Part-61

4.9.0 For power cables, copper conductor shall be used for current rating of up to 10 A. For higher current rating, conductor can be aluminium/copper. Minimum size of copper conductor shall be 2.5 sq.mm and aluminium conductor shall be 6 sq.mm.

4.10.0 Conductor of control cables shall have plain annealed copper. The minimum size of control cable shall be of 1.5 sq.mm. For CT circuit minimum size shall be 2.5 sq.mm copper. Control cables shall have 20% spare cores.

4.11.0 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and knee point voltage. Minimum 2.5 sq.mm copper cables shall be used for connection of CT to load. In case 2.5 sq.mm size impose unacceptably high burden on CTs, 4 sq.mm copper shall be used. Voltage transformer leads shall be checked for voltage drop which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 2.5 sq.mm copper conductor exceeds this value, higher conductor sizes shall be used.

4.12.0 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.

4.13.0 Design ambient air temperature and ground temperature shall be considered at 50℃ and 40℃ respectively for cable sizing.

4.14.0 For 11 kV & 6.6 kV cables, screen of each core shall be sized to withstand 300 A for 1 sec. For 33 kV cables, screen of each core shall be sized to withstand system earth fault current for 0.16 sec.

4.15.0 For HT motors the voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 2.5% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 5% of rated voltage

4.16.0 For LT motors the voltage drop in the cable, during motor starting condition, shall be limited to 15% and during full load running condition, shall be limited to 3% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 6% of rated voltage.

4.17.0 Cables for the following systems shall be fire survival type.

- DC emergency lube oil pumps
- DC seal oil pump
- DC emergency lighting cables for main building.
- Batteries to chargers and DC distribution boards
- Turbine lub oil pumps
- Jacking oil pumps
- Emergency turbine trip by push button in control room
- Inter trip cables between Boiler master fuel trip and turbine trip relays
- Inter trip cables between Generator trip relays and turbine trip relays/400 kV circuit breaker/generator field breaker/UT breakers

4.18.0 Method of curing for HT XLPE insulation shall be **gas/steam curing**.

4.19.0 Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.

4.20.0 For armoured cables, armouring shall be of aluminium for single core cables. For multicore armoured cables, armouring shall be of galvanised steel.

4.21.0 All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.

4.22.0 Multi-core cable color coding shall be as follows:

- Red, yellow, blue, black and gray for five core cables
- Outer sheath shall be of black in colour.
- For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.

4.23.0 Three core 19/33 kV earthed grade, 11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded semi conducting compound as conductor screen
- Extruded XLPE insulation
- Extruded semi conducting compound as insulation screen
- Copper tape as metallic screen for each core
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.24.0 Single core 19/33 kV earthed grade,11/11 kV unearthed grade, 6.6/6.6 kV unearthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded Semi conducting compound as conductor screen
- Extruded XLPE insulation
- Extruded Semi conducting compound as insulation screen
- Copper tape as metallic screen
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

4.25.0 Multicore 1.1 kV earthed grade cables shall constitute the following:

- Circular / shaped, stranded aluminium conductor (compacted for >10 sq.mm)
- Extruded XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.26.0 Single core 1.1 kV earthed grade cables shall constitute the following:

- Circular stranded and compacted aluminium conductor
- Extruded XLPE insulation
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

4.27.0 **Trailing power and control cables for mobile equipment shall constitute the following:**

Unearthed grade HT power cables, earthed grade LV power cables and control cables shall be flexible trailing with annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed. For HT cables, insulation screen shall be provided. Cables shall conform to applicable IS/IEC standard requirements.

4.28.0 **Fire survival cables**

Fire survival cable shall be of copper conductor and comply with IEC-60331 (withstanding 750 degree C temperature for 3 hours). Also the halogen acid contents in outer sheath shall not be more than 2% when tested as per IEC-60754 and the smoke density in percent light absorption shall not exceed 20% when tested as per ASTM-D-2843. 1.1 kV earthed grade fire survival cables shall constitute the following:

- Circular/shaped stranded and compacted annealed copper conductor
- Elastomeric materials (XLPE, EPR, SR, or LSOH) insulated
- Glass mica tapped
- Extruded FRLS compound or LSOH material as inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS compound or LSOH material as inner sheath

4.29.0 Multicore 1.1 kV earthed grade control cables shall constitute the following as per IS:1554-1 / 7098-1:

- Multi stranded annealed copper conductor
- Extruded PVC / XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.30.0 Multi pair 1.1 kV earthed grade, overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.31.0 Multi pair 1.1 kV earthed grade, individual and overall screened signal cables shall constitute the following as per BS EN 50288-7:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair

- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

4.32.0 **Cable drums**

Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. All wooden parts shall be manufactured from durable quality wood duly seasoned and treated with copper nepthenates or zinc nepthenates for preserving the wood. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by `U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS 10418.

4.33.0 **Cable identification system**

a) In addition to manufacturer's identification on cables as per IS, following marking shall also be embossed/printed on the outer sheath at an interval of one metre throughout the length of cables.

- BIS mark
- Manufacturer's name and or trade mark.
- Year of manufacture
- Cable code
- Type of cable and voltage class.
- Nominal cross section area of conductor and no.of cores.
- Progressive sequential length making.

b) Cables shall be marked as having FRLS outer sheath at every 5 meters.

c) The embossing/printing shall be progressive, automatic, in line and marking shall be legible and indelible.

d) Multi-core cable color coding shall be as follows:

- Red, yellow and blue for three core cables
- Outer sheath shall be of black in colour.
- For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
- For multi pair cables, each pair shall be coloured and numbered.

5.0.0 **TESTS**

Cables offered shall be type tested and proven type. Routine tests shall be carried out on 100% drums. 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. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc.

5.1.0 **Type Test**

a) Tests on conductor

i) Annealing Test (for copper)
ii) Tensile test (for aluminium)
iii) Wrapping test (for aluminium)
iv) Resistance test

b) Tests for armour wires/strips
c) Tests for thickness of insulation and sheath
d) Physical tests for insulation

i) Tensile strength and elongation at break
ii) Ageing in air oven
iii) Shrinkage test
iv) Hot test
v) Water absorption (gravimetric)

e) Physical test for outer sheath

i) Tensile strength and elongation at break
ii) Ageing in air oven
iii) Shrinkage test
iv) Hot deformation
v) Heat shock test
vi) Loss of mass test in air oven
vii) Thermal heat stability test (as per IS : 5831)
viii) Bleeding and blooming test

f) Anti-termite and anti-rodent test (on outer sheath).
g) Partial discharge test
h) Bending test
i) Dielectric power factor test

i) As a function of voltage
ii) As a function of temperature

j) Insulation resistance (volume resistivity) test
k) Heating cycle test
l) Impulse withstand test
m) High voltage test
n) Flammability test
o) Cold impact test

5.2.0 **Acceptance Test**

a) Annealing test (for copper)
b) Tensile test (for aluminium)
c) Wrapping test (for aluminium)
d) Conductor resistance test
e) Test for thickness of insulation and sheath
f) Hot set test for insulation
g) Tensile strength and elongation at break test for insulation and outer sheath
h) Partial discharge test (for screened cables)
i) High voltage test
j) Insulation resistance (volume resistivity) test

5.3.0 **Routine Test**

a) Conductor resistance test
b) Partial discharge test

c) High voltage test

5.4.0 **Special Test**

a) Oxygen index test as per IS 10810 Part-58
b) Temperature index test as per IS 10810 Part-64
c) Acid gas generation test as per IS 10810 Part-59
d) Smoke generation test as per IS 10810 Part-63
e) Flammability tests as per IS 10810 Parts-53 and 62
f) Flame retardant test as per IS 10810 Part-61

5.5.0 **Site Test**

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.
a) Insulation resistance test
b) High voltage test

6.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Design basis report
- Cable sizing calculation
- General arrangement drawings
- Technical data sheet
- Test reports
- Catalogues
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SECTION–3.29: ELECTRICAL INSTALLATION

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Electrical installation and also supply and installation of the following items:

- Rubber mats for switchgear
- Caution boards
- Sand buckets
- First aid box
- Sheet steel cover for /cable shaft/trench etc.
- Sheet steel hood for the outdoor electrical equipment/motor
- Cable route markers & Cable joint markers
- Shock hazard chart
- Erection hardware

2.0.0 CODES AND STANDARDS

Installation of cabling work shall comply with the latest edition of following Indian standards, rules, regulations and acts.

- IS: 1255 : Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
- IS: 732 : Electrical wiring installation (system voltage not exceeding 650 V).
- IS 10028 : Code of Practice for selection, Installation & maintenance of transformers.
- IS 10118 : Code of practice for selection, installation & maintenance of Switchgear & Control gear.
- IS: 5216 : Guide for safety procedures and practices in electrical works.
- IS 2551 : Danger notice plates
- IS 8923 : Warning Symbol for dangerous voltages.
- Indian Electricity Act.
- Indian Electricity Rules.
- Fire insurance regulations.
- Regulations laid down by the Chief Electrical Inspector of the State.
- Regulations laid down by the Factory Inspector of the State.

3.0.0 GENERAL REQUIREMENTS

3.1.0 The work shall be carried out in the best workman like manner in conformity with the latest editions / amendments of relevant specifications / codes / standards / regulations.

3.2.0 Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, erecting, testing and commissioning of all items / equipment and care shall be exercised in handling to avoid distortion to stationary structures, marring to finish, or damaging of delicate instruments or other electrical parts.

3.3.0 All the equipment covered under this specification shall be installed in neat, professional manner such that the structures and equipment are level, plumb, squat, properly aligned and oriented. Clearance around electrical panels / equipment shall be as per relevant standards.

3.4.0 The Contractor shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering. Finished work where required shall be suitably covered to

keep it clean and free from defacement or injury. Contractor shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to Contract.

3.5.0 All safety rules and codes as applicable to work shall be followed without exception. All safety appliance and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Contractor for his personnel.

3.6.0 The Contractor shall provide guards and prominently display caution notices if access to any equipment / area is considered unsafe and hazardous. In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation, before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it.

3.7.0 The Contractor shall have a separate cleaning gang to clean all equipment under erection as well as the work area and the project site at regular intervals to the satisfaction of Owner. In case this is not done, the Owner shall have the right to carry out the cleaning operation and any expenditure incurred in this regard shall be to the Contractor account.

3.8.0 The Contractor shall ensure that instruments and gauges to be used for testing and inspection have valid calibration and the accuracy can be traced to National Standards.

3.9.0 It shall be the Contractor's responsibility to obtain approval from local statutory authorities including Electrical Inspector / CEA, wherever applicable, for carrying out any work or for installation carried out which comes under the purview of such authorities. All such documents and original certificates shall be handed over to Owner which then shall be property of the Owner.

3.10.0 The installation shall be carried out only by electrical Contractor, holding a valid license, issued by relevant authorities for carrying out installation work of the voltage classes involved, under the direct supervision of a person holding valid certificates of competency for the same voltage classes, issued or recognized by the state Government.

3.11.0 The installation shall have to be approved by statutory government authorities like Electrical Inspector, Factory Inspector, Insurance Officials etc. It shall be the responsibilities of Contractor to prepare and submit all necessary drawings, calculations and test certificates to electrical inspectorate and obtain approval/certification prior to installation and commissioning work and also arrange inspection by them after installation.

Necessary fees and other charges for the same shall be paid by Contractor.

3.12.0 Contractor shall take utmost care in holding instruments, relays and other delicate mechanisms wherever these are supplied separately. They shall be installed only after the associated panels have been erected and aligned. The packing materials employed for safe transit of these shall be removed after ensuring that panel have been completely installed and no further movement of the same are necessary. Any damage shall be immediately reported to Owner.

3.13.0 All the electrical equipment, panels, motors, busduct, cables etc. shall be stored under covered shed and oil filled power transformers can be stored outdoor. The OEM recommendation for electrical equipment shall be strictly adhered and proper periodical record shall be maintained, which shall be inspected by Owner.

4.0.0 CABLING CONCEPT

4.1.0 Cabling installations shall be carried out on trays. In all electrical rooms and control rooms, cable spreader room shall be provided. A clear working space of 800 mm shall be provided

horizontally between trays and on either side of the trays. A clear head room clearance of 1800 mm shall be provided in the cable spreader room.

4.2.0 In transformer yard and outdoor switchyard, cables shall be laid in cable trenches. Cable trenches shall have cable trays installed at a vertical spacing of 300 mm between the trays and supported at every 1500-2000 mm to trench wall. Cables shall be laid on trays only. Separate trays shall be provided for each of HT, LT, Control, signal cables. In the cable trench, a clear working space of atleast 600 mm shall be provided adjacent to trays. Cable trenches shall be properly sloped and connected to sump. For Cabling from equipment to trenches, GI pipe can also be used.

4.3.0 For short cable runs in auxiliary plant areas local to equipment shall be laid in floor slits up to near the equipment. Cable trenches are not permitted in other areas.

4.4.0 In the plant buildings and structures cables shall be laid overhead suitably supported on along wall/structures.

4.5.0 All interplant cable tray routing shall be on overhead cable trestles or combined with pipe trestles in a separate tier..

4.6.0 Cable routes shall be segregated unit wise, to the extent possible. Similarly, cables for the standby drives shall preferably be taken through the alternative route. Separate routes shall be considered for duplicate control supply cables, first and second channel protection cables, and cables to common station service of two or more units.

4.7.0 Cables shall be avoided below oil pipes and in the vicinity of steam pipes.

4.8.0 Cable trays shall be laid in vertical formation in boiler, mill and ESP areas to avoid accumulation of coal-dust / ash on cables and cable-trays.

4.9.0 Cables shall not be routed in coal conveyor gallery, a separate cable gallery shall be provided.

4.10.0 In cable trenches, pipe racks/ cable racks, overhead routes, cable shafts and cable spreader rooms, cables shall be laid in cable trays only. Fewer cables installed along buildings, structures, ceilings, walls, etc., which are required to be protected against mechanical damage, shall be taken in GI conduits.

4.11.0 GI Conduits shall be used for flameproof installations, wherever required, with sealing at both ends.

4.12.0 Entry of cables from trenches into buildings shall be atleast 300 mm above finished ground level.

4.13.0 Where direct heat radiation from equipment/pipes exists, heat isolating barriers for cabling system shall be adopted.

4.14.0 Wherever cables are to be laid below roads and railway tracks, the same shall be taken through ducts buried at a suitable depth.

4.15.0 At certain places where leakage of oil or other hazardous material may cause damage to the cables, cable trenches/slits may be sand-filled, after installation of cables.

4.16.0 In corrosive atmosphere, PVC conduits shall be used for routing cables. Metallic pipes / conduits shall not be used in corrosive areas.

4.17.0 Three phase AC single core cables, while laying in steel conduits, shall be laid in trefoil formation only.

4.18.0 Complete cable tray & accessory installation work shall be inspected for proper alignment, leveling (by use of plumb lines), use of proper accessories, provision of proper bending radius and high quality workmanship.

4.19.0 Cable trays shall be ladder type for power and electrical control cables, while perforated type cable trays shall be used for instrumentation and control cables. However, in vertical cable tray risers, all trays shall be ladder type.

4.20.0 Flexible conduits shall be used between fixed conduits and equipment terminal boxes, where vibration is anticipated.

4.21.0 Junction boxes shall be installed so that they are level, plumb & properly aligned and present a pleasing appearance. Boxes shall be adequately supported by means of proper supporting arrangement.

5.0.0 CABLE TRAY AND SUPPORT SYSTEM INSTALLATION

5.1.0 Cable trays shall be bolted to tray mounting supports with a minimum clearance of 300 mm between cable tray tiers / as shown in the drawings.

5.2.0 For horizontal runs in door and in trenches, cable trays shall be supported at an interval of 1500 mm and for outdoor installation it shall be 2000 mm. For vertical cable risers/shafts cables shall be supported at every 1000 mm interval.

5.3.0 Support system shall be so designed that it is able to withstand weight of the cable trays, weight of the cables (75 Kg/metre run for each cable tray), concentrated load of 75 Kg between every support span without any permanent deflection. Factors of safety of atleast 1.5 shall be considered.

5.4.0 Cable tray supports shall be of bolted (similiar to Unistrut) type, which shall be installed at site, by bolts. Fixing of tray supports by welding is not allowed. Cable tray support structure shall be bolted to the steel structure by clamping and to concrete structures by embedding or using anchor fasteners.

5.5.0 All cable way sections shall have identification, designations as per cable way layout drawings and painted/stenciled at each end of cable way and where there is a branch connection to another cable way. Minimum height of letter shall be not less than 60 mm. For long lengths of trays, the identification shall be painted at every 10 meter. Risers shall additionally be painted / stenciled with identification numbers at every floor.

5.6.0 Tray covers shall be provided for outdoor overhead cable trays on top most tiers. Tray covers shall be provided for top tray of horizontal tray runs located under grating floor or insulated piping, and for all trays routed in areas where oil might enter or accumulate. The cable risers or vertical raceways shall also be covered by cable tray covers up to 1.5 metres from respective floor for mechanical protection. The tray cover shall be of galvanized sheet steel, removable type.

5.7.0 Atleast 250 mm spacing shall be maintained between top of the trays and beams/piping etc..

5.8.0 Typical cable tray installation details are shown in the drawings enclosed in Section-7 of Volume-II.

6.0.0 CONDUITS/PIPES/DUCTS INSTALLATION

6.1.0 Rigid steel conduits shall be used indoors in non-hazardous areas. Unplasticised PVC conduit shall be used for duct banks and for some below grade concrete encased conduit.

6.2.0 Exposed conduits shall be routed parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical conduit bends or fittings. Conduits shall be securely supported within 900 mm of connections to boxes and cabinet.

6.3.0 Embedded conduits shall have a minimum concrete cover of 50 mm. All conduits to be embedded in concrete shall be inspected to ensure continuity and accuracy of placement before concrete is poured. All embedded pipes/conduits, sleeves, long radii bends etc. shall have at least 50 mm long extension beyond the embedded part, for extension of the same or for providing end plugs. If any embedded conduit is not required, it shall be plugged/sealed. All accessories/fittings required for making the installation complete, shall include tees, elbows, check nuts brass or galvanized steel end caps, PVC/brass bell mouths for water proof sealing, pull boxes, saddles, spacers and required steel supporting work.

6.4.0 Flexible conduit shall be terminated using suitable end coupler and check nut at both ends.

6.5.0 All conduits installed outdoor shall be sloped towards pull boxes, hand holes/manholes for drainage. Low points of conduits not terminating in pull boxes, hand holes/manholes shall be provided with weep holes for drainage. Care shall be taken to see that no rough edge is left around the weep holes. Where no provision for drainage can be made, both ends of conduits shall be sealed after cable is laid through. Minimum slopes of 1 in 400 shall be provided.

6.6.0 Exposed conduit shall be adequately supported by racks, clamps, straps or by other approved means. Conduits supports shall be erected square and true to line and grade. For bending of conduits, bending machine shall be arranged at site by the Contractor to facilitate cold bending. The bends formed shall be smooth.

6.7.0 When two lengths of conduits are joined together through a coupling, running thread equal to twice the length of coupling shall be provided on any one length to facilitate easy dismantling. The Contractor shall have at site die for threading pipe or conduit. After threading of conduits anti corrosive paint shall be provided.

6.8.0 Occupancy of conduits shall not be greater than 40%.

6.9.0 Liquid tight flexible metallic conduit shall be used for connections to solenoid valves, limit switches; pressure switches etc., and for connection to motors or other vibrating equipment and across areas where expansion or movement of the conduit is required.

6.10.0 Minimum bending radius for conduits shall be 10 times the external diameter of the conduit.

6.11.0 All conduits shall be permanently identified at each end with the conduit number assigned to it as per the applicable drawings.

6.12.0 Pull boxes shall be installed between termination points wherever required to facilitate cable out at a maximum interval of 30 metres.

6.13.0 Conduits shall be firmly fastened within 900 mm of each junction box, cabinet or fitting. Conduits shall be supported at least every 2000 mm.

7.0.0 CABLE INSTALLATION

7.1.0 Power and control cables shall be laid on separate tiers. The laying of different voltage grade cables shall be on different tiers according to the voltage grade of the cables. Generally HT cables shall be laid on top most tier and cables of subsequent lower voltage grades on lower tiers of trays. Separate cable trays shall be used for the following:

- HT Power Cables
- LT Power Cables
- Control Cables

- Instrumentation/communication cables
- Fire Survival cables

7.2.0 Single core cable in trefoil formation shall be laid with spacing equal to the diameter of the Trefoils and clamped at every two metre. All multicore cables shall be laid in touching formation. Power and control cables shall be securely fixed to trays /supports with self-locking type nylon cable strap with de-interlocking facility at every 5 meter interval for horizontal run and cables laid in vertical run of trays shall be securely fixed to trays/supports by galvanized steel clamps at every one metre interval. All power cables should be clamped individually.

7.3.0 HT cables and LT power cables of >16 sq.mm shall be laid in one layer only. LT power cables of up to 16 sq.mm can be laid in two layers. Control cables can be laid in 3 layers.

7.4.0 Bending radii for cables shall be as per manufacturer's recommendations.

7.5.0 Where cables cross roads/rail tracks, the cables shall be laid in hume pipes embedded in ground with a minimum cover of 1 metre or with RCC covering for lower depth.

7.5.0 In each cable run some extra length shall be kept at suitable point to enable one straight through joints to be made, should the cable develop fault at a later stage. Control cable termination inside equipment enclosure shall have sufficient lengths so that shifting of termination in terminal blocks can be done without requiring any splicing.

7.6.0 For Directly Buried cables, construction of cable trench for cables shall include excavation, preparation of sieved sand bedding, riddled soil cover, concrete protective covering, back filling and compacting, provision of route markers and joint markers. Before the cables are placed, the excavated portion shall be filled with a layer of sand and leveled. The cables laid over it shall then be covered with 150 mm sand on top of the largest diameter cable and sand shall be lightly pressed. A protective covering of concrete shall then be provided on top. The remaining portion of the excavated trench shall then be back filled with soil, rammed and leveled.

7.7.0 RCC cable route and RCC joint markers shall be provided wherever required. The voltage grade of the higher voltage cables in route shall be engraved on the marker. Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable Joint'. The marker shall project 75 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road crossings and drain crossings. Top of cable marker/joint marker shall be sloped to avoid accumulation of water/dust on marker.

7.8.0 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry, and at every 30 meters in cable tray/trench runs. Cable tags shall also be provided inside the switchgear, motor control centers, control and relay panels etc. where a number of cables enter together through a gland plate. Cable tag shall be of rectangular shape for power cables and control cables. Cable tag shall be of 2 mm thick aluminium with number punched on it and securely attached to the cable GI wire.

7.9.0 Where a cable route crosses a permanent road/railway line cables shall be drawn through hume pipes or G.I. pipes. Pipes should be laid in a straight configuration. Filling criteria in any pipe shall not be more than 40%.

7.10.0 Conduits shall be used for routing of cables (power / control) from cable trays to equipment/ junction boxes. Pipe sleeves shall be used for routing of cables between floors, road crossing, entry/exit from outside of building etc. All conduits/pipe shall have their ends closed by caps till the cables are pulled. After the cables are pulled, the ends shall be sealed by suitable sealing compound having 2 hour fire withstand capability.

7.11.0 The location of cable joints, if any, shall be clearly indicated with cable marker with an additional inscriptions "Cable-Joint" and "Cable Number".

8.0.0 CABLE TERMINATION AND JOINTING

8.1.0 All cable entries in the equipment shall be sealed by cable glands.

8.2.0 Adequate length of cables shall be pulled inside the switchgear, control panels, terminal boxes etc. so as to permit neat termination of each core / conductor.

8.3.0 Power cable terminations shall be carried out in a manner such as to avoid strain on the terminals by providing suitable clamps near the terminals.

8.4.0 Control cable cores entering switchgear or control panels shall be neatly bunched and strapped with PVC perforated tapes / nylon ties and suitably supported to keep them in position at the terminal block. All spare cores shall be connected to spare terminals, wherever possible. If spare terminals are not available, spare cores shall be neatly dressed and suitably taped at both ends.

8.5.0 Screened control cables of small cross sectional area, shall be terminated by means of Maxi-Termi termination system.

8.6.0 Termination and jointing of HT cables shall be done with approved type termination/ jointing kits. Cable joints are permitted, only when the route length exceeds one full drum length.

8.6.0 Screened control cables of small cross sectional area, e.g. 0.5 mm^2, shall be terminated by means of maxi-termi termination system. Contractor shall ensure the availability of all tools, tackles and accessories such as maxi-termi guns, clips, wire etc. required for the termination of small cross section screened control cables by this method. Compressed air supply for maxi-termi guns shall also be the responsibility of Contractor.

8.7.0 Individual cores of control cables shall have ferrules for identification. Ferrule numbers shall be provided as per control schemes and other related documents. The spare cores shall be ferruled as spare.

8.8.0 Fiber optic termination and splicing equipment shall be used for cutting, finishing and joining fiber optic cables. An optical fiber tool shall be used to slice into the cable's outer coating and unpack the fibers without damaging them. Fiber optic cleaners, cleaning chemicals or solvents and cleaner dispensers shall be used for preparation of the cut and polished joint or splice. Fiber optic cables shall be terminated by using connectors to couple the cable to network devices. Fiber optic connectors shall be specifically designed to limit light loss and provide a secure connection to a device. The fiber optic termination connectors shall have a bayonet mount and a cylindrical ferrule to hold the fiber in place.

9.0.0 OVERHEAD LINE STRINGING WORK

9.1.0 Stringing work shall mean the activities of fixing of insulator and insulator hardware, jointing, tensioning, clamping with armour rod, providing dampers, repairing of conductors (if any), fixing the conductor at tension hardware etc.

9.2.0 The stringing work shall be carried out with the help of tensioner and puller machine. Manual stringing shall not be allowed. Stringing work shall be carried out as per approved sag tension chart.

9.3.0 Sufficient numbers of aluminum snatch blocks shall be used for paying out the conductors. Necessary precautions shall be taken to avoid conductor rubbing on the ground by providing

adequate ground roller, rollers on supports etc. Additional rollers shall also be provided to cross thorny hedges, footing and other obstructions to avoid scratching of conductor.

9.4.0 The conductor and earth wire shall be made to sag correctly as per stringing charts, before they are finally transferred to the hardware for conductors and to clamps for earth wire. No joint shall be made at less than 30 m from the tower end and no joint shall be permitted in road and other important crossings spans. There shall not be more than one joint in a span of each conductor.

9.5.0 Dynamometers shall be used in tensioning the conductors. All conductors shall be stressed to their maximum working load at the time of stringing, as per approved stringing charts. The minimum clearance between the lowest point of conductor and ground shall not be less than required.

9.6.0 The stringing sheaves, when suspended on the transmission structure for sagging, shall be so adjusted that the conductor shall be on the sheaves at the same height as the suspension clamp to which it is to be secured.

9.7.0 Proper guys shall be provided to counter balance the paving out tension of conductor / earth wire at the tension locations, to avoid damage to towers and / or accident.

10.0.0 SAFETY REQUIREMENTS

10.1.0 Provisions of Indian Electricity Rules in respect of various safety requirements (especially as provided at Rule 29, 35, 36, 42, 43, 44, 64, 74 to 80, 87 & 92) shall be complied with.

10.2.0 The minimum safety working clearances shall be maintained for the bare conductors or live parts of any apparatus in outdoor substations as per IE rule 64 a) ii).

10.3.0 All practical steps shall be taken to prevent operating the earth moving, lifting and housing machinery in dangerous proximity to a live overhead power line.

10.4.0 Barricades or barriers shall be installed to prevent accidental contact with energized lines or equipment. Where appropriate, signs indicating the hazard shall be pasted near the barricade or barrier.

10.5.0 Rubber gloves and insulated shoes shall invariably be worn in all cases while operating gang operating switches controlling high tension lines and equipment where accidental contact of operating personnel with live parts are likely. While working near live lines and equipment and working on live low-tension lines and equipment, gloves shall be worn.

10.6.0 Safety belts shall invariably be used in all cases while working on overhead systems like lines, bus bars, substation equipment etc.

10.7.0 Tested rubber mats shall be kept in front of operating panels / switches etc. They shall be checked for condition periodically and replaced as necessary.

10.8.0 First aid box shall be maintained. These shall be checked periodically and refilled or items replaced as necessary.

10.9.0 Chart for providing relief and treatment of person electrocuted shall be displayed prominently at suitable places in the substation. These shall be checked for condition periodically and replaced as and when necessary.

10.10.0 Firefighting equipment such as fire buckets filled with sand and fire extinguishers for both electrical and oil fires shall be maintained and kept at easily accessible place in substation

10.11.0 The Contractor shall supply and install all danger plates as per IS 2551. The danger plates shall be written in Hindi, local language and English and shall be provided as required for all electrical equipment.

10.12.0 All safety appliances and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Contractor for his personnel.

10.13.0 The following minimum safety working clearances shall be maintained for the bare conductors or live parts of any apparatus in outdoor substations excluding overhead lines of installations of voltage exceeding 650 volts.

Highest System Voltage (kV)	Safety Working Clearance (Metres)
12	2.6
36	2.8
72.5	3.1
145	3.8
245	4.6
420	6.4

10.14.0 The above safety working clearances are based on an insulation height of 2.44 m, which is the height of lowest point on the insulator (where it meets the earthed metal) from the ground.

11.0.0 TESTING AND COMMISSIONING

11.1.0 The Contractor shall take full responsibility of testing at erection, pre-commissioning and commissioning stages of all the equipment / system being installed by him. The Contractor shall submit to the Owner a checklist for testing and commissioning and the activities shall be carried out in accordance with the checklist. The Contractor shall carry out the commissioning tests and checks after erection at site as per applicable standards and also as recommended by manufacturers.

11.2.0 On completion of erection work, the Contractor shall request the Owner for inspection and test. The Owner shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor. The installation shall be then tested and commissioned in the presence of the Owner and put on trial run for stipulated contract period.

11.3.0 The Contractor shall arrange for inspection of his installation work by Electrical Inspector and shall obtain necessary approval certificate for his installation work and charging. Any modification work required by Electrical Inspector must be undertaken by the Contractor at his own cost. All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.

11.4.0 Following successful inspection and testing, all the equipment shall be commissioned and put on trial run in a manner mutually agreed upon based on the commissioning schedule.

11.5.0 The Contractor shall have to bring all testing equipment and instruments in sufficient numbers to carry out the job simultaneously in more than one area. Tests shall be conducted by qualified and experienced personnel. Valid calibration certificates for the testing equipment shall be produced.

11.6.0 All documents / records regarding test data and all other measured values shall be submitted to Owner for approval and subsequent record and reference. The results of all tests shall conform

to the specification requirements as well as any specific performance data guaranteed during finalization of Contract.

11.7.0 All checks and tests as per manufacturer's drawings / manuals, relevant codes of installation and commissioning checklists for various electrical equipment such as transformers, breakers, motors, switchgear, relays, meters etc. shall be carried out.

11.8.0 The Contractor shall perform operating tests on all switchgear and panels to verify operation of switchgear / panels and correctness of the interconnections between various items of the equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment for functional checking of all control circuits, e.g. closing, tripping, control interlock, supervision circuits, alarm circuits etc. All connections in the switchgear shall be tested from point to point for possible earth or phase faults.

11.9.0 Contractor shall submit specified copies of site testing procedures, test formats along with details of site test instruments proposed to be deployed at site along with respective valid calibration certificates, six weeks prior to commencement of site testing, for approval by Owner. Only procedures and test formats approved by Owner shall be used for site testing. After completion of commissioning of all equipment and prior to handing over, six sets of such signed test data in the agreed / approved formats shall be furnished prior to issue of provisional acceptance of the equipment / installation.

11.10.0 The testing of all electrical equipment as well as the system as a whole shall be carried out at site to ensure that the equipment and its components are in satisfactory condition and shall successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted design, engineering and construction standards as well as accepted codes of practice.

11.11.0 All tests shall be carried out by the Contractor using his own instruments, testing equipment as well as qualified testing personnel.

11.12.0 The results of all tests shall conform to the specification requirements as well as any specific performance data guaranteed during finalization of the Contract.

11.13.0 At site, all equipment shall be energized only after certification by the personnel performing the test that the equipment is ready for energizing and with concurrence of the Owner.

11.14.0 The various commissioning checks / tests to be carried out shall be in accordance with applicable standards and equipment supplier's recommendation.

11.15.0 Site tests

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

a. Cables

- Check for physical damage.
- Check for insulation resistance before and after termination/ jointing.
- HT cables shall be pressure tested before commissioning.
- Check of continuity of all cores of the cables.
- Check for correctness of all connections as per relevant wiring diagrams.
- Check for correct polarity and phasing of cable connections.
- Check for proper earth connections for cable glands, cable boxes, cable armour, screens etc.
- Check for provision of correct cable tags, core ferrules, and tightness of connections.

b. Cable trays/ supports and accessories

- Check for proper galvanizing/ painting and identification number of the cable trays/ supports and accessories.
- Check for continuity of cable trays over the entire route.
- Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
- Check for earth continuity and earth connection of cable trays.

12.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Block diagram for cabling
- Typical details of cabling installation
- Details of cable trays and accessories
- Layout of IPB Busduct , Segregated phase Busduct layout and 415 V NSPB Busduct
- DG Room layout
- Transformer Yard Layout
- Electrical room equipment layout for Power house building
- Electrical equipment layout for ESP building
- Electrical room equipment layout for various auxiliary buildings
- Electrical room equipment layout for non-plant buildings
- Cable Trench layout for Transformer Yard
- Cable routing layout for power house building
- Cable routing layout for Boiler floors
- Cable routing layout for ESP
- Interplant Cable routing layout
- Cable routing layout for Main control building
- Cable routing layout for switchyard and switchyard control building
- Cable routing layout for DG building
- Cable routing layout for all electrical rooms & control rooms
- Cable Routing layout for all plant buildings
- Cable Routing layout for all non-plant buildings
- Cable Schedule for power cables, control cables and signal cables for all Switchgear, equipment and control panels
- Interconnection Schedule for all Switchgear, equipment and control panels
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SECTION–3.28: EARTHING & LIGHTNING PROTECTION SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Earthing & Lightning protection system.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following:

a) Buried earth mat for the main plant, auxiliary plants, non plant buildings and switchyard
b) Embedded earth mat in the concrete floor of buildings, electrical rooms including GIS building.
c) Equipment enclosure earthing for all electrical equipment
d) Earthing of all metallic structures including cable racks
e) Electronic earthing for all DCS/Respective control system/SAS/EMS and other electronic equipment
f) Earthing for communication system
g) Lightning protection for GIS building, Switchyard and transformer yard
h) Lightning protection for main plant building, Boiler, ESP
i) Lightning protection for Chimney
j) Lightning protection for Cooling tower
k) Lightning protection for Ash silo structure
l) Lightning protection for CHP buildings and structures
m) Lightning protection for Ash buildings and structures
n) Lightning protection for all auxiliary plant buildings/structures and outdoor equipment/structures
o) Lightning protection for all non-plant buildings and structures

3.0.0 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 following Standards except where modified and /or supplemented by this specification.

a) IS: 3043 Code of Practice for Earthing
b) IS: 2309 Protection of building and allied structures against lightning - Code of practice
c) IS: 1079 Specification for hot rolled carbon steel sheet and strips
d) IS: 2629 Recommended practice for hot dip galvanizing on iron & steel
e) IS: 4759 Specification for hot-dip zinc coatings on structural steel and , allied products
f) IS: 6745 Methods for determination of weight of zinc-coating on zinc coated articles.
g) IEEE 80 IEEE Guide for safety in AC substation grounding
h) IEEE 142 Grounding of industrial & commercial power system.
i) CBIP manual on AC earthing system
j) Indian Electricity Rules

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Earthing System

4.1.1 Earthing system shall be provided for complete power station including switchyard.

4.1.2 Earthing system shall comprise the following:

- Neutral earthing to establish the ground reference of the electrical system
- Safety ground connections for protecting personnel from injury and property from damage
- Equipment earthing to ensure a low impedance return path for ground current should an electrical fault occur between the live conductors and the equipment enclosure

4.1.3 Various system earthing envisaged in the power project are as follows:

S. No.	System Voltage	Neutral	Maximum earth fault current
1.	400 kV system	Solidly earthed	63 kA
2.	33 kV system	Solidly earthed	25 kA
3.	Generator	High impedance earthed	10 A
4.	11 kV system	Medium resistance earthed	300 A
5.	6.6 kV system	Medium resistance earthed	300 A
6.	415 V system	Solidly earthed	65/50 kA

The safety and equipment earthing systems should meet the following requirements:

a) All metallic enclosures on equipment and exposed noncurrent-carrying conductive materials capable of becoming energized due to either insulation failure, inadvertent contact with an energized conductor, or building up of a static or induced voltage should be earthed.

b) The earthing arrangement should ensure a deliberate earth fault current return path, so that the (overcurrent or earth fault) protection shall sense the fault and either trip the faulty circuit or provide an alarm to the station operator.

c) The earthing should limit the step and touch voltage to acceptable limits during an earth fault.

d) The earthing conductors and connections should withstand the earth fault current for the duration of the fault, without being damaged by thermal, thermo-mechanical or electromechanical stresses.

e) The earthing conductors should be continuous; no switching device should be inserted in the earthing conductors (except where the operation of the switching device shall also automatically disconnect all power sources to the equipment earthed by that conductor).Equipment enclosures should not be used as part of the earthing conductor.

f) The earthing conductors should be mechanically reliable or protected in order to withstand any possible mechanical stress imposed on them. The exposed connections of earthing conductors should be accessible for inspection.

g) The earthing system should be designed to minimize corrosion to adjacent structures, equipment and enclosures.

4.1.4 The earth mat design for GIS building , switchyard and transformer yard shall be designed as per IEEE 80. The earthing system of Switchyard shall meet the following requirements:

- Ensure adequate earth fault current for operation of earth fault protection
- Limit step and touch voltages to acceptable limits during earth fault
- Earthing conductors and connections shall withstand earth fault current for the duration of the fault

4.1.5 The earth mat shall be designed with grid spacing such that safe voltage gradients are maintained. Earth conductors shall be installed below ground shall be spaced in a grid pattern to provide the earthing mesh grid throughout the site. Switchyard earth mat shall be interconnected with main plant earth mat by a minimum of two parallel conductors.

4.1.6 The mild steel earth grid shall be designed to withstand 40 years of corrosion and still retain safe touch and step potentials in accordance with IEEE 80. Corrosion rate shall be arrived at as per soil resistivity report.

4.1.7 The earth mat of the station shall be designed such that the total ground resistance does not exceed 0.5 ohm.

4.1.8 Earth mat and all earthing conductors for GIS building earthing shall be of copper. The earthing conductor material for other locations shall be corrosion resistant steel.

4.1.9 400 kV system earth fault current of 63 kA shall be considered for earthing design. The earthing design shall consider the following:

- Earth fault current duration for conductor sizing : 1 sec
- Shock duration for mesh sizing : 0.5 sec
- Depth of buried earthing conductor : minimum 600 mm
- Human body weight for step / touch voltage calculation : 70 kg
- Resistivity of concrete : 500 ohm m

4.1.10 Contractor shall carry out earth resistivity test of power project site and shall establish homogeneous soil resistivity for earthing design. Number of earth resistivity test locations shall be not less than 10. The test locations shall be subject to Owner's approval.

4.1.11 For Gas insulated switchyard the following aspects shall be considered:

- All metallic enclosures should normally operate at ground voltage level.
- When grounded at the designated points, the bus enclosure design should ensure that no significant voltage differences exist between individual enclosure sections and that neither the supporting structures nor any part of the grounding systems is adversely influenced by the flow of induced currents.
- To avoid the circulation of enclosure currents beyond regular return path within the GIS assembly, power cable sheath grounds should be tied to the grounding system via connections that are separated from the GIS enclosures. Very fast transients generated by switching or by faults in the GIS may cause these insulation elements to flashover. In such cases, the consequences of such flashovers on current distribution within the grounding system should be considered.
- Enclosure return currents also cannot be permitted to flow through any mounted current transformers.
- In GIS building, earth mat of copper flat shall be embedded in the concrete floor in grid / mesh form. Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.

4.1.12 The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences. The following shall be ensured.

- The grounding system shall ensure safe touch & step voltages in all the enclosures
- All GIS equipment, bus ducts, enclosures, control cabinets, supporting structure etc. shall be connected to the ground bus of GIS.
- The enclosure of the GIS shall be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections

should be provided for each of circuit breaker, transformer terminals, cable terminals, surge arrestors, earth switches and at each end of the bus bars.

- The grounding continuity between each enclosure shall be effectively interconnected with copper bonds of suitable size to bridge the flanges.
- Suitable measure shall be provided to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, phase/ earth fault and discharges between contacts during switching operation. Suitable barrier of non-linear resistor at SF6/ Air termination, cable bushing etc. to mitigate transient enclosure voltage shall be provided.

4.1.13 Earthing terminal of each lightning arrester and capacitor voltage transformer shall be directly connected to earth electrode which in turn, shall be connected to station earthing grid.

4.1.14 Isolation of main plant earth mat and GIS Switchyard earth mat shall be provided by test link.

4.1.15 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it.

4.1.16 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

4.1.17 Earthing conductor shall be buried 2000 mm outside the Switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

4.1.18 For the power house building involving turbine hall, boiler and ESP, earthing conductor shall be buried in ground in mesh form to enable earthing of all major steel structures, electrical equipment etc.

4.1.19 For auxiliary plants, earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. Earth risers shall be extended to the building interior for equipment earthing.

4.1.20 In all the electrical rooms, earth mat (galvanized steel flat) shall be embedded in the concrete floor in grid / mesh form. Earthing conductors embedded in the concrete floor of the building shall have approximately 50 mm concrete cover.

4.1.21 Earth pit shall be constructed as per approved drawing. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 6000 mm. Earth pits shall be treated with salt and charcoal.

4.1.22 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment / structure foundations. Earthing conductors crossing the road / rail tracks shall be laid at 600 mm depth.

4.1.23 All earth electrodes shall preferably be driven to a sufficient depth to reach permanently moist soil. Electrodes shall preferably be situated in a soil which has a fine texture and which is packed by watering and ramming as tightly as possible. The electrodes shall have a clean surface, not covered by paint, enamel, grease or other materials of poor conductivity.

4.1.24 Earth pits shall be located avoiding interference with road, building foundation, column, equipment foundation etc. The disconnect facility shall be provided for individual earth pits to check their earth resistance periodically. Proper symmetry and distance between earth pits shall be maintained as per applicable standards and procedures. Treated earth pits shall conform to relevant standard.

4.1.25 Construction of trench for earthing conductor shall include excavation, laying of conductor, back filling and compacting. Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Minimum earth coverage of 300 mm shall be provided between earth conductor and the bottom of trench / foundation / underground pipes at crossings.

4.1.26 HV Neutral point of the following transformers shall be directly connected to earth through two numbers treated earth pit.

- Generator transformers
- Standby transformer
- 33 kV winding of Auxiliary transformer

4.1.27 LV Neutral point of the following transformers shall be directly connected to earth through two numbers treated earth pit.

- LT Service transformers

4.1.28 LV Neutral Points of the following transformers shall be connected to Neutral Grounding Resistors (NGRs). NGR shall be connected to earth through two numbers treated earth pit.

- Unit transformer
- Station Transformer
- Unit auxiliary transformer
- Station auxiliary transformer
- Other auxiliary transformers

4.1.29 Earth pits/earth electrodes shall be interconnected to near by station earthing grid.

4.1.30 For equipment earthing, earthing conductor shall be sized to withstand earth fault current of the system for the duration permissible by the protection device. Thickness of galvanising shall be atleast 610 gm/sq.m for all steel conductors.

4.1.31 Size of the earthing conductor shall be not less than the following:

Sl. No.	Equipment	Size/ type of Earthing material
1)	Main earthing conductor / Earth mat	40 mm dia corrosion resistant steel rod
2)	Earth risers from earth mat	40 mm dia corrosion resistant steel rod or 65X8 mm size GS flat
3)	Rod earth electrode	40 mm dia corrosion resistant steel rod
4)	Earth conductor embedded in concrete in GIS building	Copper flat
5)	Earth conductor embedded in concrete	50X6 mm GS flat
6)	Treated earth pit for power circuit	Minimum 65 mm dia galvanized steel pipe electrode as per IS:3043
7)	Electronic earthing	Chemical earth pit with copper electrode
8)	EHV Equipment	
	a) Equipment earth pad to structure, Structure to earth mat	2 nos. 75X8 mm galvanized steel (GS) flat
	b) Control cubicle, Mechanism box	2 Nos. 50X6 mm GS flat

Sl. No.	Equipment	Size/ type of Earthing material
	c) Lightning arrester Insulating base to surge counter	50 mm^2 copper cable
	d) Lightning arrester Surge counter to earth (without touching structure)	75X8 mm GS flat
	e) CVT neutral to earth electrode	75X8 mm GS flat
	f) Earth switch rod to isolator frame	2 nos. copper flexible
9)	Switchyard Towers	
	a) Tower peak to test link	7/3.66 mm galvanized steel shield wire
	b) Test link to main earth mat	50X6 mm GS flat
	c) Structure to earth mat	75X8 mm GS flat
10)	HT transformers (enclosure and neutral)	65X8 mm GS flat
11)	LT transformers (enclosure and neutral)	75X8 mm GS flat
12)	DG set (enclosure and neutral)	50X6 mm GS flat
13)	Generator, LAPT, NGT, NGT neutral	50X6 mm GS flat
14)	HT Switchgear, HT motors, HT busducts	50X6 mm GS flat
15)	LT Switchgear (PCC & MCC), LT busduct	75X8 mm GS flat
16)	All distribution boards	50X6 mm GS flat
17)	LT motors of 75 kW and above	50X6 mm GS flat
18)	LT motors of 30 kW to <75 kW	32X5mm GS flat
19)	LT motors of 9.3 kW to <30 kW	25X3mm GS flat
20)	LT motors of 5.5, 7.5 kW	4 SWG GS wire
21)	LT motors of <5 kW	6 SWG GS wire
22)	Charger / UPS	50X6 mm GS flat
23)	Lighting panels	25X6 mm GS flat
24)	Relay panels / SAS panel	25X6 mm copper flat
25)	Cable trays	50X6 mm GS flat
26)	CT junction box / PT junction box	50X6 mm GS flat
27)	Lighting / Control junction boxes	14 SWG GS wire
28)	Lighting poles/masts	20 mm dia, mild steel earth electrode
29)	Local push button stations	8 SWG GS wire

4.1.32 Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity. Steel columns, metallic stairs, hand rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing.

4.1.33 Metallic conduits shall not be used as earth continuity conductor.

4.1.34 Flexible earthing connectors shall be provided for moving parts.

4.1.35 50 mm x 6 mm galvanized steel flat shall run all along the cable tray routes and the same shall be welded / connected to each of the tray /rack. Further, this flat shall be earthed at both ends and at an interval of 30 m.

4.1.36 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making earth connection. Equipment bolted connections, after being checked and tested, shall be painted with anti-corrosive paint / compound.

4.1.37 Connection between earthing conductors shall be welded type. For rust protection, the welds shall be treated with red lead and coated with two layers bitumen compound.

4.1.38 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

4.1.39 Metallic sheaths and armour of all multi-core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

4.1.40 Earthing conductors along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 1000 mm. Wherever it passes through walls, floors etc., pipe sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

4.1.41 Railway tracks within the plant area shall be bonded across fish plates and connected to earthing grid at several locations.

4.1.42 Electronic panels and equipment shall be grounded utilising an insulated copper ground wire terminated at separate earth electrode.

4.1.43 For electronic equipment such as DCS, Respective control system, SAS, EMS etc., chemical earthing pit shall be provided. The earth pit shall be tested and proven type and shall be guaranteed for service life of 40 years. The chemical earth pit shall comprise pipe electrode, crystalline conductive mixture, bentonite etc. constructed in a pit of not less than 4000 mm depth. The pit shall be effective in all weather conditions and offer medium resistance. For electronic earthing system, earthing conductor shall be of copper.

4.1.44 **Earthing of chimney**: Earthing shall be carried out by routing 50x6 mm galvanised steel strip earthing conductor from chimney top up to ground. Each earthing conductor shall be earthed by using 40 mm dia 4 metre mild steel rod and shall also be interconnected with the power station earthing grid.

4.1.45 Earthing of cabling system

- Armour of the HT cables and LT single core cables shall be earthed only at one end of cable.
- Armour of other cables shall be earthed at both ends of cable.
- Screen of HT power cables shall be earthed at one end only.
- Screen of C&I screened control cables shall be earthed at one end.
- Screen of electronic earthing system cables shall be earthed as per the requirements.

4.1.46 After completion of grounding system installation, the measurement of ground resistance shall be performed by the Contractor. continuity of earth conductors and efficiency of all bonds and joints shall be checked. Before measurement, the overhead ground wires shall be disconnected from the GIS Switchyard. The method of measurement shall be as per relevant standards / codes. The ground resistance of GIS Switchyard grounding system shall be not more than 0.5

ohm. Earth resistance at earth terminations shall be measured in presence of Owner's representatives

5.0.0 LIGHTNING PROTECTION SYSTEM

5.1.0 Direct stroke lightning protection (DSLP) shall be provided in the GIS Switchyard by lightning masts and shield wires including connections, earth pits etc. to make the lightning protection complete for the outdoor GIS Switchyard including reactors. The arrangement shall be based on DSLP calculations. Contractor shall furnish necessary design calculation for approval by Owner.

5.2.0 The lightning protection system in the transformer yard shall cover the following equipment in the protection zone.

- Generator transformers
- Station transformers
- Standby transformers
- Auxiliary transformers

5.2.0 All areas of the power station shall be provided with lightning protection. The lightning protection system for buildings shall consist of air termination network, down conductors, test link and earth electrodes.

5.3.0 Air termination network consisting of vertical or horizontal conductors or combination of both shall be provided for the building. Down conductors shall follow the most direct path possible between the air terminal network and the earth termination network. Each down conductor shall be provided with a test link for testing. An earth electrode shall be connected to each down conductor.

5.4.0 For Lightning protection, material & sizes shall be as follows:

- Vertical air termination : 20 mm dia galvanised steel rod
- Horizontal air termination : 25X6 mm Galvanised steel Strip
- Down conductor : 25X6 mm Galvanised steel Strip
- Test link : 150x50x6 mm Galvanised steel Strip with Box
- Earth Electrodes : Treated earth pit with rod electrode as per IS:3043

5.5.0 Thickness of galvanising shall be atleast 610 gm/sq.m for all galvanised steel conductors.

5.6.0 The lightning protection system shall not come in direct contact with other equipment/systems such as cables, conduits, electrical equipment, underground metallic ducts etc. All metallic structures within vicinity shall be bonded to the lightning protection system.

5.7.0 All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.

5.8.0 Lightning conductor when used above ground level and shall be connected through test link with earth electrode/earthing system. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth. Down conductor shall not be connected to other earthing conductors above ground level.

5.9.0 Each down conductor shall be provided with a test link at 1500 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be of welded type.

5.10.0 Down conductors shall be cleated on outer side of building wall/ welded to outside building columns at 750 mm interval.

5.11.0 Lightning conductor on roof shall be cleated on surface of roof using insulated clamps/saddles for conductor fixing at an interval of 1000 mm for horizontal run and 750 mm for vertical run..

5.12.0 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

5.13.0 Installation of lightning conductors on the roofs of buildings shall include construction of support, laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying, fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.

5.14.0 Lightning protection system for chimney

5.14.1 The lightning protection system for chimney shall be installed in accordance with IS 2309. Pointed vertical air terminal rods shall be provided at the top and these shall be equally spaced at 120 degree around the circumference of the top flue cane. Air terminals shall project not less than 1000 mm above the highest part of the flue cane. Air terminals shall be mechanically and electrically connected to a continuous circumferential conductor.

5.15.0 For Lightning protection, material & sizes shall be as follows:

- Vertical air termination : 20 mm dia lead coated steel rod
- Horizontal air termination (top 12 metre): 25X3 mm lead coated copper strip
- Horizontal air termination (remaining portion): 50X6 mm Galvanised steel Strip
- Down conductor (top 12 metre) : 25X3 mm lead coated copper strip
- Down conductor (remaining portion) : 50X6 mm Galvanised steel Strip
- Coronal band (top) : 70 sq.mm lead coated copper conductor
- Coronal band (mid-height) : 70 sq.mm copper conductor
- Test link : 150x50x6 mm Galvanised steel flat in steel enclosure
- Earth Electrodes : Treated earth pit with rod electrode as per IS:3043

5.14.2 Two cable collars, , shall encircle the chimney; one at the top, interconnecting the lower ends of the air terminals and the down conductors, and one approximately mid-height of the chimney, connecting the down conductors. Not less than four down conductors along shell shall be located along the exterior wall of the shell, shall extend to the chimney base to earth electrode pit, and shall be connected to the plant grounding grid.

5.14.3 Air terminals, connections, conductors, clamps, fixtures, anchors, etc., exposed within 12000 mm of the top of the chimney shall have a continuous lead covering of a sheath of commercially pure lead not less than 2 mm in thickness.

5.14.4 During construction, temporary lightning protection should be maintained by connecting the concrete reinforcement to two permanent electrical grounding conductors. After the top lift of the chimney shell has been completed, temporary air terminals which may consist of reinforcing bars, should be installed at the top to serve as a temporary protection until the lining and cap are completed and permanent air terminals are installed.

5.16.0 Lightning Protection System for cooling tower and Ash Silo

5.15.1 Pointed vertical air terminal rods shall be provided at the top and these shall be spaced around the circumference of the top. Air terminals shall consist of galvanized steel conductors, each not less than 20 mm diameter galvanized steel rod, projecting not less than 1000 mm above the highest part structure. Air terminals shall be mechanically and electrically connected to a continuous circumferential conductor. Number of down conductors as per IS: 2309, shall be located along the exterior wall, shall extend to the base to earth electrode pit, and shall be connected to the power station earth grid.

5.17.0 For Lightning protection, material & sizes shall be as follows:

- Vertical air termination : 20 mm dia lead coated steel rod
- Horizontal air termination : 50X6 mm Galvanised steel Strip
- Down conductor : 50X6 mm Galvanised steel Strip
- Coronal band (at top)) : 70 sq.mm copper conductor
- Test link : 150x50x6 mm Galvanised steel flat in steel enclosure
- Earth Electrodes : Treated earth pit with rod electrode as per IS:3043

5.15.2 During construction, temporary lightning protection should be maintained by connecting the concrete reinforcement to two permanent electrical grounding conductors.

5.16.0 On completion of lightning installation, continuity of earth conductors and efficiency of all bonds and joints shall be checked. Earth resistance at earth terminations shall be measured in presence of Owner. Resistance of individual earth electrode shall be measured after disconnecting it from the grid. Tests shall be carried out as per IS : 3043 for earthing installation including the following:

a) Earth continuity checks
b) Earth resistance of the complete system, sub-system and earth pits

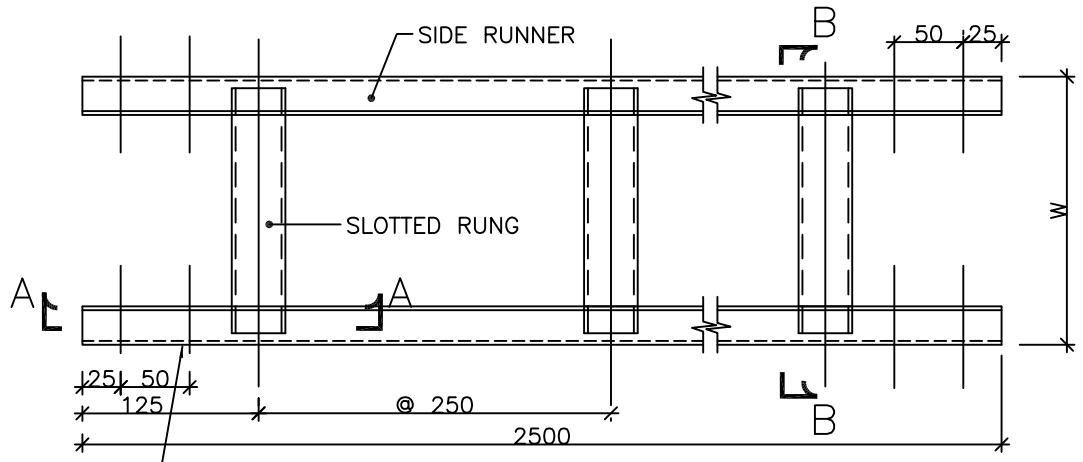
6.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

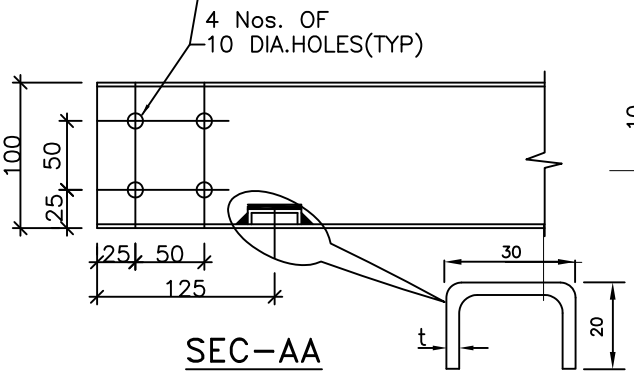
- Soil resistivity report
- Design basis report for earthing and lightning protection system
- Earthing design calculation
- Typical installation drawings for earthing and lightning protection
- Electronic earthing layout and details
- Earthing layout for Transformer Yard
- Earthing layout for Power house building, Boiler and ESP
- Earthing layout for Chimney
- Earthing layout for Cooling tower
- Earthing layout for all auxiliary plant buildings
- Earthing layout for all non-plant buildings
- Earthing layout for GIS building and Switchyard
- Lightning protection design calculation
- Lightning protection layout for Power house building, Boiler and ESP
- Lightning protection layout for transformer yard
- Lightning protection layout for all auxiliary plant buildings
- Lightning protection layout for all non-plant buildings
- Lightning protection layout for GIS building and Switchyard
- Lightning protection layout for Chimney
- Lightning protection layout for Cooling tower
- Field quality plan

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS AND FRP TYPE)

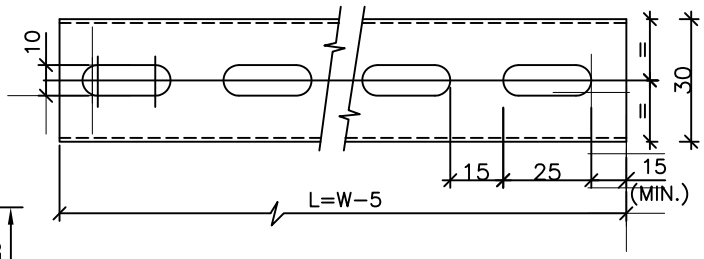
CUSTOMER	TAMIL NADU GENERATION & DISTRIBUTION CORPORATION LIMITED				
PROJECT	2 X 660 MW UDANGUDI STPP STAGE–I				
JOB NO. 435	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA	DPT CODE–E		NAME	SIGN	DATE
			DRN	SKS		
			DSN	SKS		
			CHD	VY		
			APP	SL		
		DWG. NO. PE–DG–435–507–E005				
		SHT. 01 OF 26 REV. 0				



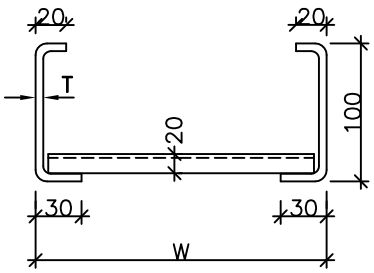
LADDER TYPE CABLE TRAY



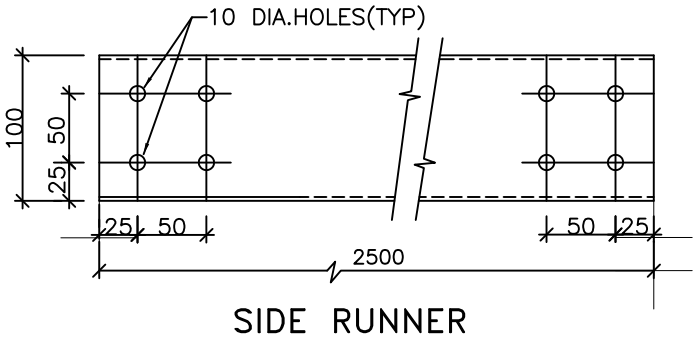
SEC–AA



SLOTTED RUNG



SEC–BB

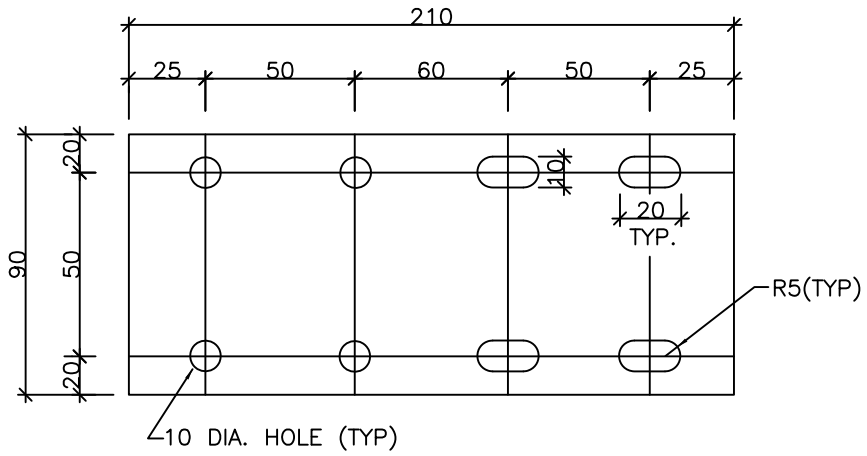


SIDE RUNNER

W	150	300	450	600
L	145	295	445	595
T	2	2	2	2
t	2	2	2	2

FOR GENERAL NOTES REFER SHEET 13 OF 26

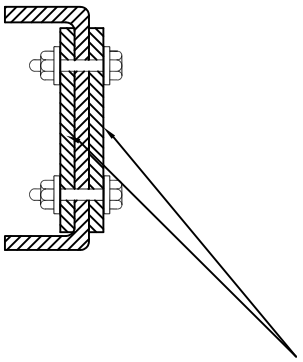
भेल BHEL — TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 02 OF 26 REV. 0



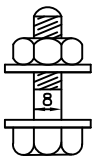
SIDE COUPLER PLATE FOR LADDER/PERFORATED TYPE TRAYS

(600/450/300/150W TRAYS)

QTY. REQUIRED/TRAY SECTION : 4 NOS.

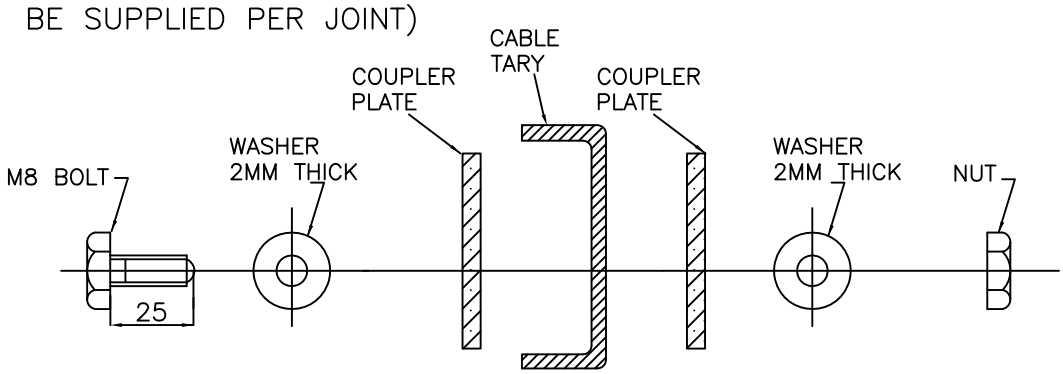


(2 NOS. COUPLER PLATES OF 2 MM THICKNESS TO BE SUPPLIED PER JOINT)



QTY. REQD/TRAY SECTION

A) 16 NOS. M8 BOLTS
B) 16 NOS. NUTS
C) 32 NOS. WASHERS

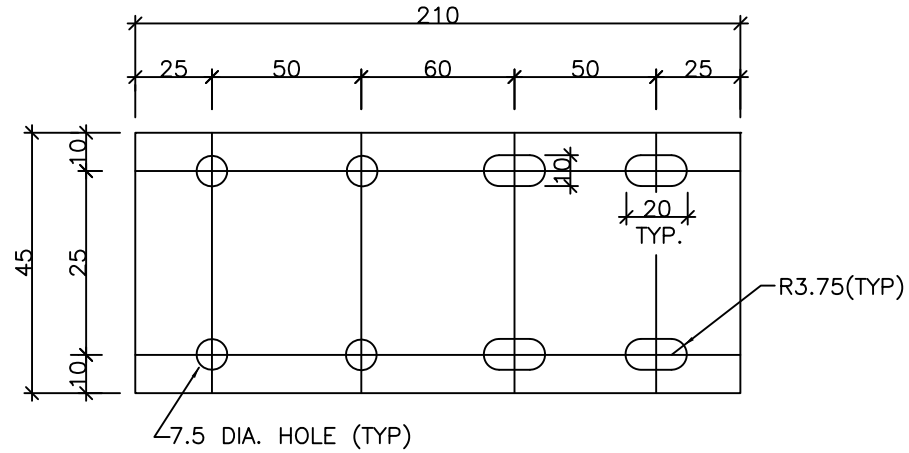


SEQUENCE OF M8 BOLT, WASHER, NUT, COUPLER PLATE & CABLE TRAY

FOR TYPICAL CABLE TRAY JOINT

FOR GENERAL NOTES REFER SHEET 13 OF 26

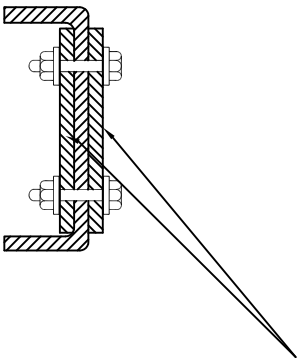
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE-DG-435-507-E005
	SHT. 03 OF 26 REV. 0



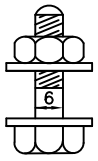
SIDE COUPLER PLATE FOR PERFORATED TYPE TRAYS

(100/50W TRAYS)

QTY. REQUIRED/TRAY SECTION : 4 NOS.



(2 NOS. COUPLER PLATES OF 2 MM THICKNESS TO BE SUPPLIED PER JOINT)



QTY. REQD/TRAY SECTION

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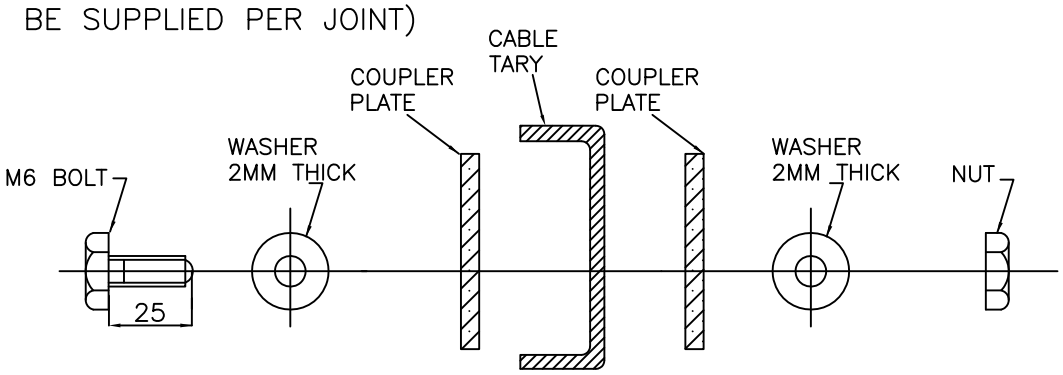
B) 16 NOS. NUTS
C) 32 NOS. WASHERS

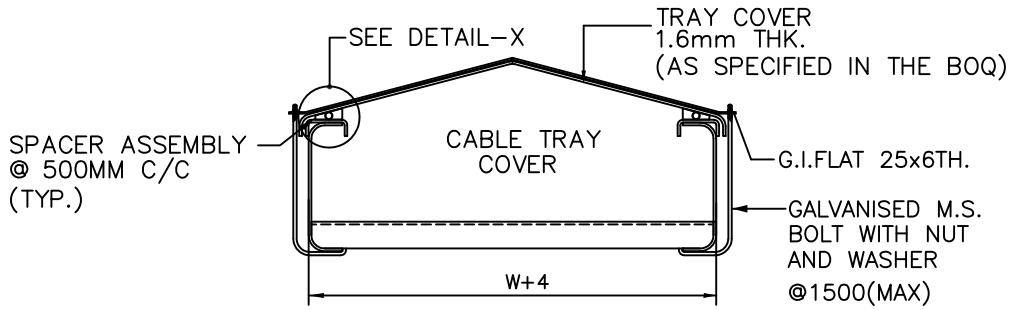


SEQUENCE OF M6 BOLT, WASHER, NUT, COUPLER PLATE & CABLE TRAY

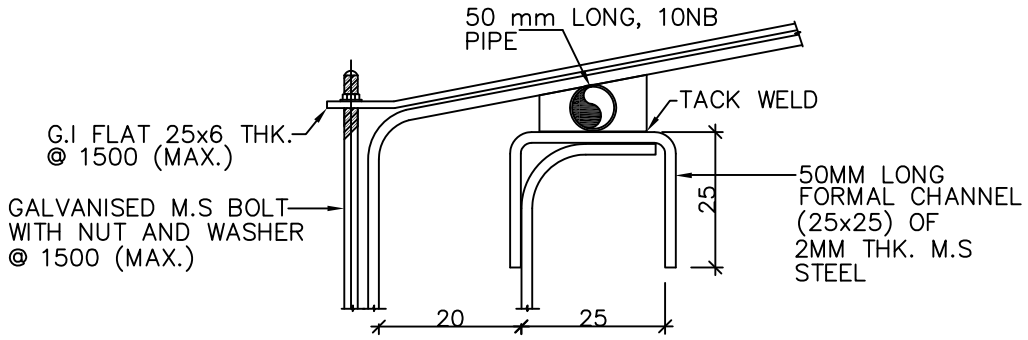
FOR TYPICAL CABLE TRAY JOINT

FOR GENERAL NOTES REFER SHEET 13 OF 26

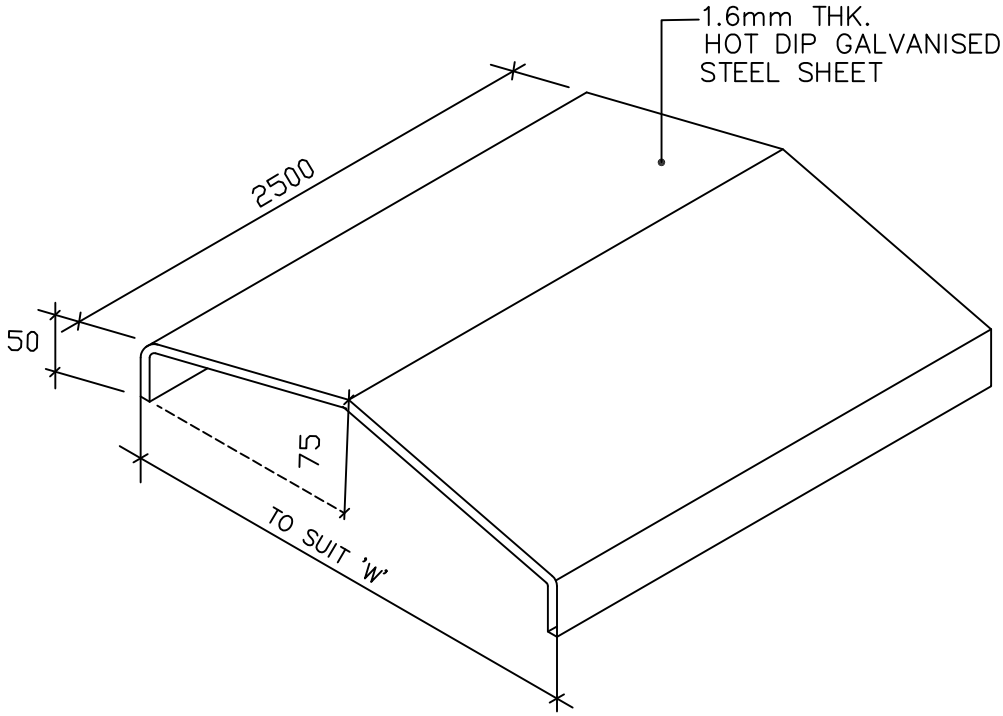
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE-DG-435-507-E005
	SHT. 04 OF 26 REV. 0



COVER FIXING (TYP.)



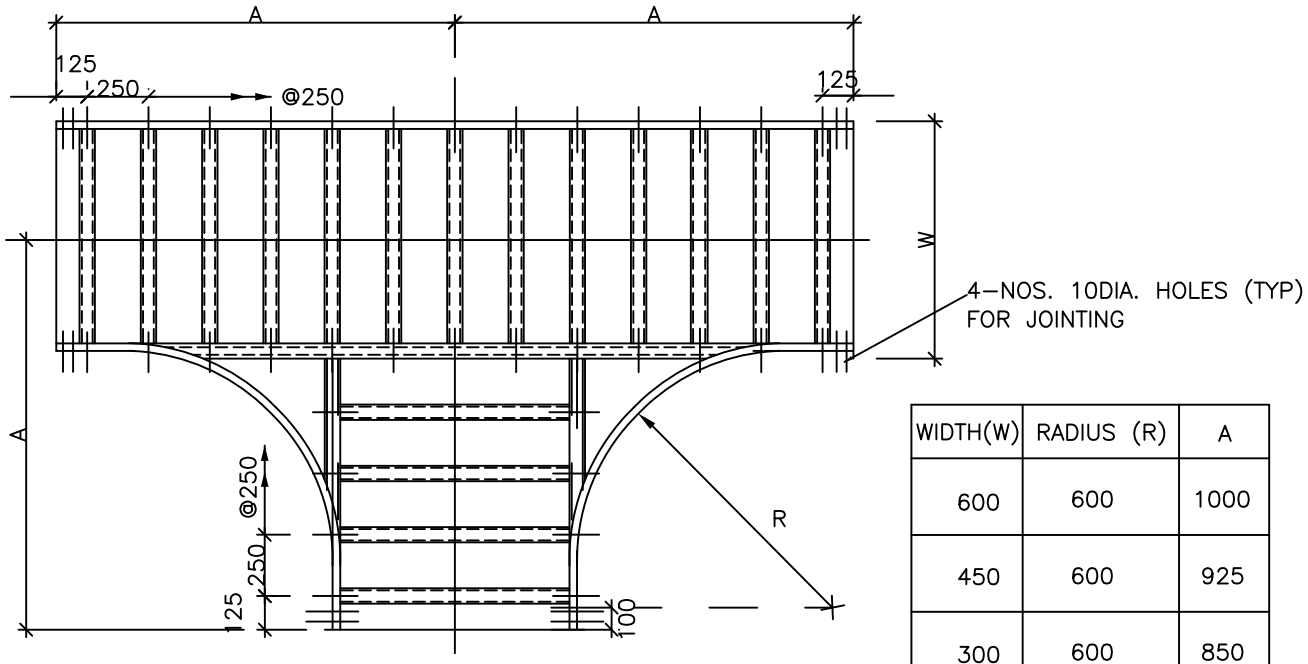
DETAIL–X



CABLE TRAY COVER

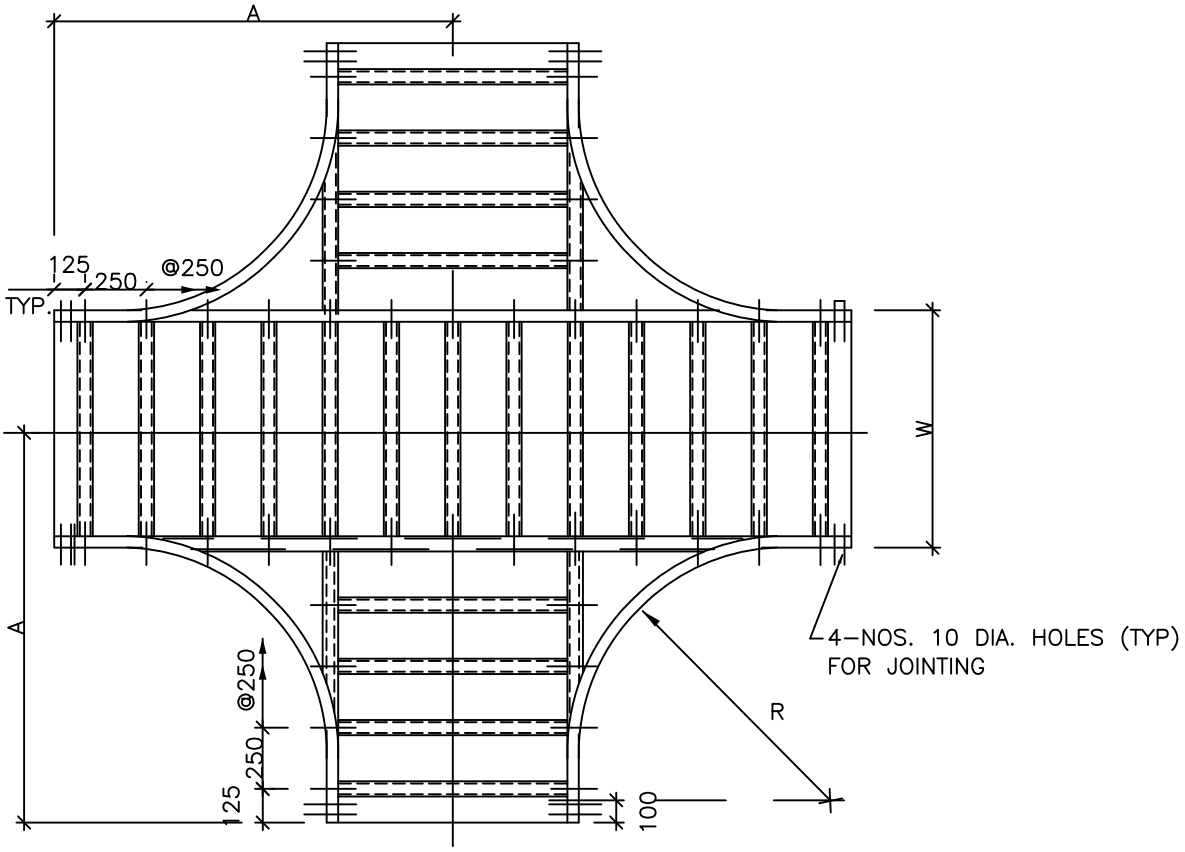
FOR GENERAL NOTES REFER SHEET 13 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 05 OF 26 REV. 0



WIDTH(W)	RADIUS (R)	A
600	600	1000
450	600	925
300	600	850

HORIZONTAL TEE–PLAN

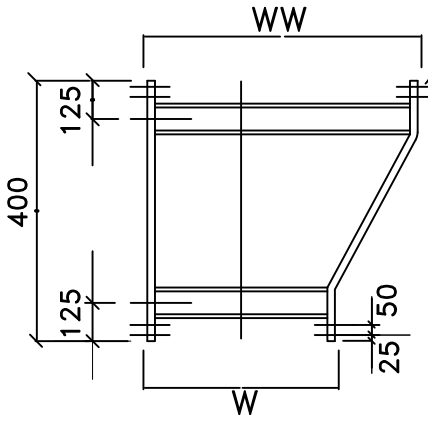


HORIZONTAL CROSS–PLAN

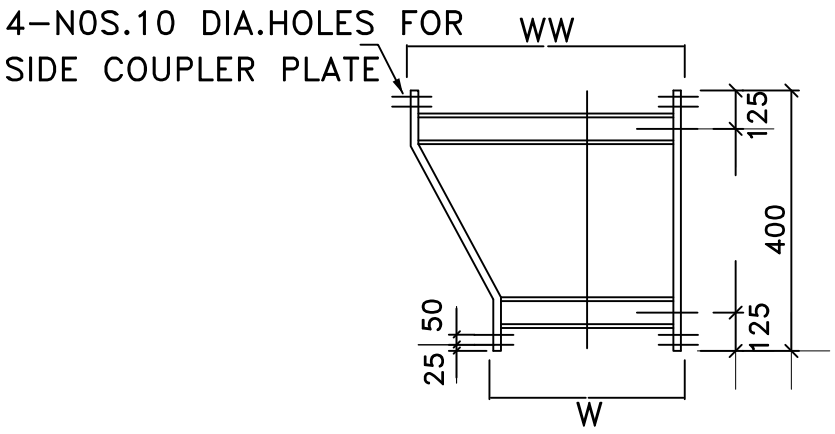
LADDER TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 13 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 06 OF 26 REV. 0



LEFT HAND REDUCER–PLAN



RIGHT HAND REDUCER–PLAN

WIDTH	WW	600	600	450
	W	450	300	300

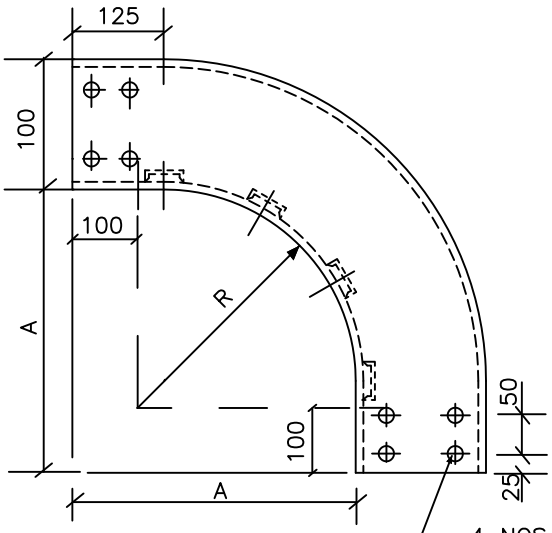
LADDER TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 13 OF 26

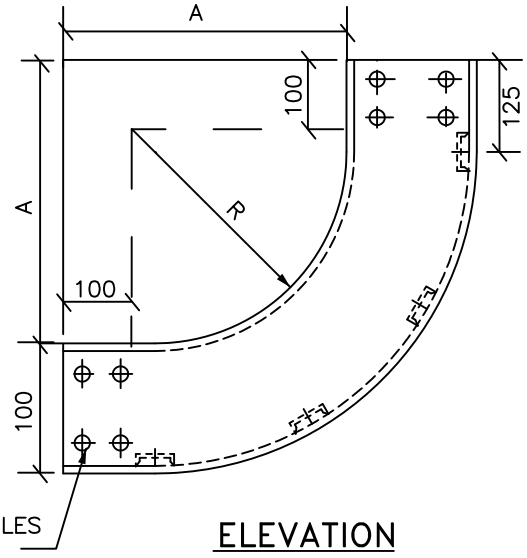
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)

DWG. NO.
PE–DG–435–507–E005

SHT. 07 OF 26 REV. 0



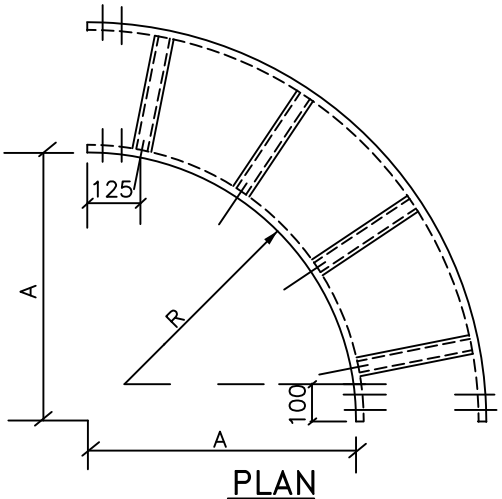
ELEVATION
90° VERTICAL BEND
(OUTSIDE)



ELEVATION
90° VERTICAL BEND
(INSIDE)

LADDER TYPE TRAYS

WIDTH(W)	RADIUS (R)	A
600	600	700
450	600	700
300	600	700

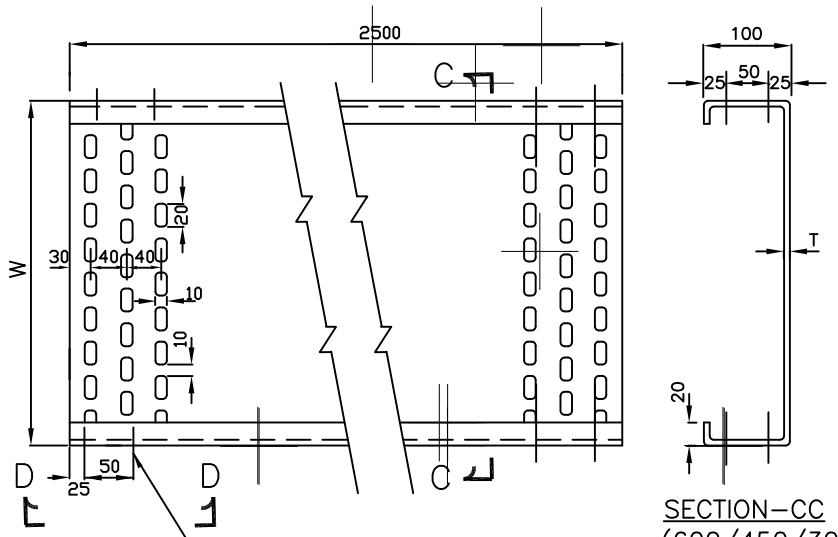


PLAN
90°HORIZONTAL BEND

LADDER TYPE ACCESSORIES

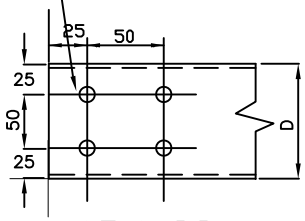
FOR GENERAL NOTES REFER SHEET 13 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE-DG-435-507-E005
	SHT. 08 OF 26 REV. 0



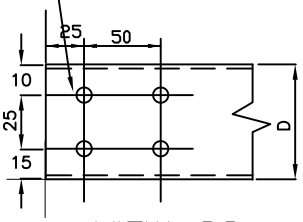
SECTION–CC
(600/450/300/150 TRAYS)

4 HOLES 10mm DIA.

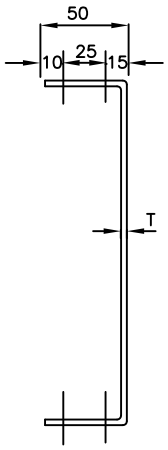


VIEW–DD
(600/450/300/
150W TRAYS)

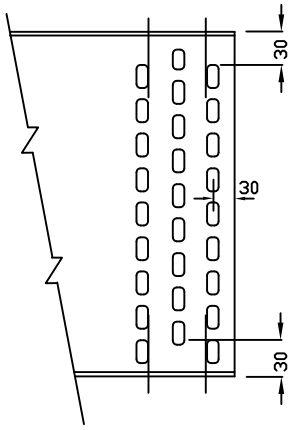
4 HOLES 7.5mm DIA.



VIEW–DD
(100/50W TRAYS)



SECTION–CC
(100/50 TRAYS)



ARRANGEMENT OF
PERFORATIONS

TRAY WIDTH W (mm)	600	450	300	150	100	50
TRAY DEPTH D (mm)	100	100	100	100	50	50
T (mm)	2	2	2	2	2	2

PERFORATED TYPE TRAY

FOR GENERAL NOTES REFER SHEET 13 OF 26

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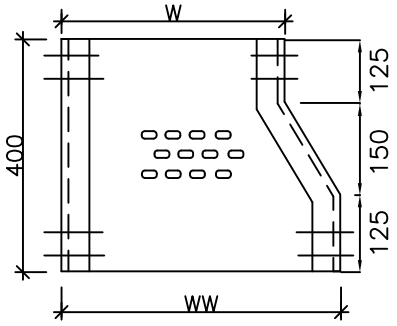
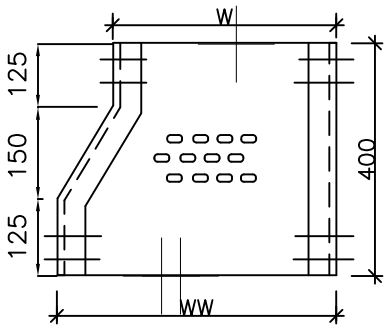
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)

DWG. NO.
PE–DG–435–507–E005

SHT. 09 OF 26 REV. 0



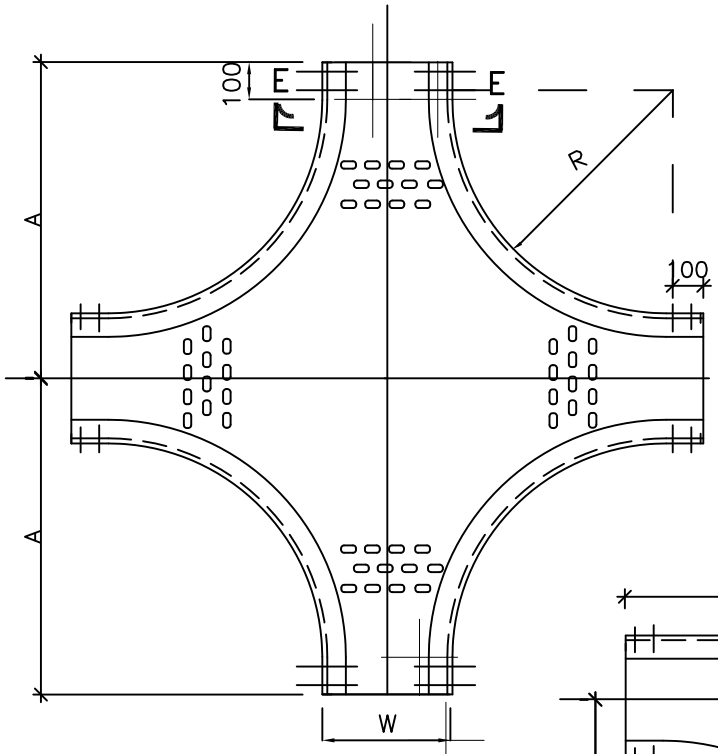
LEFT HAND REDUCER



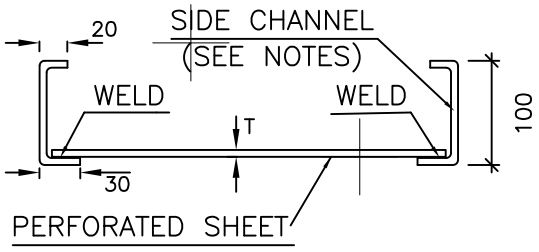
RIGHT HAND REDUCER

WW	W	DEPTH	THICKNESS
600	450	100	2
600	300	100	2
450	300	100	2

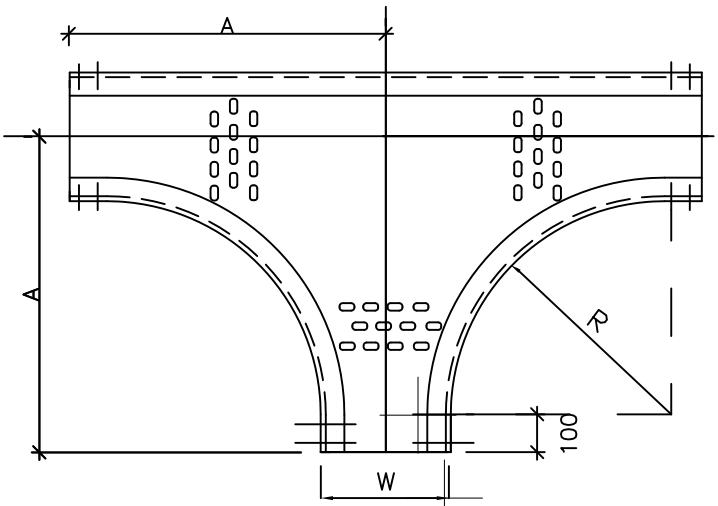
PERFORATED TYPE



CROSS



SECTION–EE



TEE

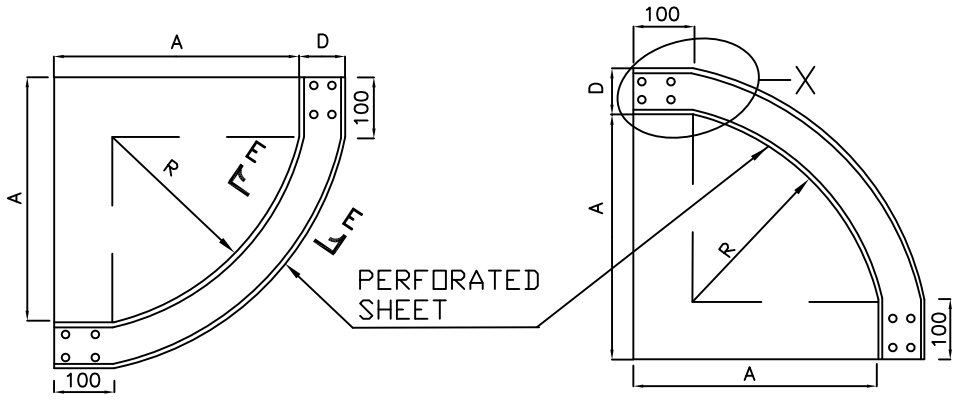
PERFORATED TYPE

WIDTH(W)	RADIUS (R)	A	T
600	600	1000	2
450	600	925	2
300	600	850	2

PERFORATED TYPE ACCESSORIES

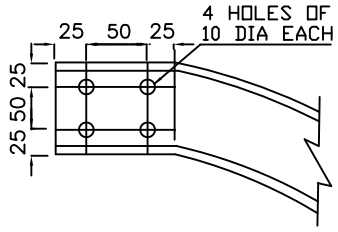
FOR GENERAL NOTES REFER SHEET 13 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 10 OF 26 REV. 0

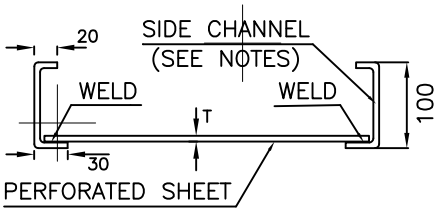


INSIDE TYPE

OUTSIDE TYPE

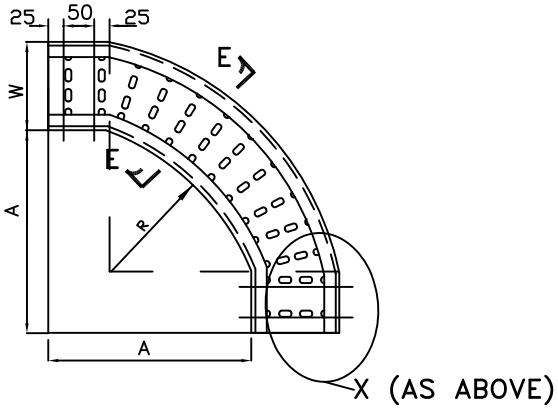


ENLARGED VIEW OF "X"



SECTION–EE

90° VERTICAL BEND – PERFORATED TYPE



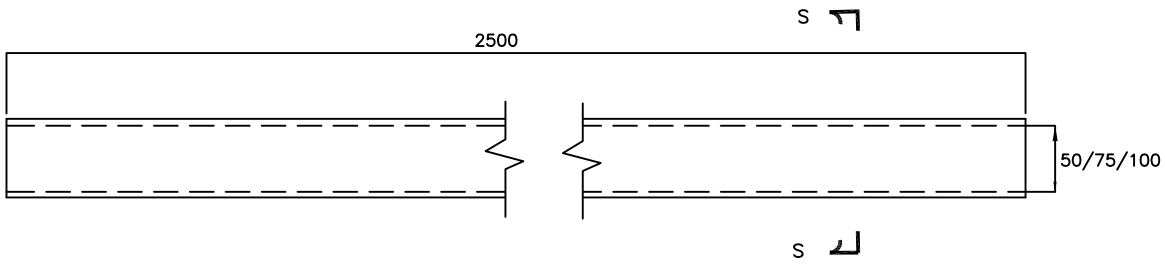
WIDTH(W)	RADIUS (R)	A	T
600	600	700	2
450	600	700	2
300	600	700	2

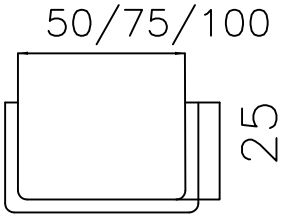
90° HORIZONTAL BEND – PERFORATED TYPE

PERFORATED TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 13 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 11 OF 26 REV. 0





SECTION–SS

CABLE TROUGH

FOR GENERAL NOTES REFER SHEET 13 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (GS TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 12 OF 26 REV. 0

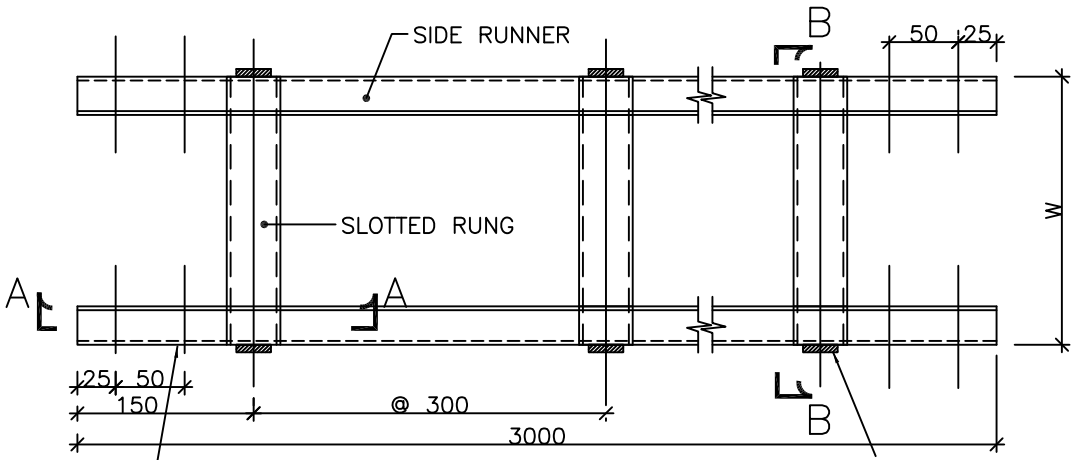
NOTES:–

1. THE LADDER AND PERFORATED TYPE CABLE TRAYS AND ACCESSORIES (INCLUDING SIDE RUNNERS OF LADDER TYPE TRAYS & ACCESSORIES) SHALL BE MADE OF 2MM HOT ROLLED M.S. SHEET. ALL THE COUPLER PLATE SHALL BE 2 MM THICK.
2. THE CABLE TRAYS & ACCESSORIES SHALL BE HOT DIP GALVANISED AS PER IS 2629. THE MASS OF ZINC COATING SHALL BE 610 gm/m² AND THICKNESS SHALL BE 86 MICRONS (MINIMUM).
3. FOR LADDER TYPE CABLE TRAYS AND ACCESSORIES, ALL RUNGS SHALL BE SLOTTED. PERFORATED TRAYS SHALL BE FABRICATED OUT OF A SINGLE M.S. SHEET.
4. STANDARD TRAY ACCESSORIES SHALL BE WITH THE RADIUS INDICATED IN THIS DRAWING.
5. SIDE CHANNELS OF PERFORATED TYPE CABLE TRAY ACCESSORIES SHALL BE WELDED WITH THE PERFORATED SHEET AT INTERVALS OF 100mm.
6. LENGTH OF WELDING SHALL NOT BE LESS THAN 25mm FOR CABLE TRAYS. THE THICKNESS OF WELDING SHALL BE AS PER IS 9595.
7. ALL TRAY CORNERS SHALL BE SMOOTH AND FREE OF SHARP EDGES.
8. THE CABLE TRAY COVER SHALL BE OF 1.6MM THICK MS SHEET AND SHALL BE HOT DIP GALVANISED.
9. THE DEPTH, WIDTH AND LENGTH OF TRAYS & TRAY COVERS SHALL BE WITHIN A TOLERANCE OF (+/–) 2 mm.
10. THE THICKNESS OF THE FINISHED PRODUCT CABLE TRAYS & ACCESSORIES SHALL NOT BE LESS THAN 2MM.
11. TO FACILITATE ASSEMBLY, ALL ACCESSORIES AT ENDS SHALL HAVE 100mm STRAIGHT PORTION.
12. ALL NUTS, BOLTS, WASHERS ETC., SHALL BE HOT DIP GALVANISED AS PER IS:1367 PART XIII FOR SIZES 12 MM & ABOVE, AND ELECTROPLATED/ZINC PASSIVATED FOR SIZES UPTO 12 MM.
13. ALL CUTTING & FORMING OPERATIONS SHALL BE COMPLETED PRIOR TO GALVENIZING.
14. FINISHED TRAYS SHALL BE FREE FROM BURRS AND SHARP EDGES.
15. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.
16. WIDTH OF CABLE TRAYS PROPOSED TO BE USED FOR THE PROJECT ARE AS UNDER:
    A)LADDER TYPE: 600W, 450W, 300W, 150W.
    B)PERFORATED TYPE: 600W, 450W, 300W, 150W, 100W, 50W.
17. THE DEPTH OF 600W, 450W, 300W, 150W TRAYS & ACCESSORIES SHALL BE 100MM. DEPTH OF 100/50W TRAYS SHALL BE 50MM.
18. 600MM WIDE TYPE CABLE TRAYS SHALL BE SUITABLE FOR A CABLE WEIGHT OF 100 Kg PER METRE (INCLUDING LIVE LOAD) OF RUNNING LENGTH OF TRAY.
19. CABLE TROUGHS OR 50/100MM WIDE PERFORATED TYPE TRAY SHALL BE USED FOR LOCAL CABLING/BRANCHING OUT FEW CABLES FROM MAIN ROUTE.

BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES	DWG. NO. PE–DG–435–507–E005
		SHT. 13 OF 26 REV. 0

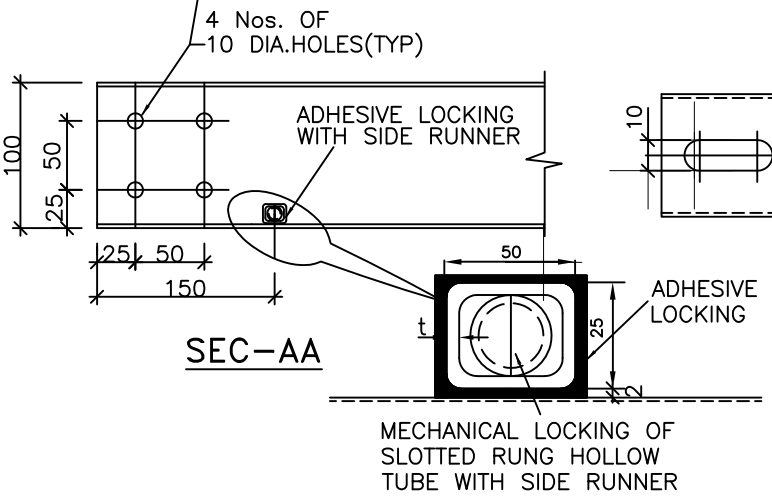
TYPICAL DETAILS OF
FRP TYPE CABLE TRAYS AND ACCESSORIES

CUSTOMER	TAMIL NADU GENERATION & DISTRIBUTION CORPORATION LIMITED					
PROJECT	2 X 660 MW UDANGUDI STPP STAGE–I					
JOB NO. 435	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA	DPT CODE–E		NAME	SIGN	DATE
			DRN	SKS		
			DSN	SKS		
			CHD	VY		
			APP	SL		
		DWG. NO. PE–DG–435–507–E005				
		SHT. 14 OF 26 REV. 0				

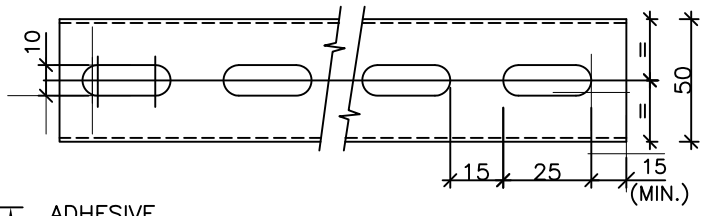


FRP LADDER TYPE CABLE TRAY

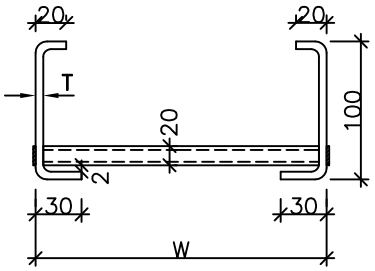
MECHANICAL LOCKING SUITABLE TO WITHSTAND LOADING SPECIFIED IN DATA SHEET–A



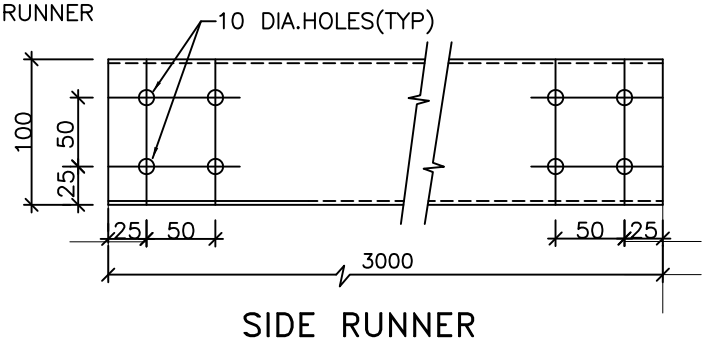
SEC–AA



SLOTTED RUNG



SEC–BB

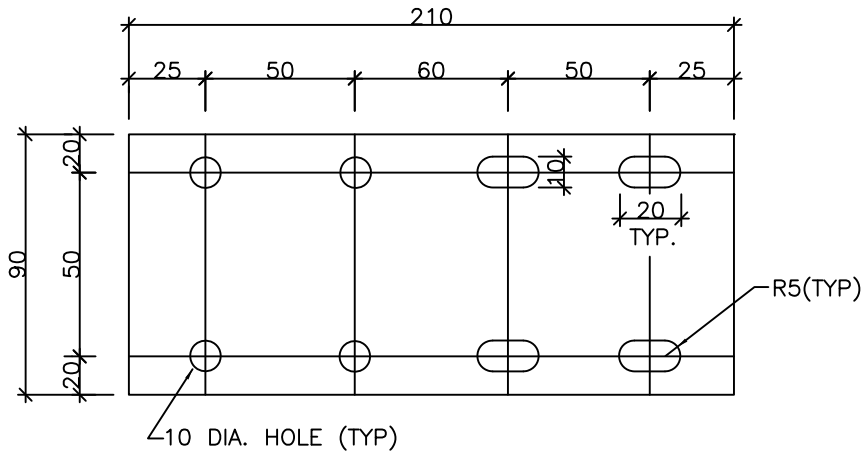


SIDE RUNNER

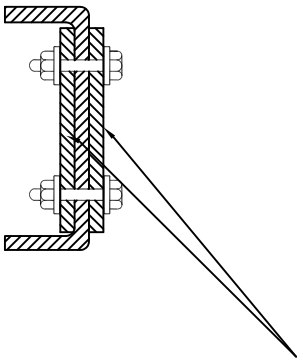
W	150	300	450	600
T	4	4	4	4
t	4	4	4	4

FOR GENERAL NOTES REFER SHEET 26 OF 26

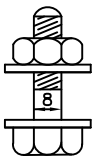
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 15 OF 26 REV. 0



FRP SIDE COUPLER PLATE FOR
FRP LADDER/PERFORATED TYPE TRAYS
(600/450/300/150W TRAYS)
QTY. REQUIRED/TRAY SECTION : 4 NOS.

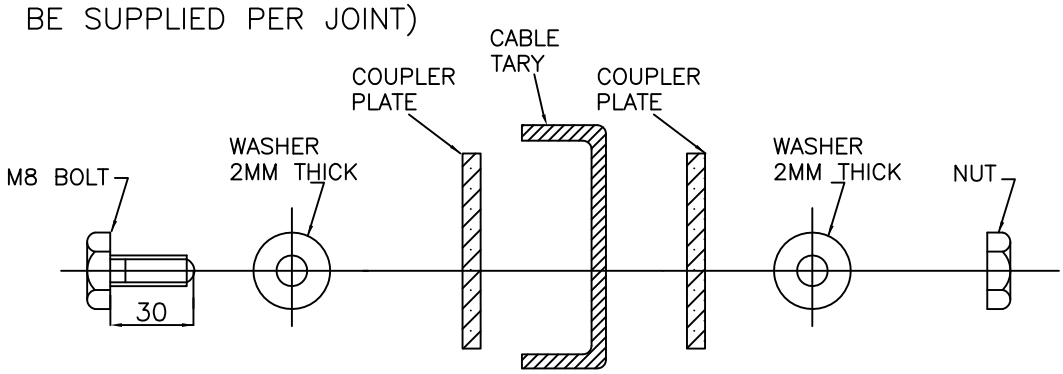


(2 NOS. COUPLER PLATES
OF 2 MM THICKNESS TO
BE SUPPLIED PER JOINT)



QTY. REQD/TRAY SECTION

A) 16 NOS. M8 BOLTS
B) 16 NOS. NUTS
C) 32 NOS. WASHERS

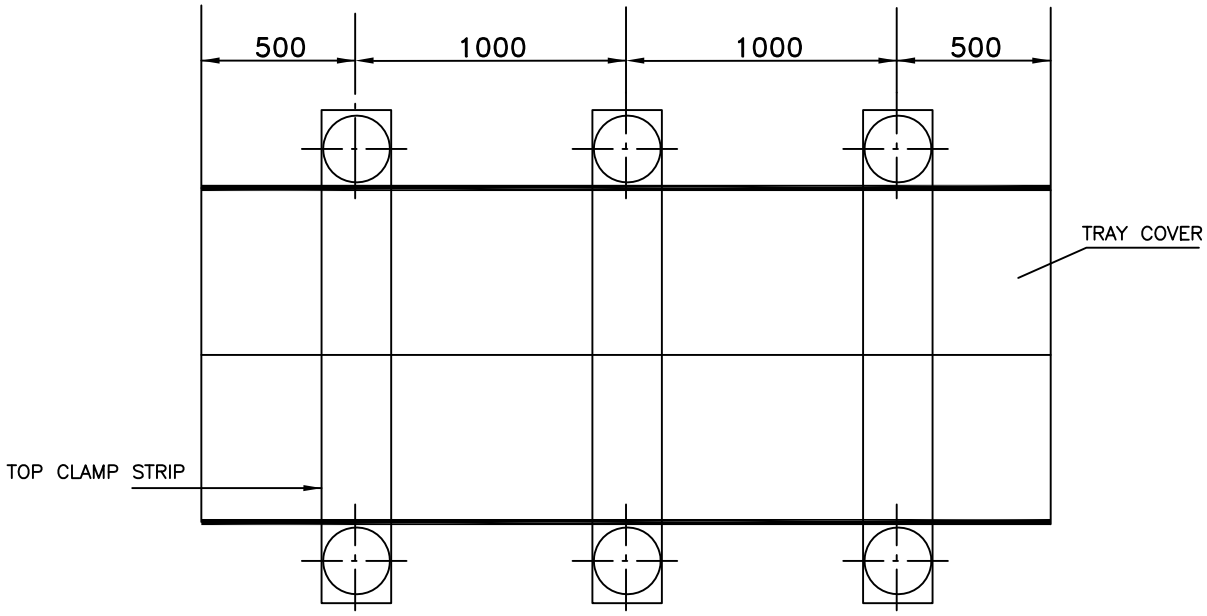


SEQUENCE OF M8 BOLT, WASHER, NUT, COUPLER PLATE & CABLE TRAY

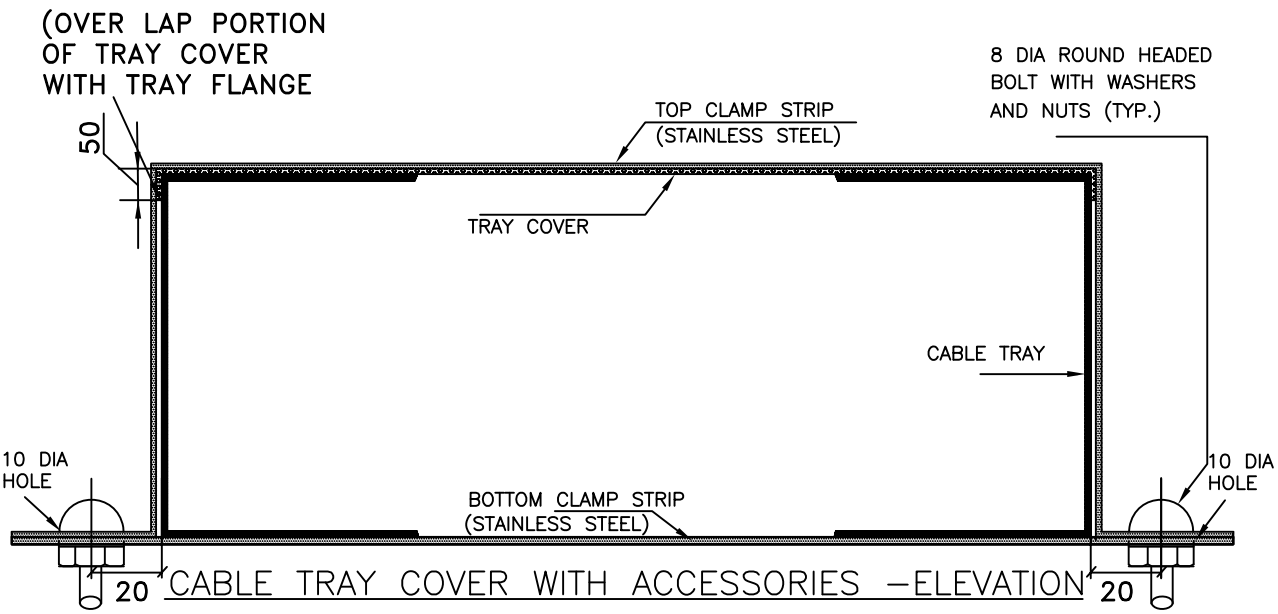
FOR TYPICAL CABLE TRAY JOINT

FOR GENERAL NOTES REFER SHEET 26 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE-DG-435-507-E005
	SHT. 16 OF 26 REV. 0



CABLE TRAY COVER WITH ACCESSORIES –PLAN



CABLE TRAY COVER WITH ACCESSORIES –ELEVATION

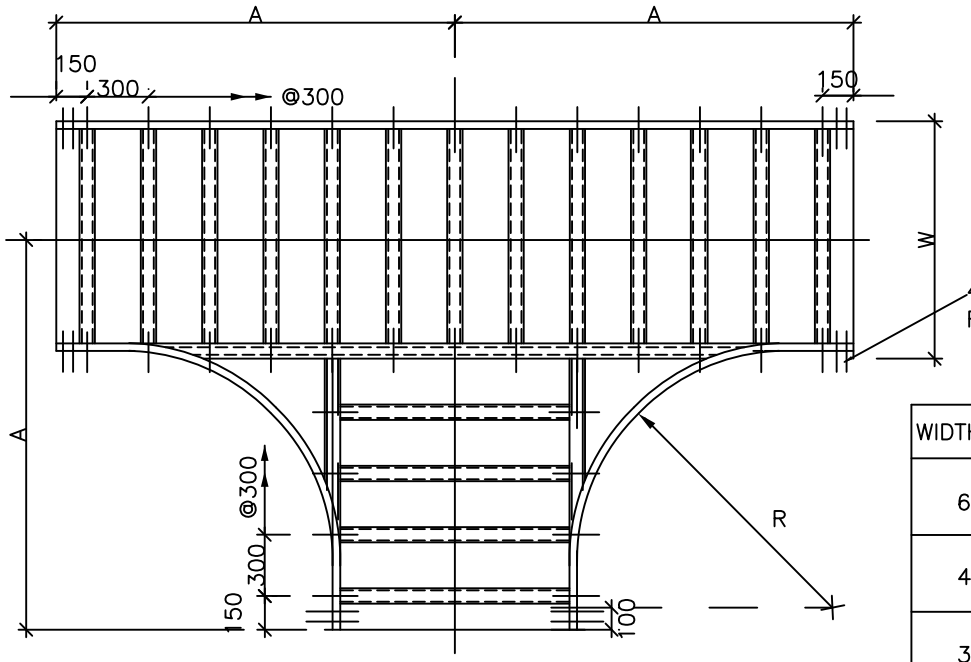
TRAY WIDTH(W)	TOP CLAMP SIZE (LxWxT)	BOTTOM CLAMP SIZE (LxWxT)
600	900X20X2	680X20X2
450	750X20X2	530X20X2
300	600X20X2	380X20X2
150	450X20X2	230X20X2

CABLE TRAY COVER SHALL INCLUDE 1 NO. OF TRAY COVER OF 3000MM LENGTH ALONG WITH 3 NOS. OF TOP CLAMP STRIP, 3 NOS. BOTTOM CLAMP STRIP AND 6 NOS. OF BOLTS ALONG WITH NUTS & WASHERS.

CABLE TRAY COVER

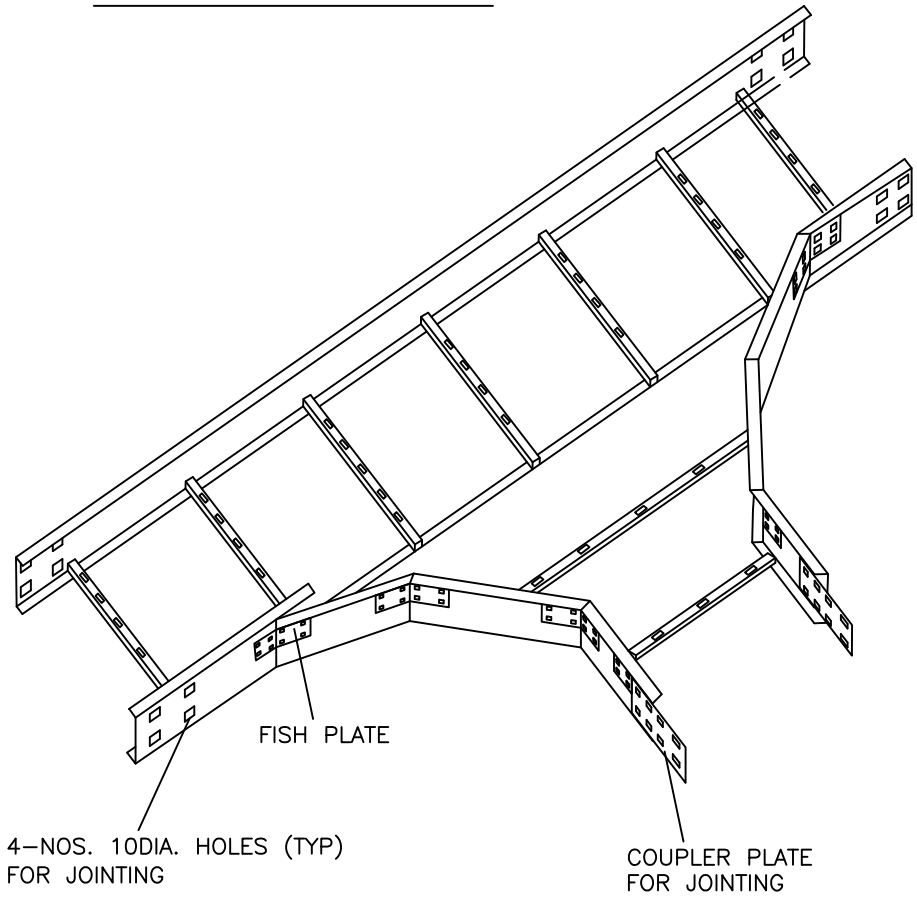
FOR GENERAL NOTES REFER SHEET 26 OF 26

बीएचईएल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE–DG–435–507–E005
		SHT. 17 OF 26 REV. 0



WIDTH(W)	RADIUS (R)	A
600	600	1000
450	600	925
300	600	850

HORIZONTAL TEE–PLAN

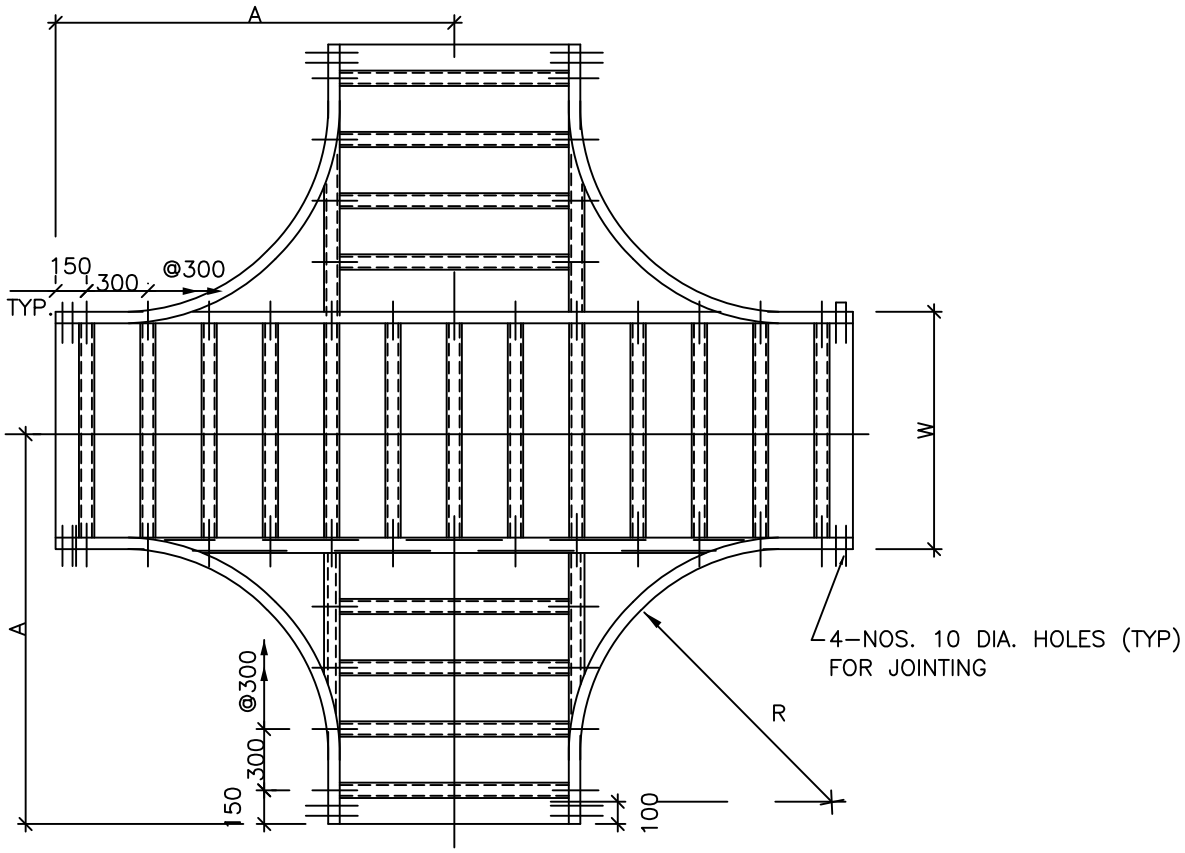


HORIZONTAL TEE

LADDER TYPE ACCESSORIES

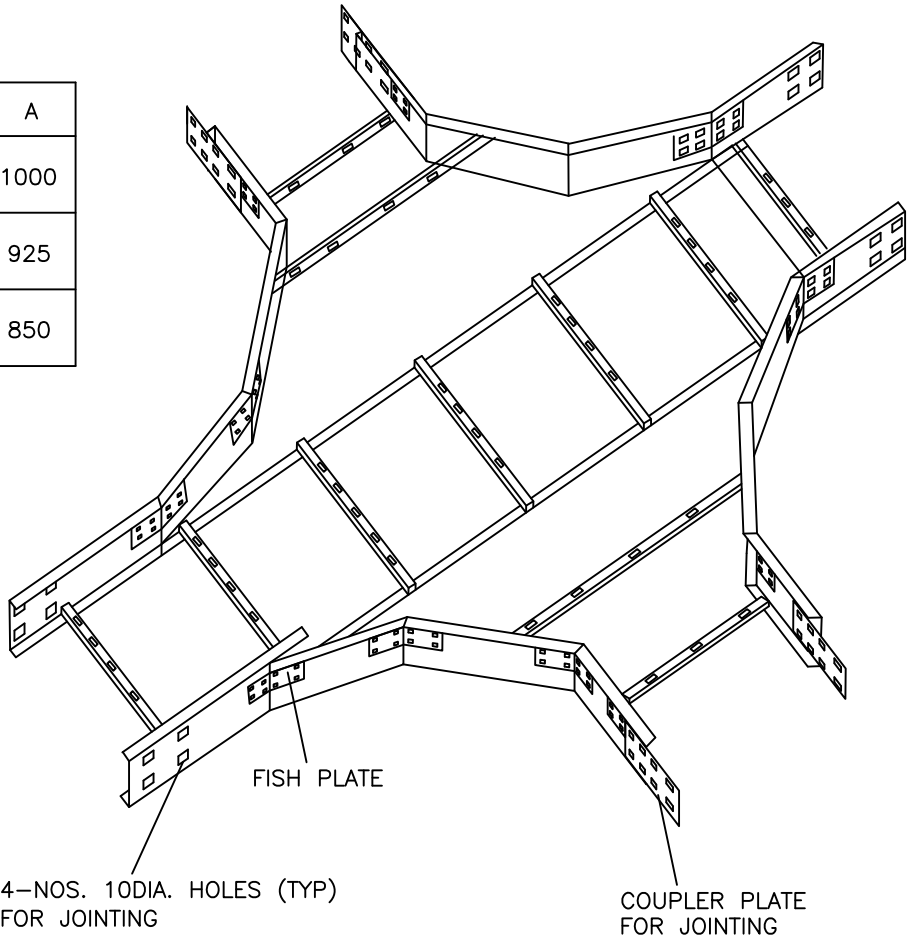
FOR GENERAL NOTES REFER SHEET 26 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE–DG–435–507–E005
	SHT. 18 OF 26 REV. 0



HORIZONTAL CROSS–PLAN

WIDTH(W)	RADIUS (R)	A
600	600	1000
450	600	925
300	600	850

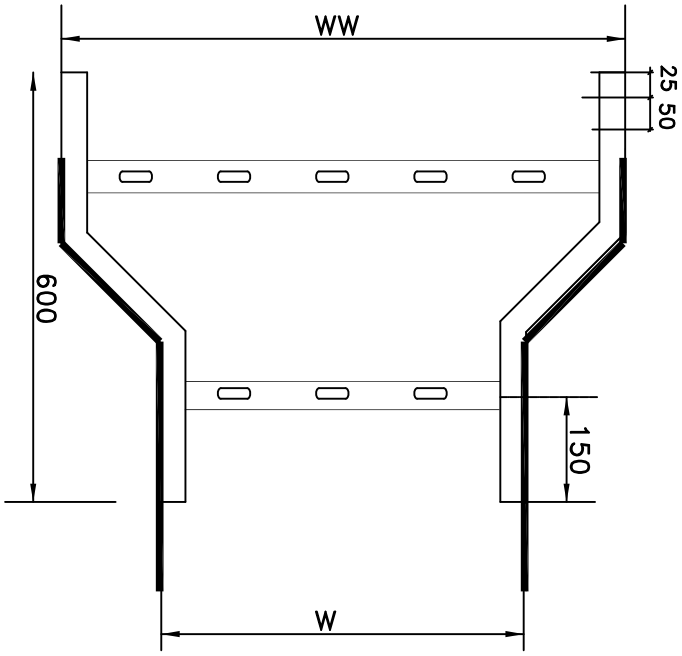


FOR GENERAL NOTES REFER SHEET 26 OF 26

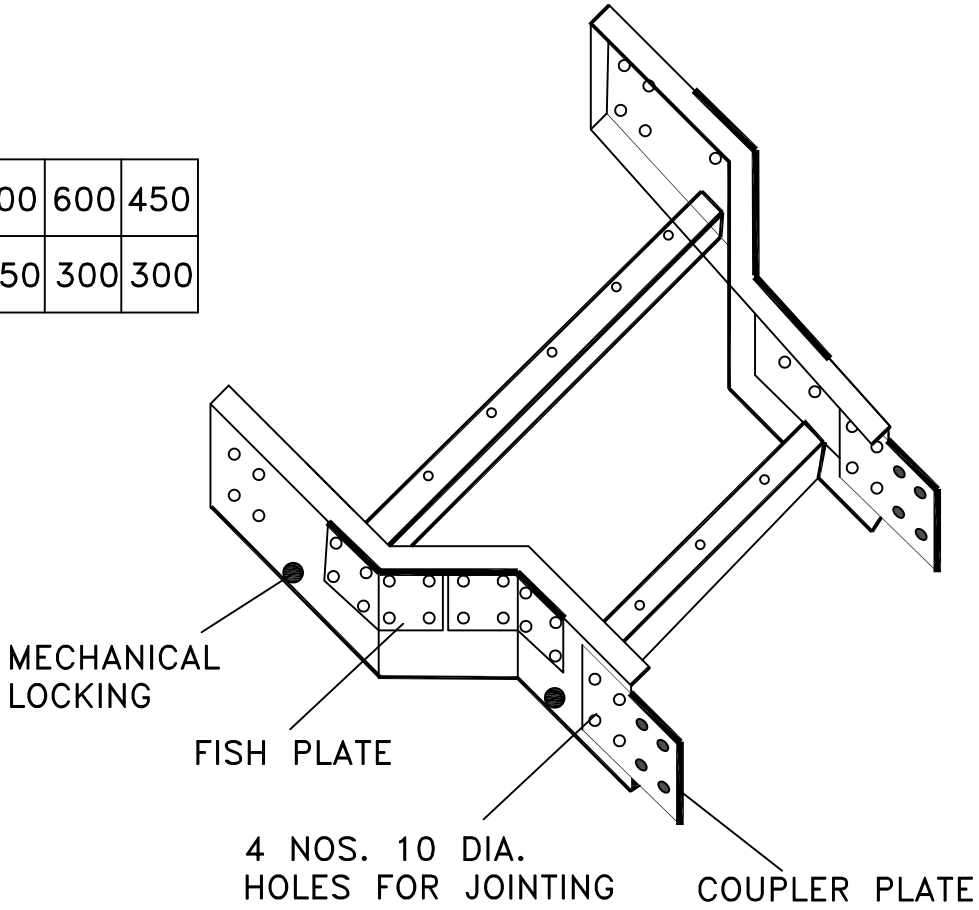
TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)

DWG. NO.
PE–DG–435–507–E005

SHT. 19 OF 26 REV. 0



WIDTH	WW	600	600	450
	W	450	300	300

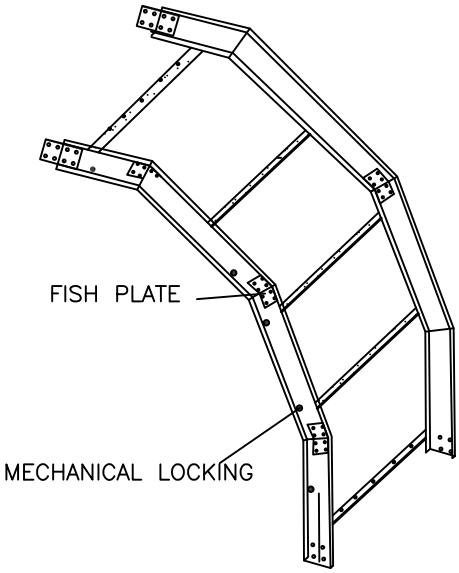


REDUCER–LADDER TYPE

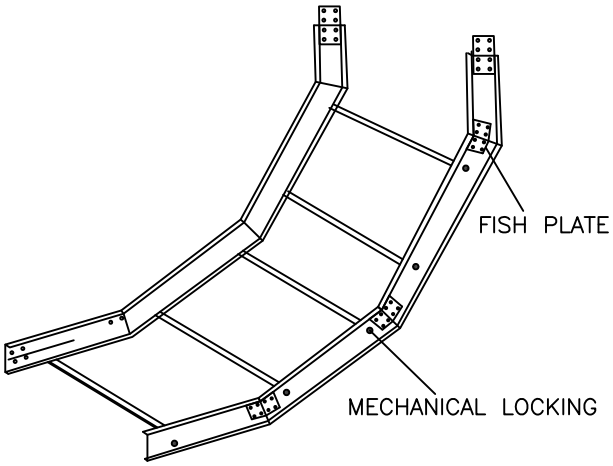
LADDER TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 26 OF 26

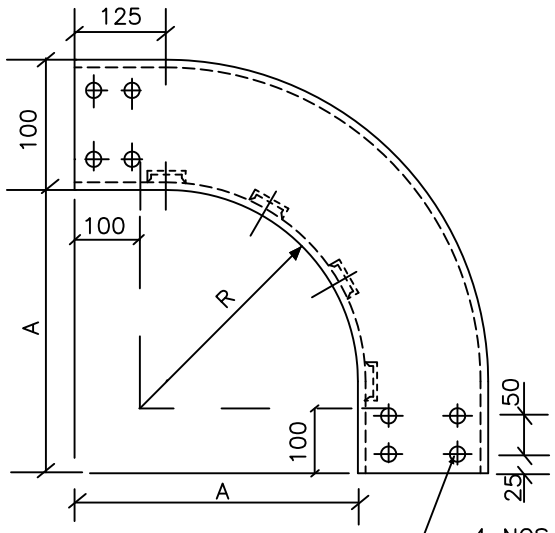
बी एच ई एल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE–DG–435–507–E005
		SHT. 20 OF 26 REV. 0



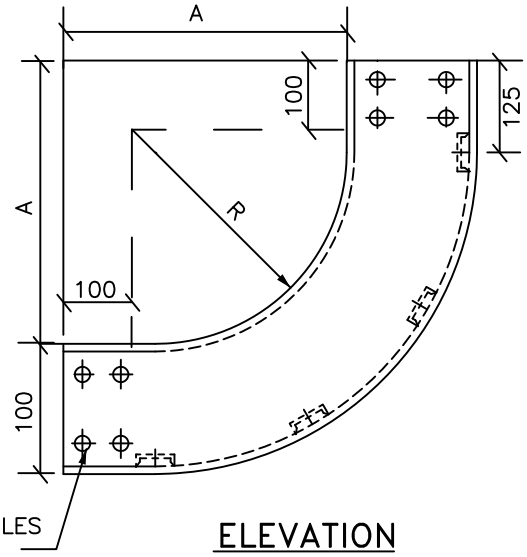
90° VERTICAL BEND
(OUTSIDE)



90° VERTICAL BEND
(INSIDE)



ELEVATION
90° VERTICAL BEND
(OUTSIDE)



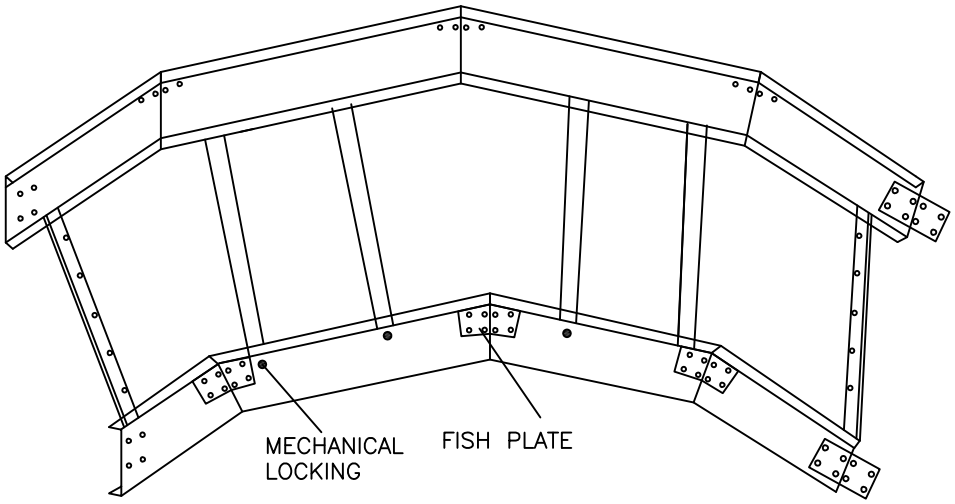
ELEVATION
90° VERTICAL BEND
(INSIDE)

WIDTH(W)	RADIUS (R)	A
600	600	700
450	600	700
300	600	700

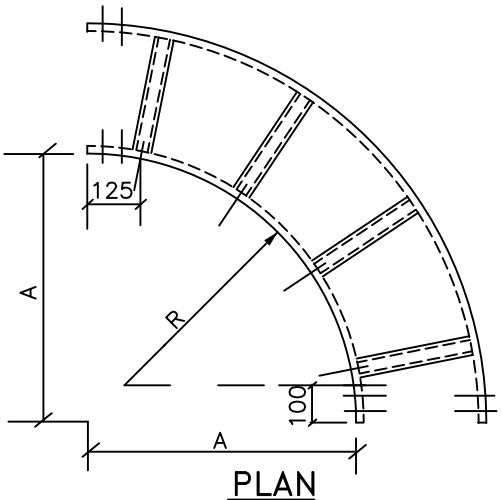
LADDER TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 26 OF 26

बीएचईएल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE-DG-435-507-E005
		SHT. 21 OF 26 REV. 0



90° HORIZONTAL BEND



PLAN

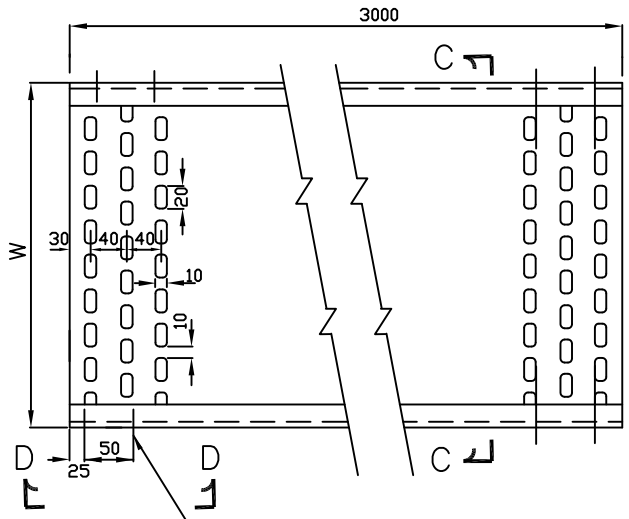
90°HORIZONTAL BEND

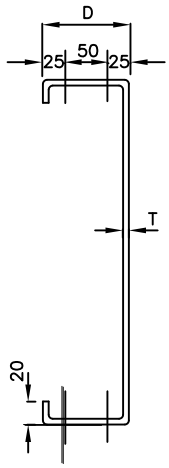
WIDTH(W)	RADIUS (R)	A
600	600	700
450	600	700
300	600	700

LADDER TYPE ACCESSORIES

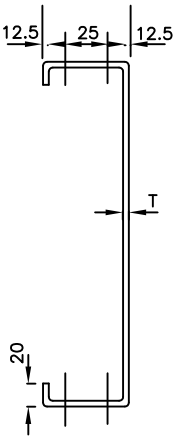
FOR GENERAL NOTES REFER SHEET 26 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE-DG-435-507-E005
	SHT. 22 OF 26 REV. 0

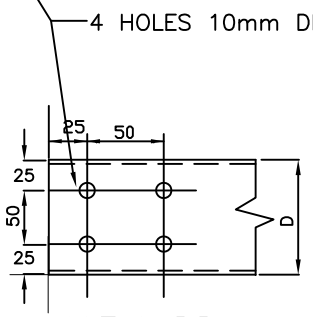




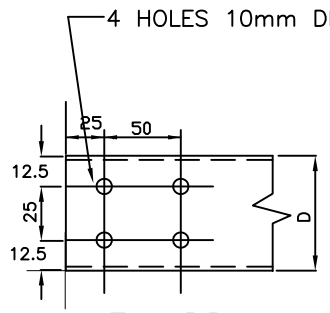
SECTION–CC
(600/450/300/
150 TRAYS)



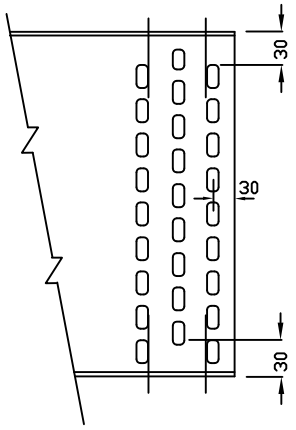
SECTION–CC
(100/50 TRAYS)



VIEW–DD
(600/450/300/
150W TRAYS)



VIEW–DD
(100W/50W
TRAYS)



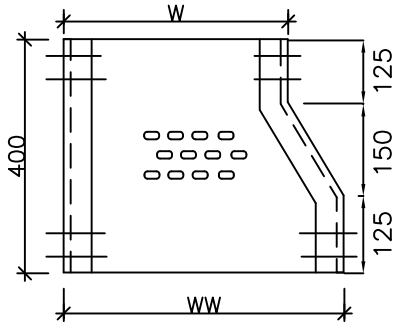
ARRANGEMENT OF
PERFORATIONS

TRAY WIDTH W (mm)	600	450	300	150	100	50
TRAY DEPTH D (mm)	100	100	100	100	50	50
T (mm)	4	4	4	4	4	4

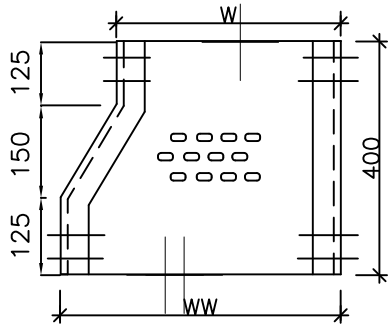
PERFORATED TYPE TRAY

FOR GENERAL NOTES REFER SHEET 26 OF 26

बीएचईएल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE–DG–435–507–E005
		SHT. 23 OF 26 REV. 0



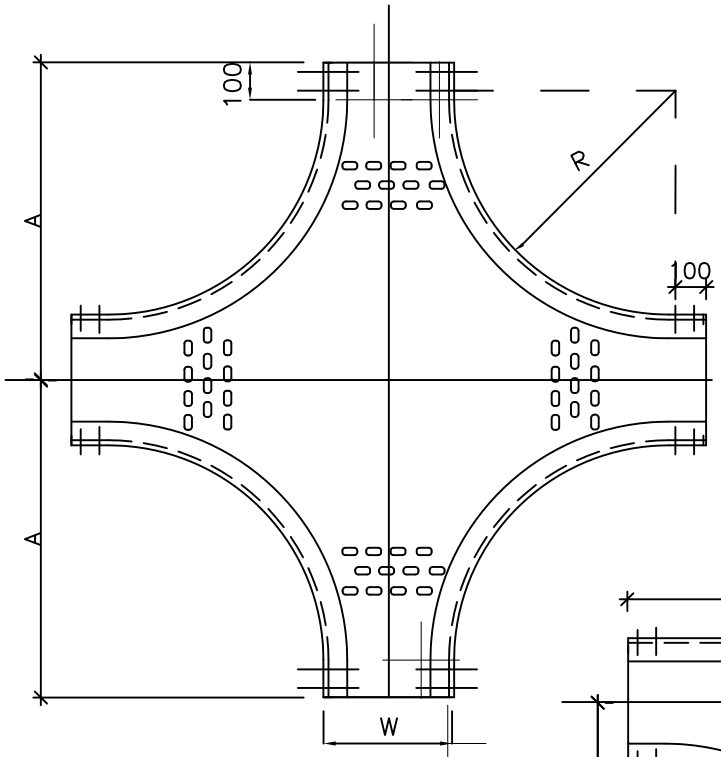
LEFT HAND REDUCER



RIGHT HAND REDUCER

WW	W	DEPTH	THICKNESS
600	450	100	4
600	300	100	4
450	300	100	4

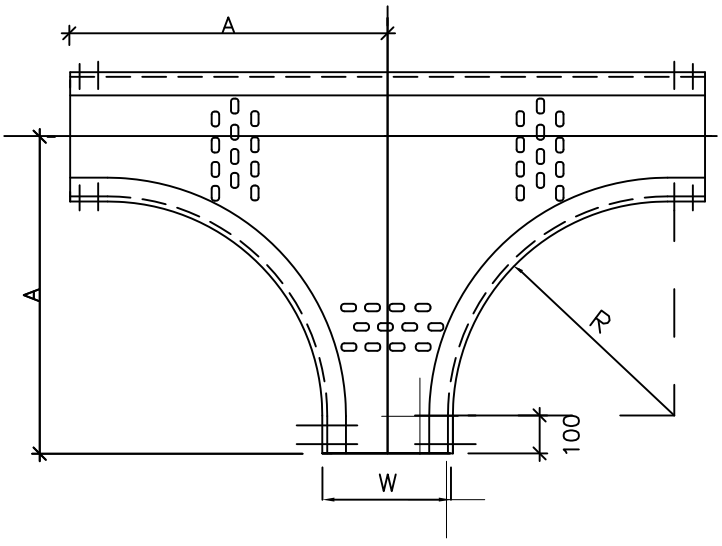
PERFORATED TYPE



CROSS

PERFORATED TYPE

WIDTH(W)	RADIUS (R)	A	THICKNESS
600	600	1000	4
450	600	925	4
300	600	850	4



TEE

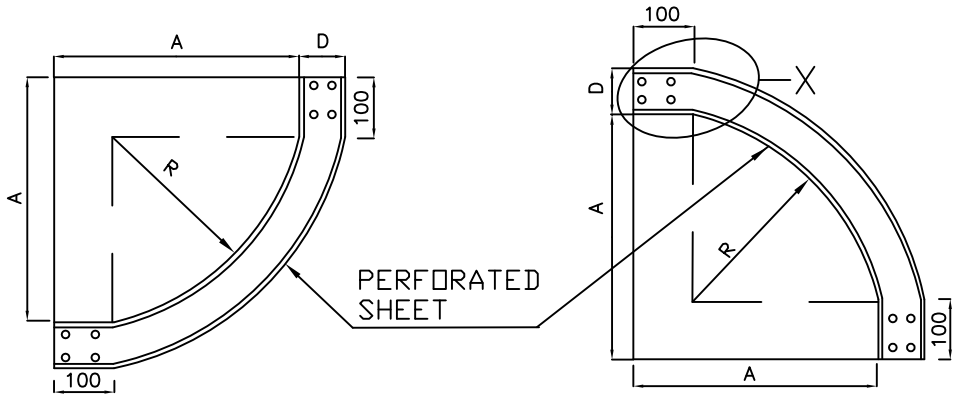
PERFORATED TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 26 OF 26

TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)

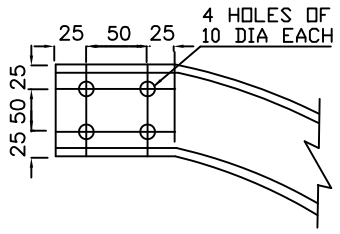
DWG. NO.
PE-DG-435-507-E005

SHT. 24 OF 26 REV. 0



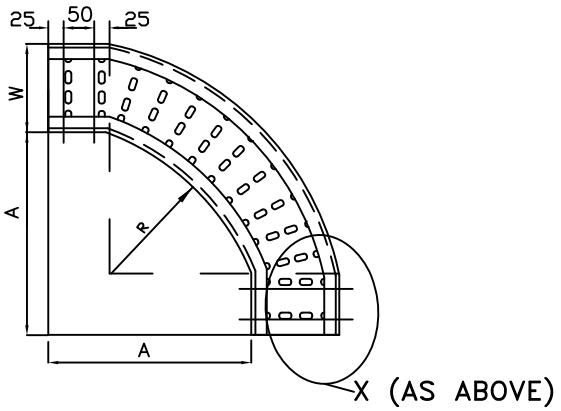
INSIDE TYPE

OUTSIDE TYPE



ENLARGED VIEW OF "X"

90° VERTICAL BEND - PERFORATED TYPE



WIDTH(W)	RADIUS (R)	A	T
600	600	700	4
450	600	700	4
300	600	700	4

90° HORIZONTAL BEND - PERFORATED TYPE

PERFORATED TYPE ACCESSORIES

FOR GENERAL NOTES REFER SHEET 26 OF 26

बीएचईएल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE-DG-435-507-E005
		SHT. 25 OF 26 REV. 0

NOTES:–

1. THE FRP TYPE LADDER AND PERFORATED TYPE CABLE TRAYS AND ACCESSORIES (INCLUDING SIDE RUNNERS OF LADDER TYPE TRAYS & ACCESSORIES) SHALL BE MADE OF 4MM THICKNESS. COUPLER PLATE SHALL BE 4 MM THICK.
2. FOR LADDER TYPE CABLE TRAYS AND ACCESSORIES, ALL RUNGS SHALL BE SLOTTED.
3. STANDARD TRAY ACCESSORIES SHALL BE WITH THE RADIUS INDICATED IN THIS DRAWING.
4. ALL TRAY CORNERS SHALL BE SMOOTH AND FREE OF SHARP EDGES.
5. THE CABLE TRAY COVER (FRP) SHALL BE OF 3MM THICKNESS SHALL BE PROVIDED ON OUTDOOR TRAYS. IT SHALL BE PROVIDED ON TOP MOST CABLE TRAY.
6. THE WIDTH, LENGTH & HEIGHT OF TRAYS & TRAY COVERS SHALL BE WITHIN A TOLERANCE OF (+) 2 mm. THE THICKNESS TOLERANCE SHALL BE (+) 0.5 mm. NO NEGATIVE TOLERANCE IN THICKNESS, WIDTH, HEIGHT OR LENGTH IS PERMITTED.
7. TO FACILITATE ASSEMBLY, ALL ACCESSORIES AT ENDS SHALL HAVE 100mm STRAIGHT PORTION.
8. ALL NUTS, BOLTS, WASHERS ETC., SHALL BE OF STAINLESS STEEL (SS 304).
9. FINISHED TRAYS & COVERS SHALL BE FREE FROM BURRS AND SHARP EDGES.
10. ALL DIMENSIONS ARE IN mm UNLESS NOTED OTHERWISE.
11. WIDTH OF CABLE TRAYS PROPOSED TO BE USED FOR THE PROJECT ARE AS UNDER:

    A)LADDER TYPE: 600W, 450W, 300W, 150W.

    B)PERFORATED TYPE: 600W, 450W, 300W, 150W, 100W, 50W
12. THE DEPTH OF 600W, 450W, 300W, 150W TRAYS & ACCESSORIES SHALL BE 100MM WHILE DEPTH OF 100W & 50W CABLE TRAY SHALL BE 50MM.
13. FOLLOWING SHALL BE LOADING ON CABLE TRAYS AT 1500MM SUPPORT SPAN:–

    FOR LADDER TYPE CABLE TRAYS:–
    600W CABLE TRAY – 90KG/M
    450W CABLE TRAY – 75KG/M
    300W CABLE TRAY – 60KG/M
    150W CABLE TRAY – 30KG/M

    FOR PERFORATED TYPE CABLE TRAYS:–
    600W CABLE TRAY – 90KG/M
    450W CABLE TRAY – 75KG/M
    300W CABLE TRAY – 60KG/M
    150W CABLE TRAY – 30KG/M
    100W CABLE TRAY – 15KG/M
    50W CABLE TRAY – 7.5KG/M

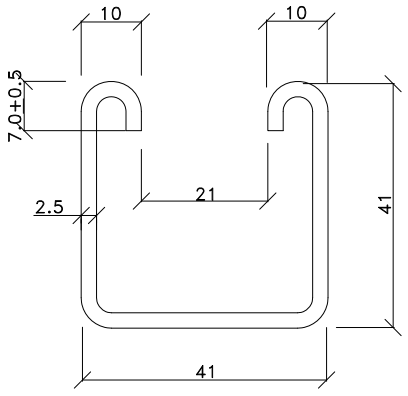
    IN ADDITION TO THIS 80KG POINT LOAD AT MID SPAN SHALL ALSO BE CONSIDERED.

बीएचईएल BHEL	TYPICAL DETAILS OF CABLE TRAYS AND ACCESSORIES (FRP TYPE)	DWG. NO. PE–DG–435–507–E005
		SHT. 26 OF 26 REV. 0

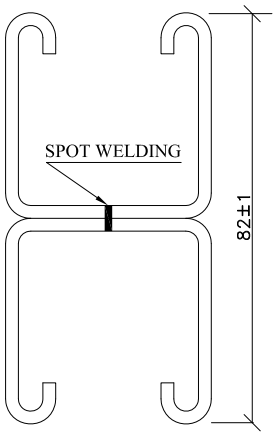
INSTALLATION DETAILS FOR CABLE TRAY SUPPORT SYSTEM

(BOLTABLE TYPE)

CUSTOMER	TAMIL NADU GENERATION & DISTRIBUTION CORPORATION LIMITED					
PROJECT	2 X 660 MW UDANGUDI STPP STAGE-I					
JOB NO. 435	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA	DPT CODE-E		NAME	SIGN	DATE
			DRN	SKS		
			DSN	SKS		
			CHD	VY		
			APP	SL		
		DWG. NO. PE-DG-435-507-E006				
		SHT. 01 OF 20 REV. 0				



SINGLE CHANNEL SC1



DOUBLE CHANNEL DC1

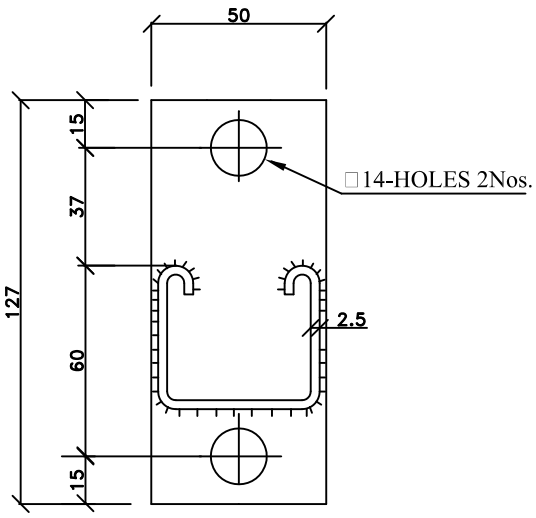
TWO LENGTHS OF SINGLE CHANNEL
SPOT WELDED BACK TO BACK
AT 75MM C/C

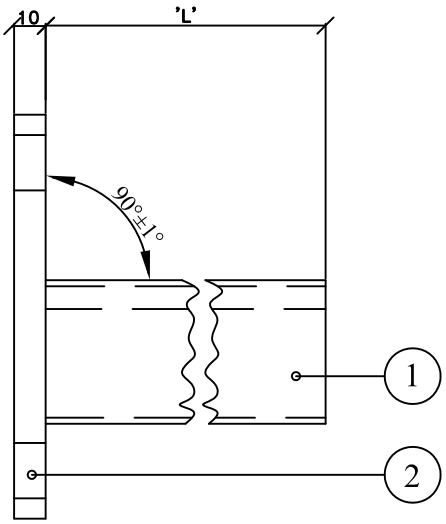
NOTE:

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : HOT ROLLED M.S. AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

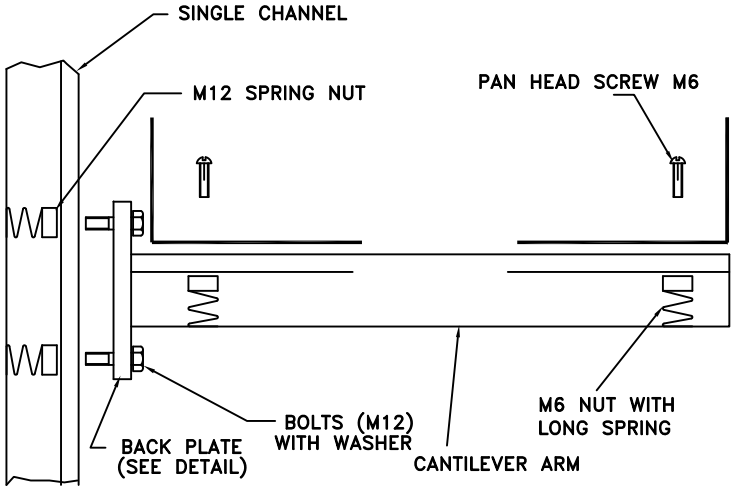
BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	DRG. NO. PE-DG-435-507-E006
		SH 2 OF 20





CANTILEVER ARMS

TRAY WIDTH IN MM	CANTILEVER ARM LENGTH (L) IN MM
150	200
300	350
450	500
600	650



TYPICAL ASSEMBLY OF CHANNEL SUPPORTS AND CABLE TRAY

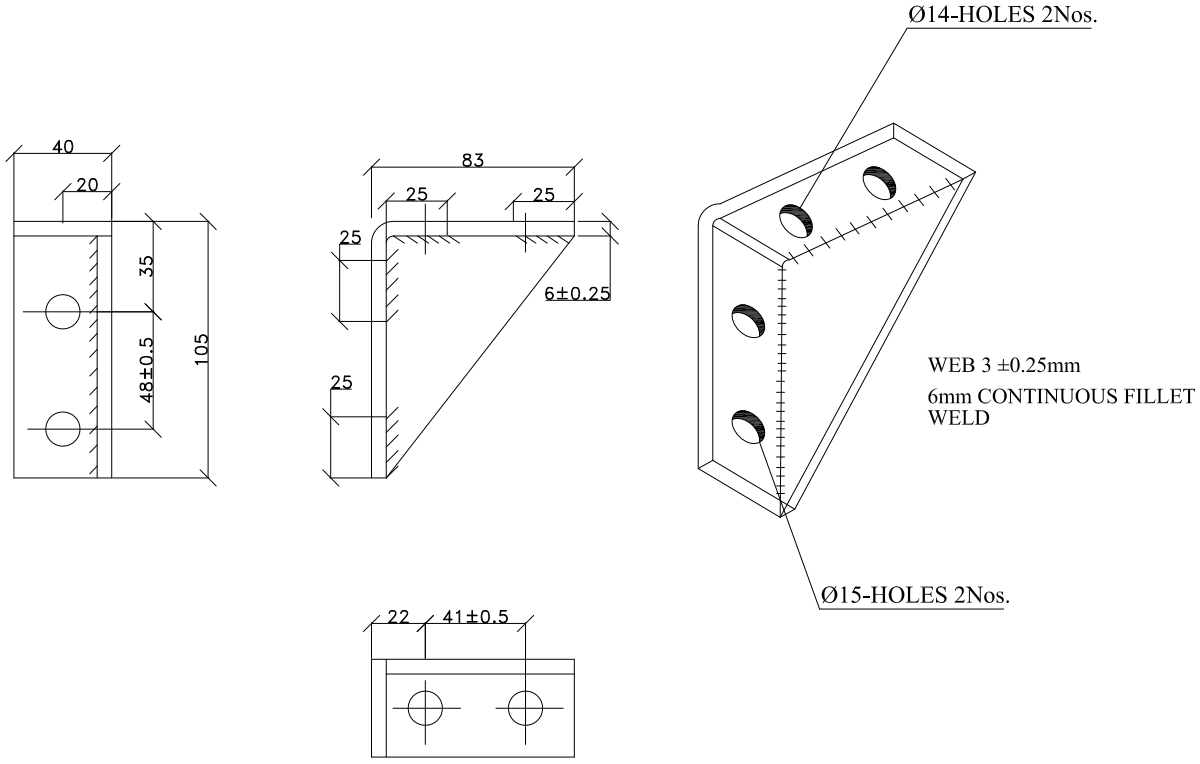
M12 HEX BOLT & WASHER–2NOs.
M12 SPRING NUTS–2NOs.
M6 PAN HEAD SCREWS & WASHER–2NOs.
M6 SPRING NUTS–2NOs.

NOTE:

1. ALL DIMENSIONS ARE IN mm.
2. ITEM NO.1 MATERIAL : HOT ROLLED M.S. AS PER IS-2062.
3. ITEM NO.2 MATERIAL : MILD STEEL AS PER IS-2062.
4. FINISH : HOT DIP GALVANISED AS PER IS 2629
5. TOLERANCE ON THICKNESS IS AS PER IS 1852
6. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
7. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

बीएचईएल BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	DRG. NO. PE–DG–435–507–E006
		SH 3 OF 20



90^0 ANGLE FITTING HL1

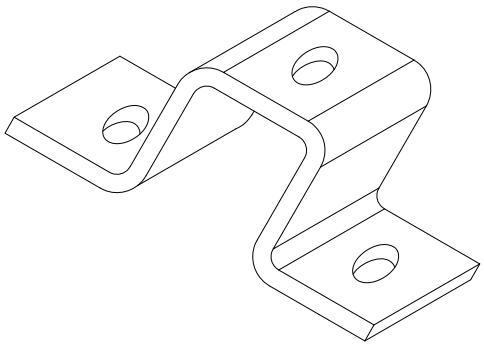
ANCHOR FASTENER–2NOs.
SPRING NUT & WASHER–2NOs.

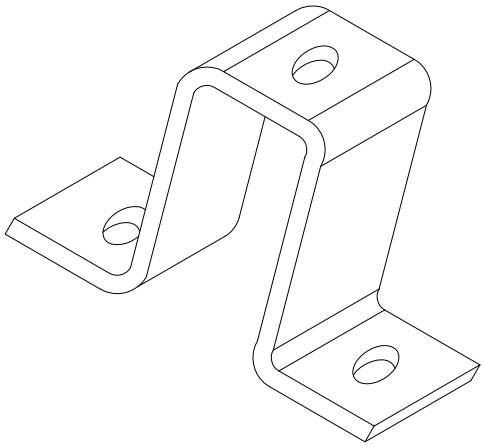
NOTE:

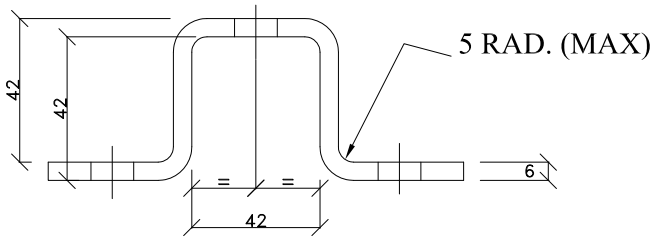
1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

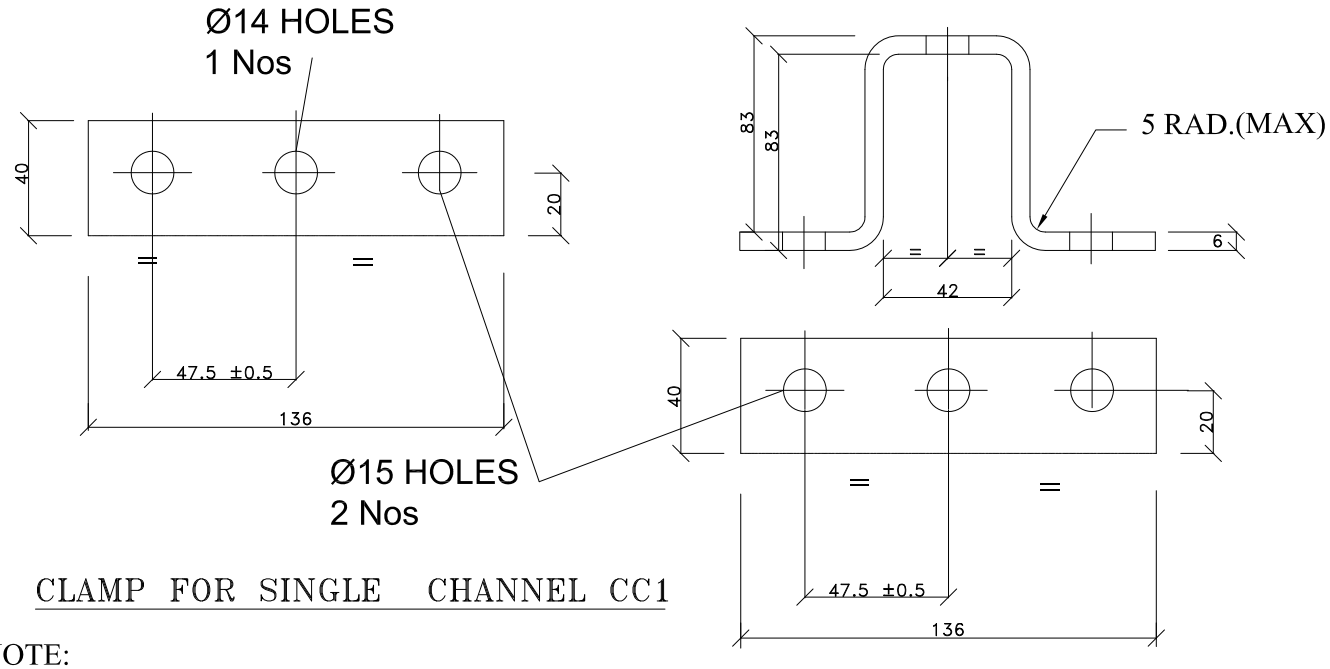
TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	DRG. NO. PE–DG–435–507–E006
		SH 4 OF 20









CLAMP FOR SINGLE CHANNEL CC1

CLAMP FOR DOUBLE CHANNEL CC2

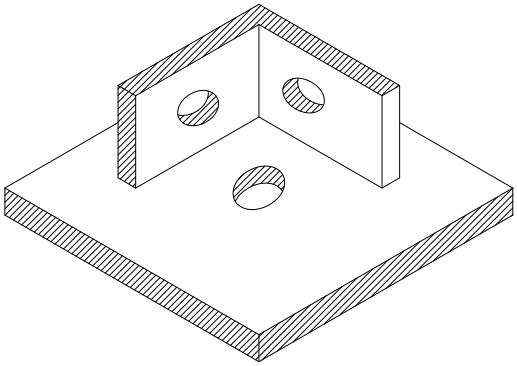
NOTE:

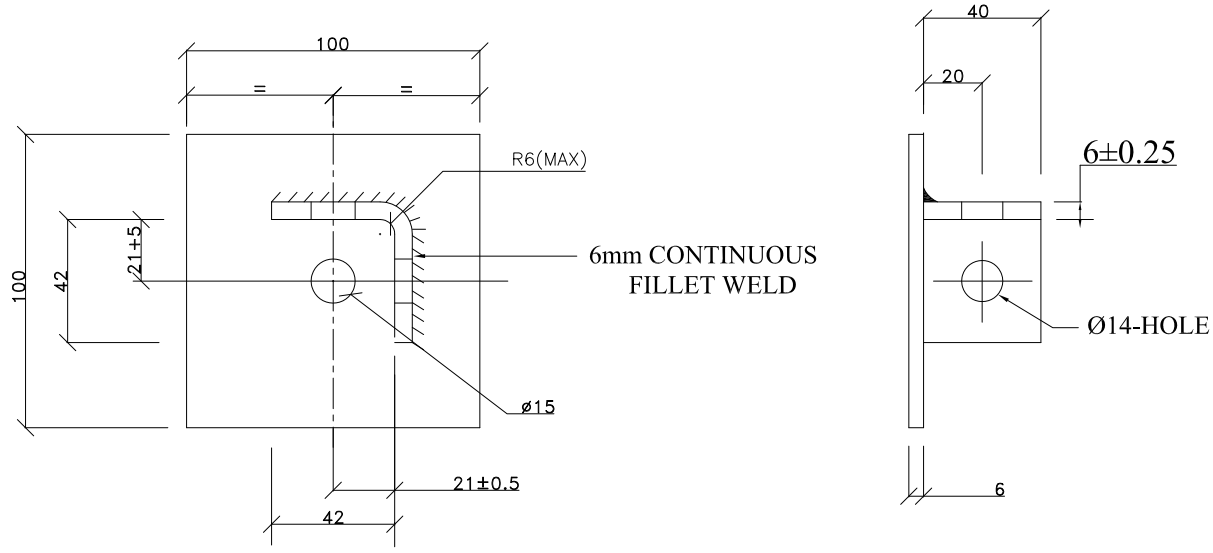
1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

ANCHOR FASTENER–2NOs.
SPRING NUT & WASHER–1NO.

TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	DRG. NO. PE–DG–435–507–E006
		SH 5 OF 20





BASE PLATE FOR SINGLE CHANNEL BP1

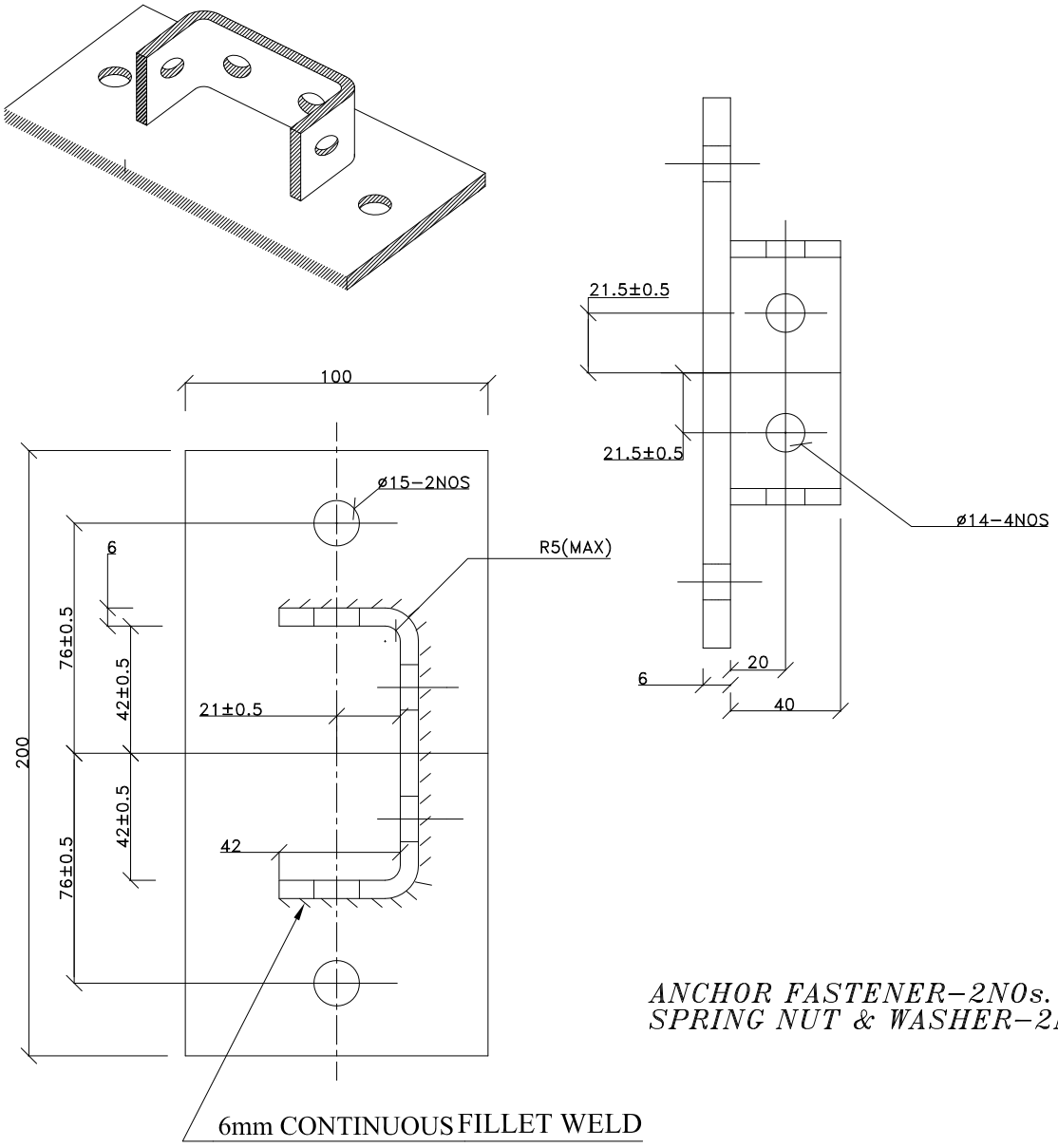
NOTE:

ANCHOR FASTENER–1NO.
SPRING NUT & WASHER–1NO.

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	DRG. NO. PE–DG–435–507–E006
		SH 6 OF 20



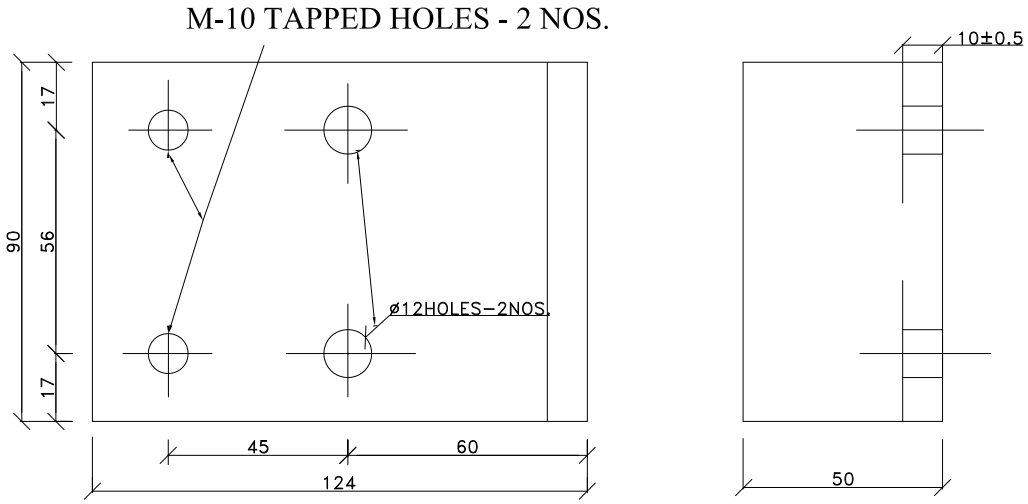
BASE PLATE FOR DOUBLE CHANNEL BP2

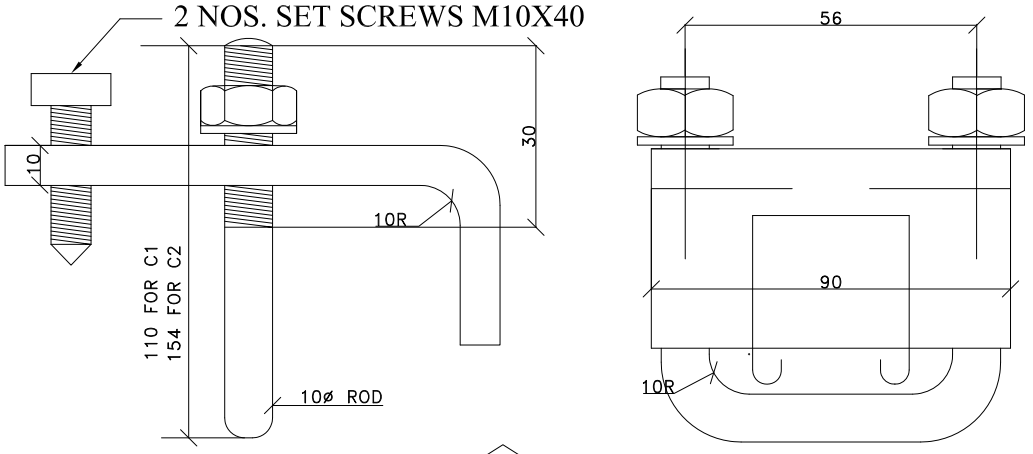
NOTE:

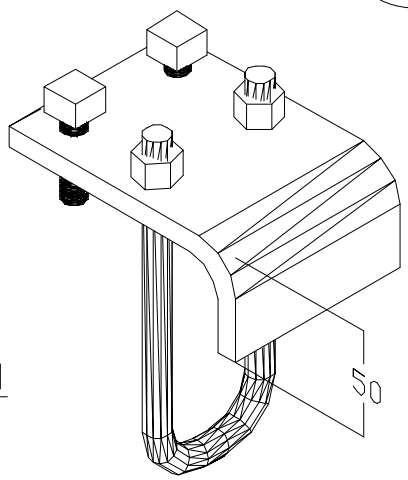
1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	DRG. NO. PE–DG–435–507–E006
		SH 7 OF 20







BEAM CLAMP - BC1

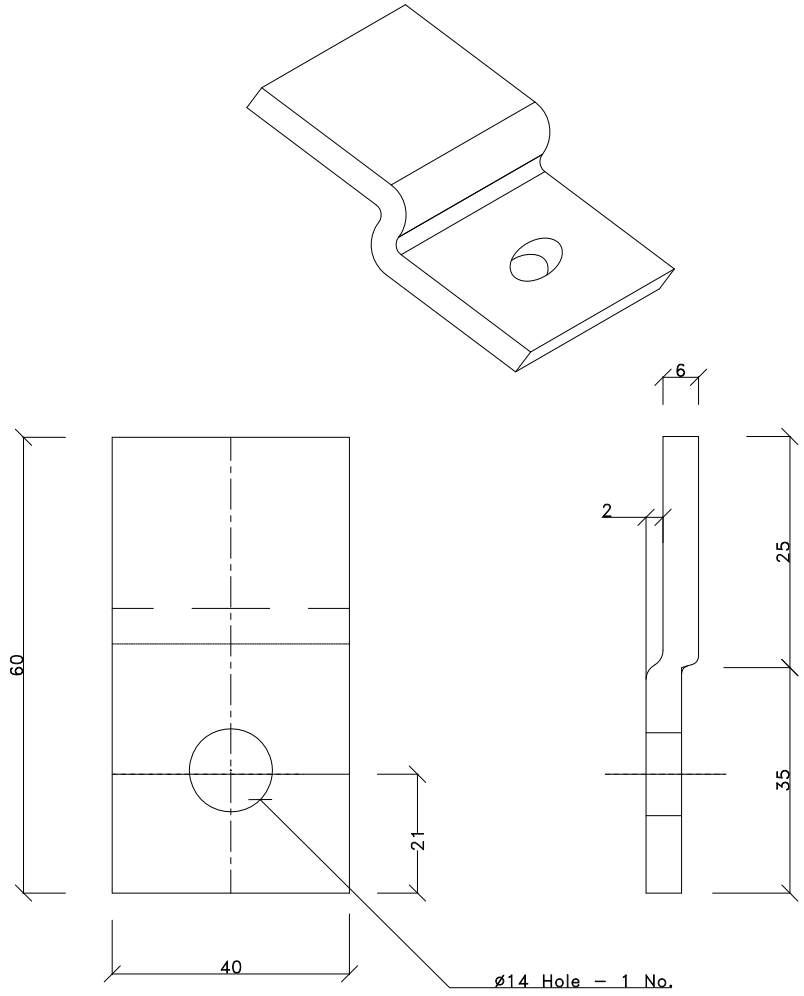
M-10 U-BOLT WITH
2Nos PLAIN WASHERS & NUTS
110 mm FOR SC 1
154 mm FOR DC1
2 NOs. SET SCREWS M10X40

NOTE:

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE-DG-435-507-E006
		SH 8 OF 20



TRAY FIXING CLAMP - TC1

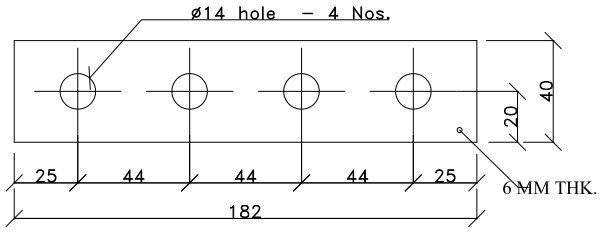
NOTE:

SPRING NUT & WASHER–1NO.

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

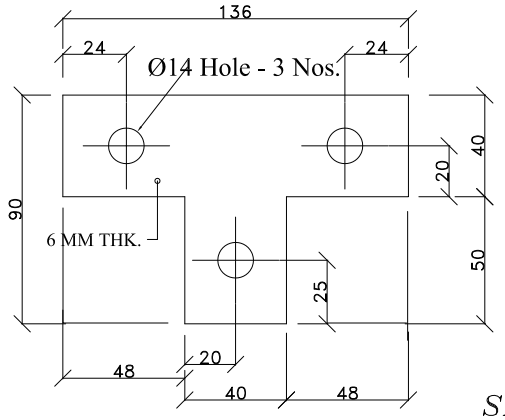
TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE–DG–435–507–E006
		SH 9 OF 20



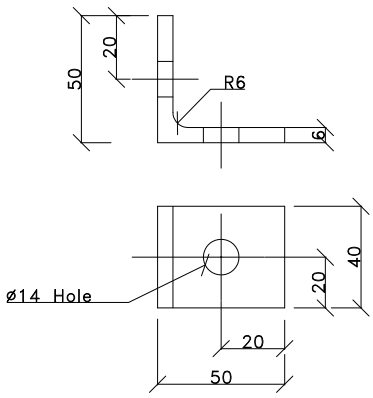
SPRING NUT & WASHER–4NOs.

FLAT PLATE STRAIGHT FITTING PF2



SPRING NUT & WASHER–3NOs.

FLAT PLATE TEE FITTING PF1



SPRING NUT & WASHER–2NOs.

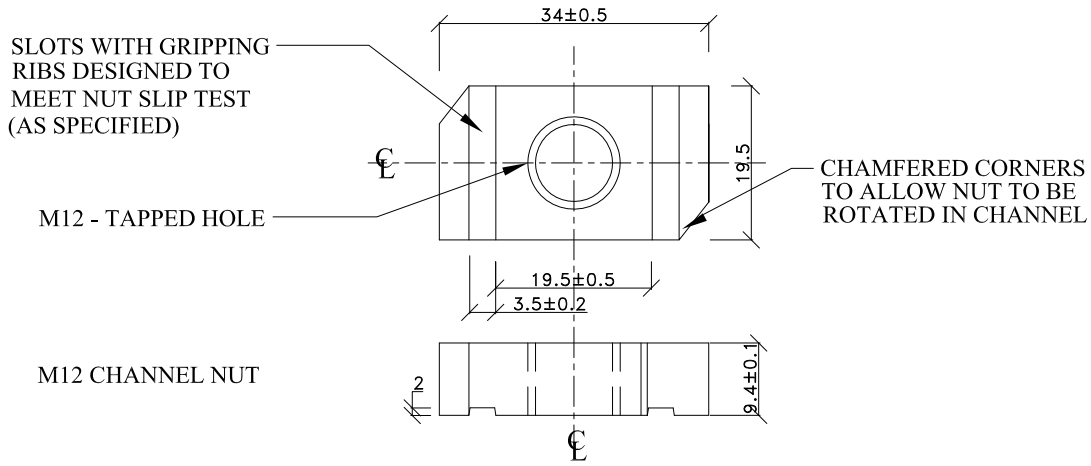
NOTE:

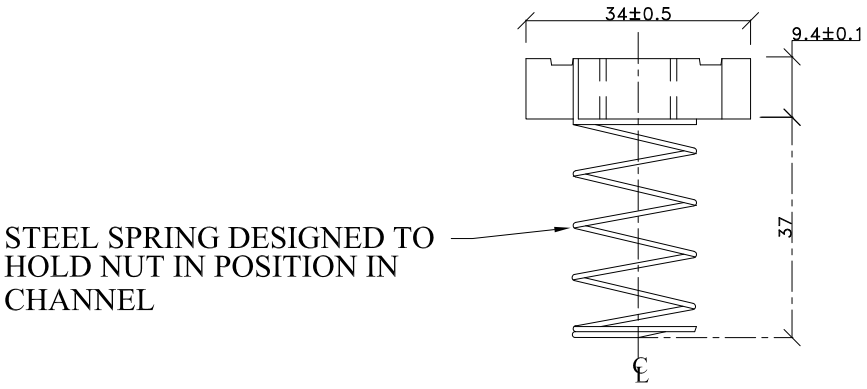
90^0 ANGLE FITTING LA1

1. ALL DIMENSIONS ARE IN mm.
2. MATERIAL : MILD STEEL AS PER IS-2062.
3. FINISH : HOT DIP GALVANISED AS PER IS 2629
4. TOLERANCE ON THICKNESS IS AS PER IS 1852
5. ALL FABRICATION TOLERANCE AS PER RELEVANT IS.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

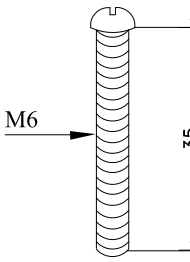
TYPICAL DETAILS OF BOLTABLE TYPE CABLE TRAY SUPPORT MATERIAL & ACCESSORIES

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE–DG–435–507–E006
		SH 10 OF 20

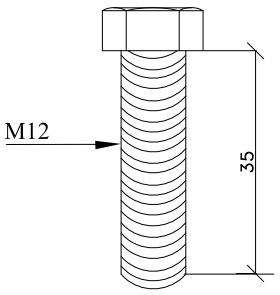




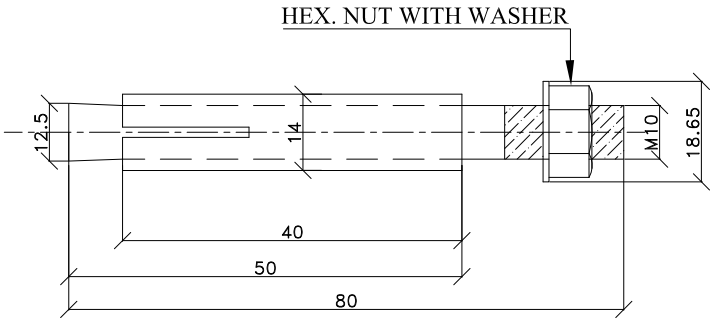
SPRING NUT ASSEMBLY



PAN HEAD SCREW



HEX BOLT

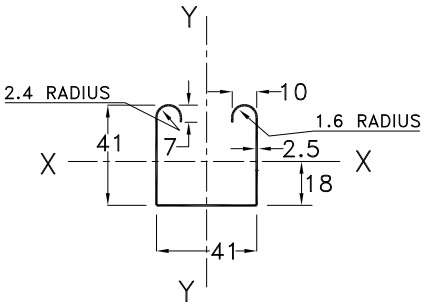


ANCHOR BOLT M10

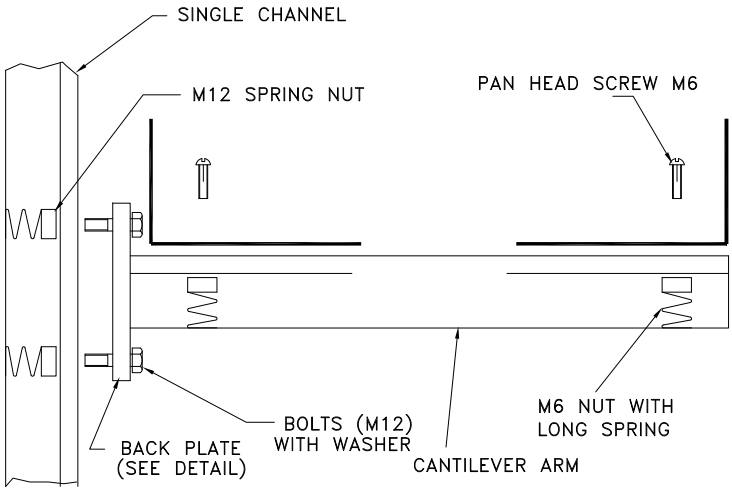
NOTES:

1. MATERIAL - MS AS PER IS - 2062.
2. M6 CHANNEL NUT DIMENSIONAL SIMILAR TO M12.
   EXCEPT HOLE DRILLED AND TAPPED TO M6 PAN HEAD SCREWS.
3. TAPPED HOLE THREADING TO MATCH WITH THREADING OF BOLTS.
4. SURFACE PROTECTION ELECTROGALVANISED / CADMIUM PLATED.
5. ALL DIMENSIONS ARE IN MM.
6. ZINC COATING SHALL BE MIN. 75 MICRON/ 610 G/SQ.M.

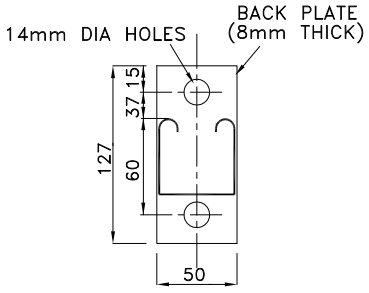
BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE-DG-435-507-E006
		SH 11 OF 20



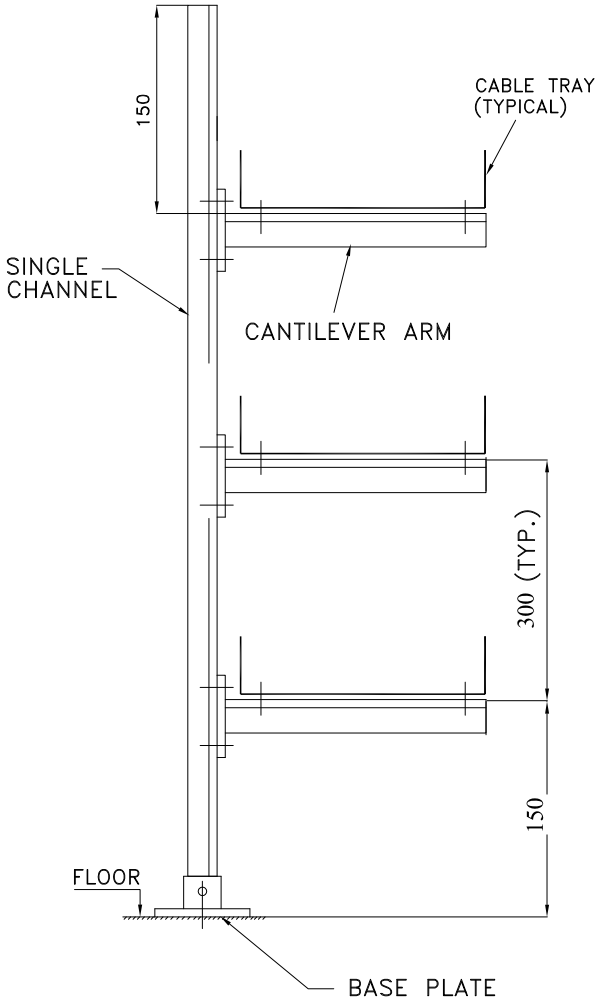
DETAIL OF ITEM–1
(SINGLE CHANNEL)

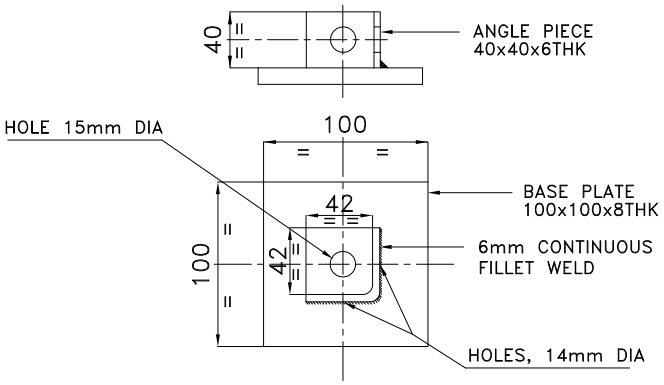


TYPICAL ASSEMBLY OF CHANNEL
SUPPORTS AND CABLE TRAY



END VIEW OF
(CANTILEVER ARM)





DETAILS OF BASE PLATE
FOR SINGLE CHANNEL

FLOOR SUPPORTED (SINGLE SIDE TYPE)

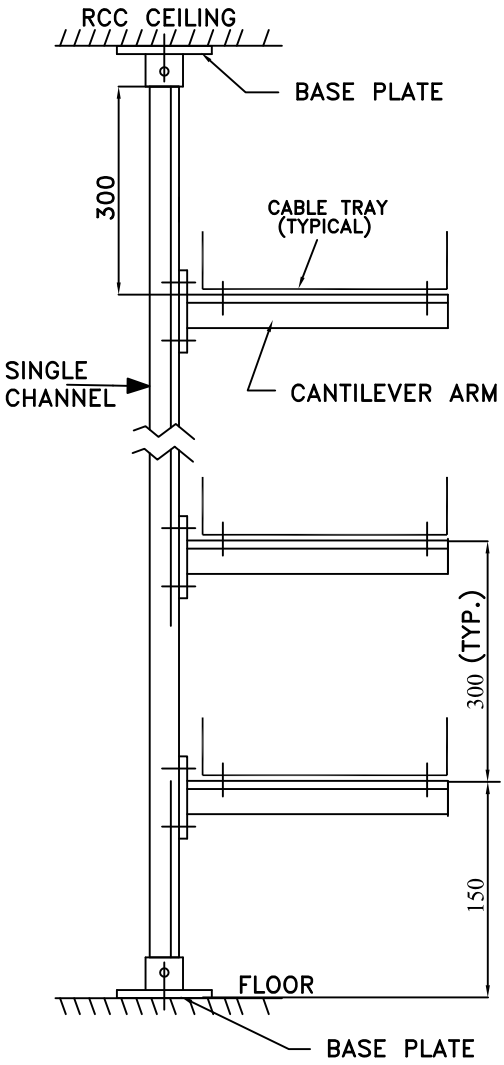
SEE GENERAL NOTES IN SHEET 17.

TITLE:

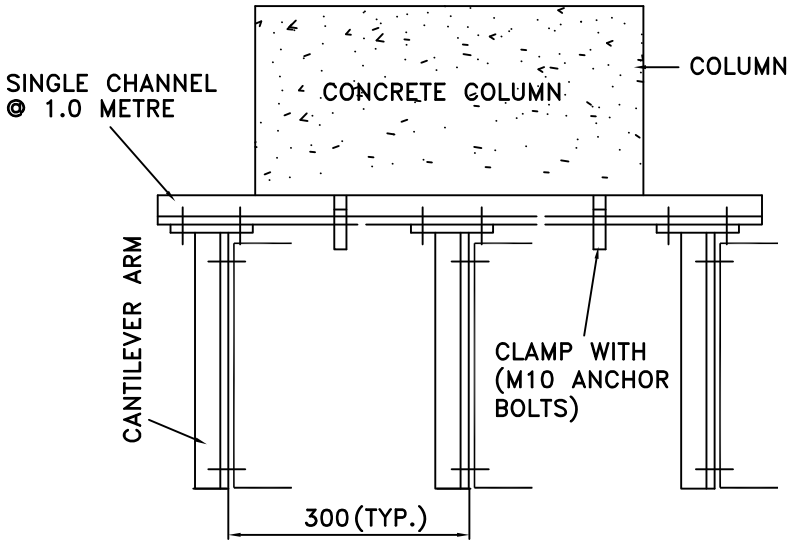
INSTALLATION DETAILS FOR
CABLE TRAYS SUPPORT SYSTEM

BHEL DRAWING NO.

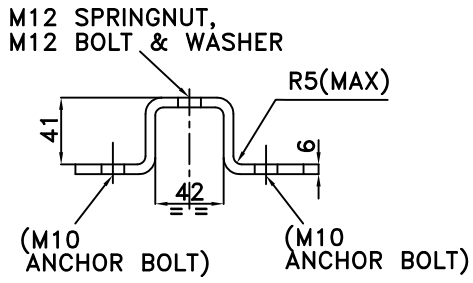
PE–DG–435–507–E006



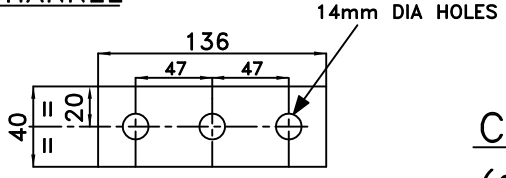
SUPPORTING ARRANGEMENT
BETWEEN FLOOR AND CEILING
(SINGLE SIDE TYPE)

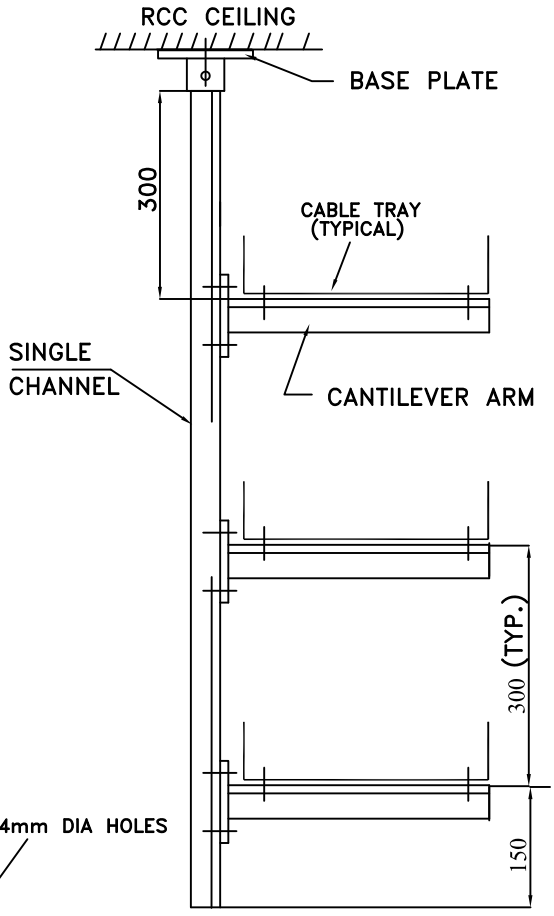


SUPPORT ARRANGEMENT
FROM BUILDING COLUMN



CLAMP FOR SINGLE CHANNEL

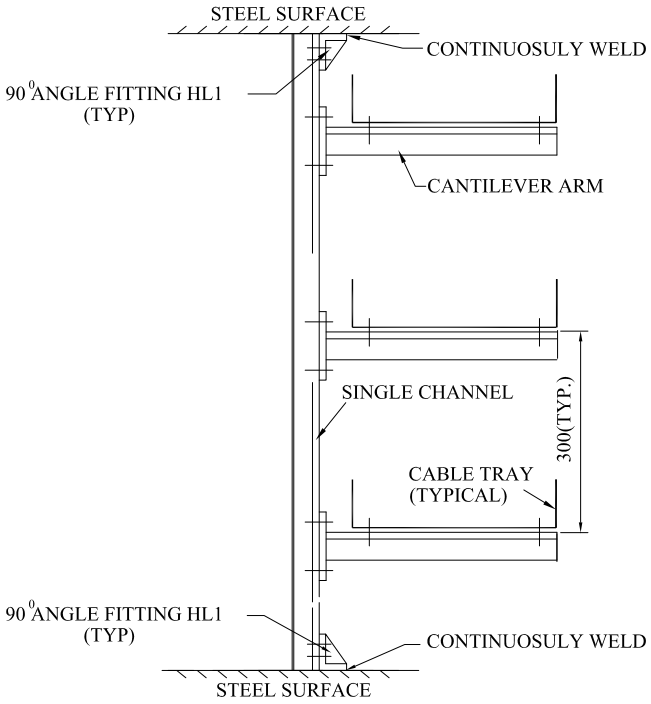


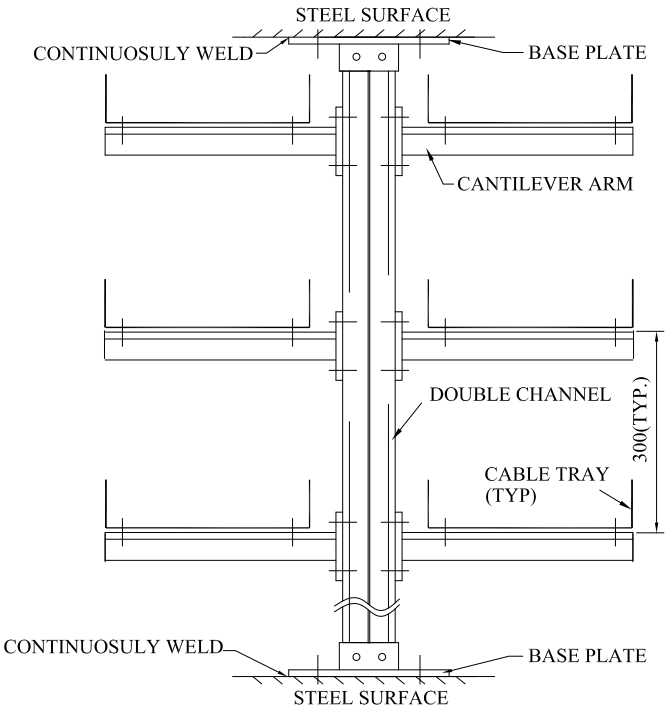


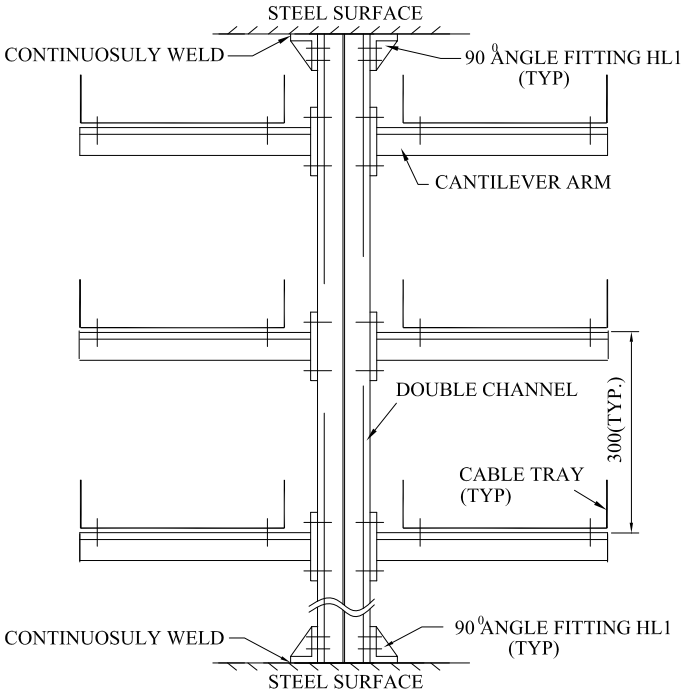
CEILING SUPPORTED
(SINGLE SIDE TYPE)

SEE GENERAL NOTES IN SHEET 17.

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE-DG-435-507-E006
		SH 13 OF 20



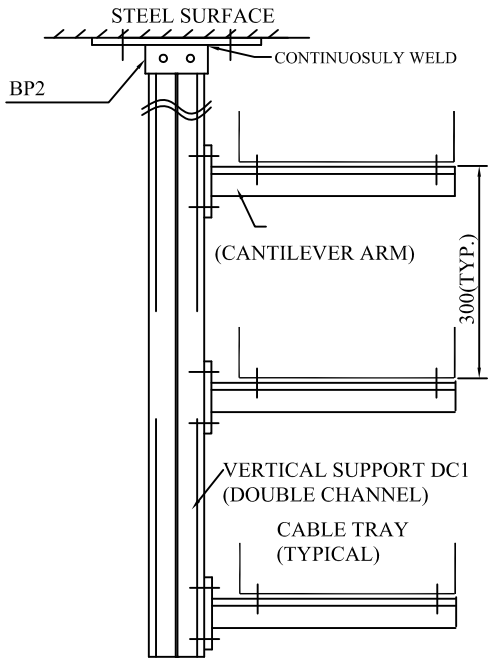




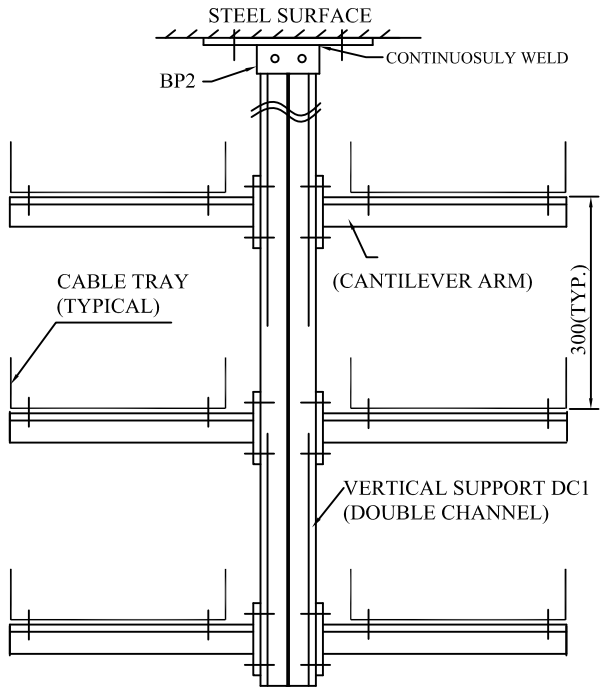
SUPPORTING ARRANGEMENT OF (SINGLE SIDE/DOUBLE SIDE) BETWEEN TWO STEEL SURFACE

SEE GENERAL NOTES IN SHEET 17.

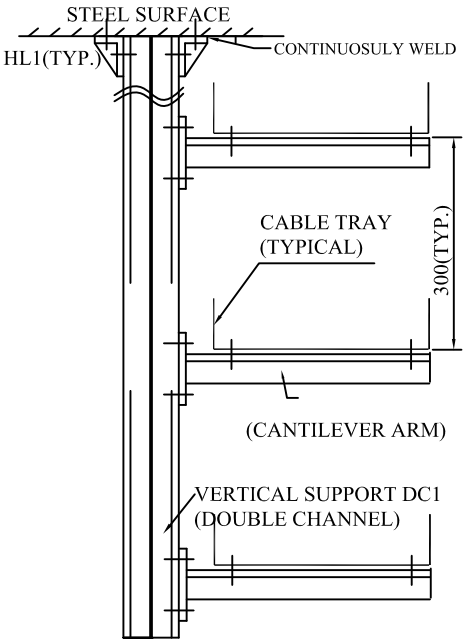
BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE-DG-435-507-E006
		SH 14 OF 20



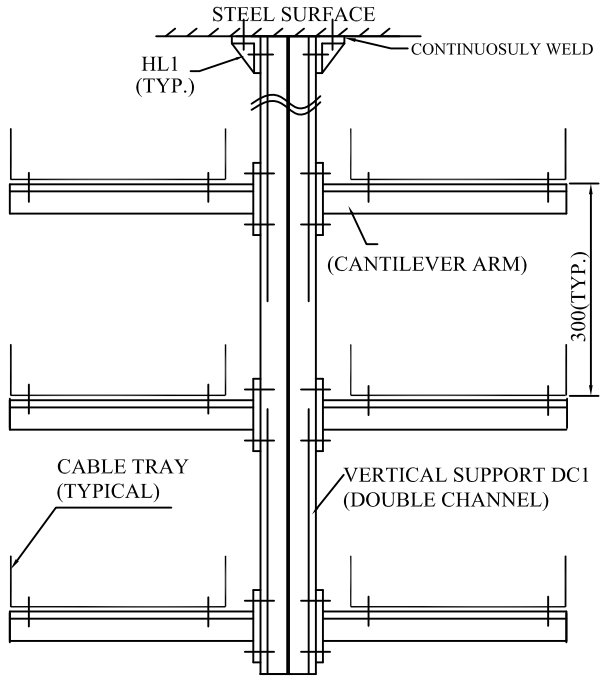
INSTALLATION DETAIL TYPE DS1:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
BASEPLATE AT TOP
APPLICABLE FOR THREE TRAYS ON SINGLE SIDE



INSTALLATION DETAIL TYPE DS2:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
BASEPLATE AT TOP
APPLICABLE FOR UPTO THREE TRAYS ON BOTH SIDES



INSTALLATION DETAIL TYPE DS3:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
WITH ANGLE FITTING HL1 AT TOP
APPLICABLE FOR MORE THAN TWO TRAYS
ON SINGLE SIDE



INSTALLATION DETAIL TYPE DS4:
DOUBLE CHANNEL SUPPORT INSTALLATION
ONLY TOP END FIXED
WITH ANGLE FITTING HL1 AT TOP
APPLICABLE FOR UPTO THREE TRAYS ON BOTH SIDES

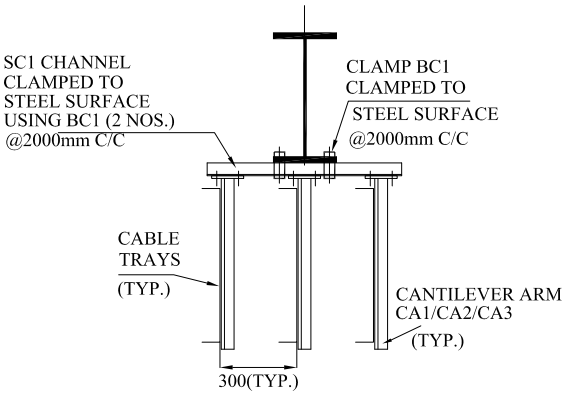
SEE GENERAL NOTES IN SHEET 17.

TITLE:

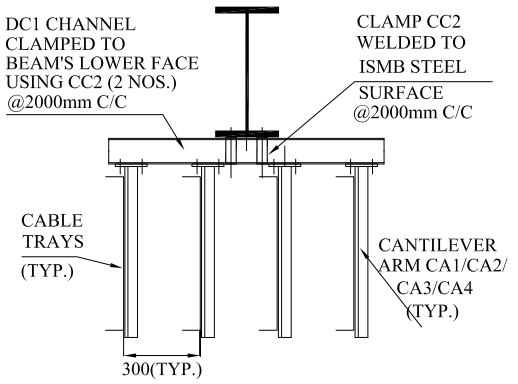
INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM

BHEL DRAWING NO.

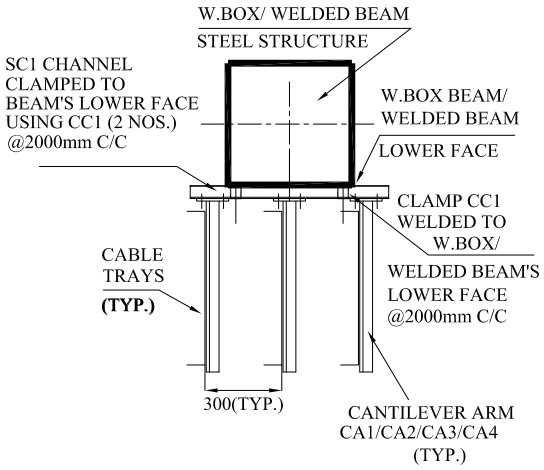
PE-DG-435-507-E006



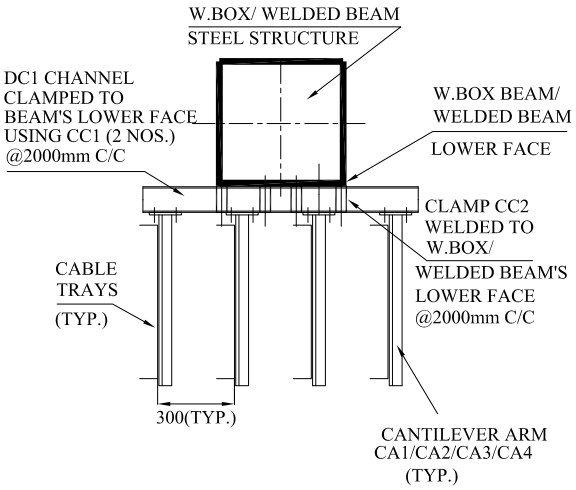
INSTALLATION DETAIL TYPE BB1:
CABLE TRAYS BELOW I-BEAMS
(UPTO & INCLUDING THREE TRAYS)



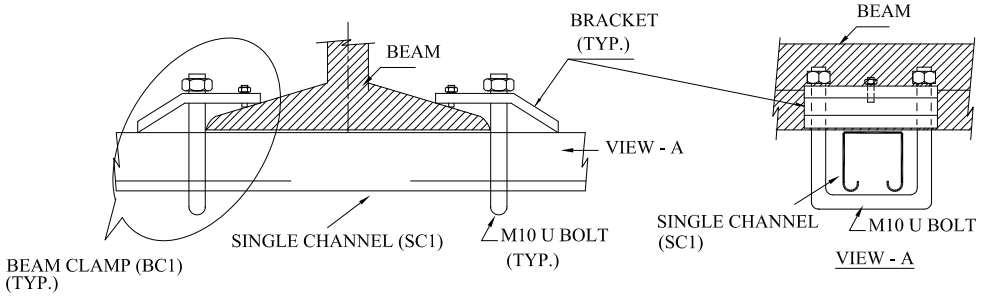
INSTALLATION DETAIL TYPE BB2:
CABLE TRAYS BELOW I-BEAMS
(MORE THAN THREE TRAYS)



INSTALLATION DETAIL TYPE BB3:
CABLE TRAYS BELOW W. BOX/
WELDED BEAM'S (APPLICABLE FOR
UPTO & INCLUDING THREE TRAYS)



INSTALLATION DETAIL TYPE BB4:
CABLE TRAYS BELOW W. BOX/
WELDED BEAM'S (APPLICABLE FOR
MORE THAN THREE TRAYS)



SINGLE CHANNEL FIXING ARRANGEMENT WITH BEAM

CABLE TRAYS SUPPORTING ARRANGEMENT AROUND BOILER PLATFORMS

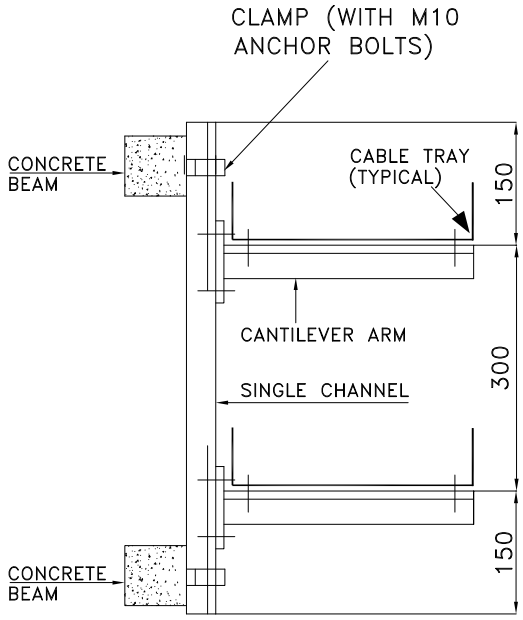
SEE GENERAL NOTES IN SHEET 17.

TITLE:

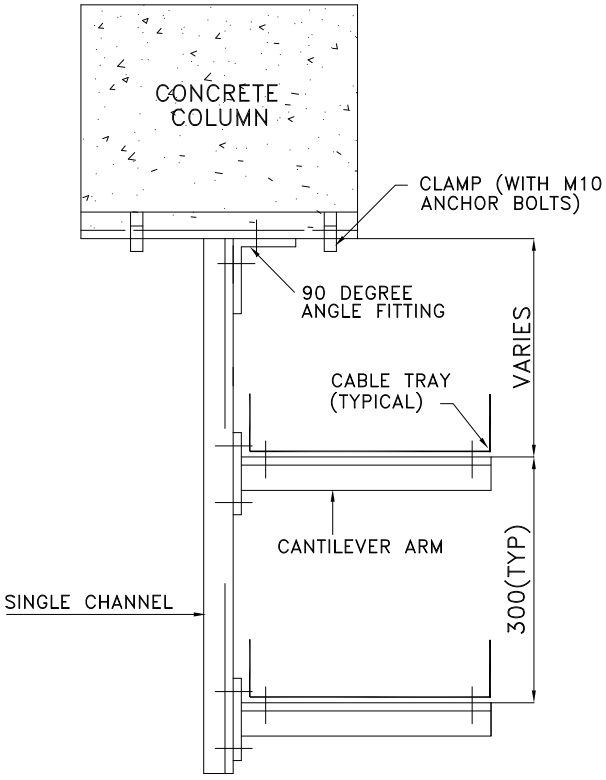
INSTALLATION DETAILS FOR
CABLE TRAYS SUPPORT SYSTEM

BHEL DRAWING NO.

PE-DG-435-507-E006



SUPPORT ARRANGEMENT
FROM CONCRETE BEAMS

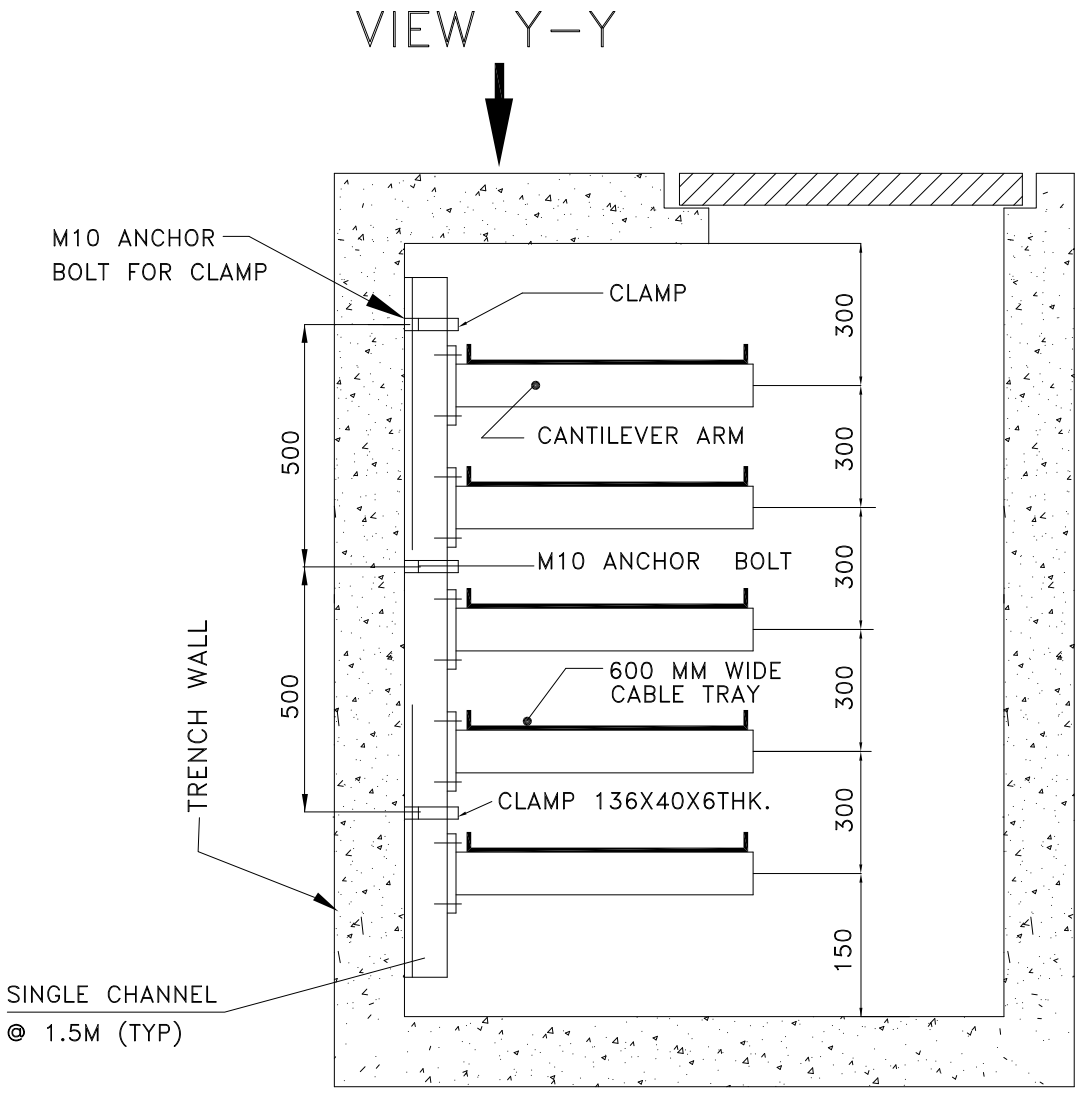


SUPPORT ARRANGEMENT
FROM CONCRETE COLUMNS
WITH ANGLE FITTING

GENERAL NOTES

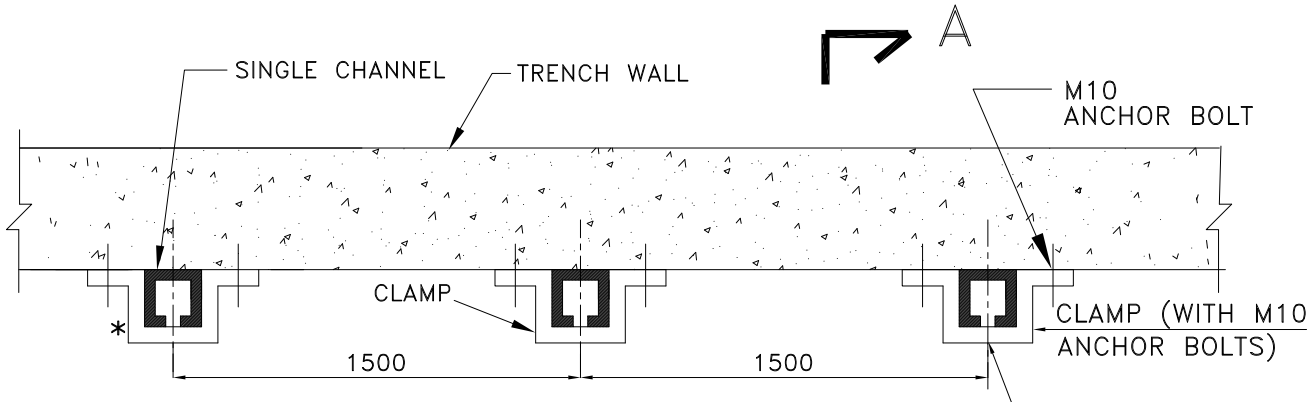
1. ALL DIMENSIONS ARE IN MM UNLESS INDICATED OTHERWISE.
2. ALL SUPPORTS ARE OF 2.5 MM THICK MS CHANNEL SECTIONS AND GALVANISED.
3. ALL FASTENERS SHALL BE ZINC PASSIVATED/ CADMIUM PLATED.
4. ALL SUPPORT SHALL BE FIXED ON WALL / COLUMN / TRENCH BY MEANS OF 136 X 40 X 6 MM THICK CLAMP.
5. ARRANGEMENT SHOWN ARE TYPICAL ONLY.
6. ALL WELDS FOR CABLE TRAY SUPPORTS SHALL HAVE A MINIMUM THROAT THICKNESS OF 6 MM.

BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE-DG-435-507-E006
		SH 17 OF 20



SECTION–AA

TYP. CABLE TRAYS FIXING ARRANGEMENT IN TRENCH

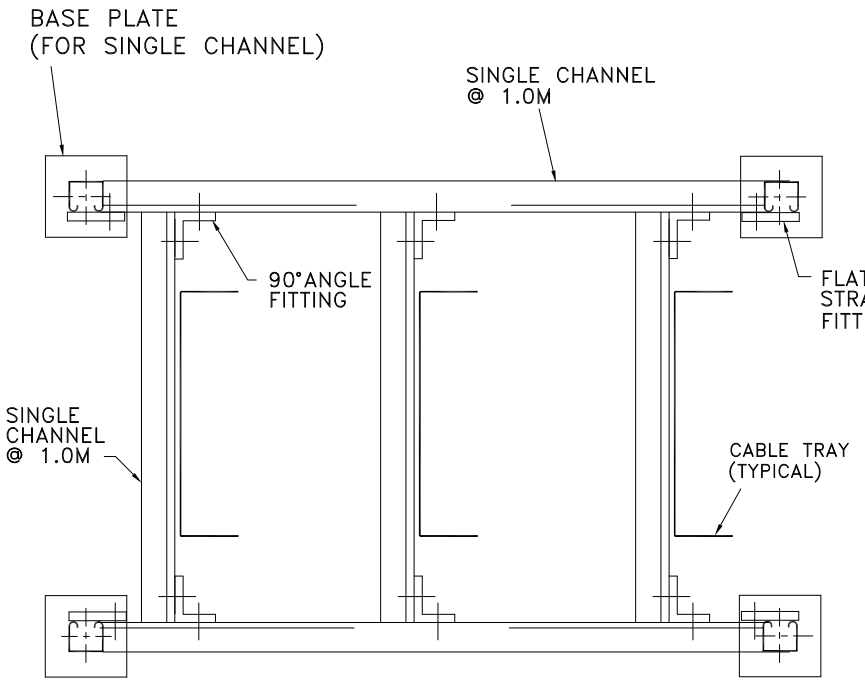


*CANTILEVER ARM IS NOT SHOWN IN PLAN

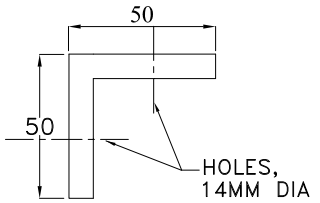
VIEW Y–Y

SEE GENERAL NOTES IN SHEET 17.

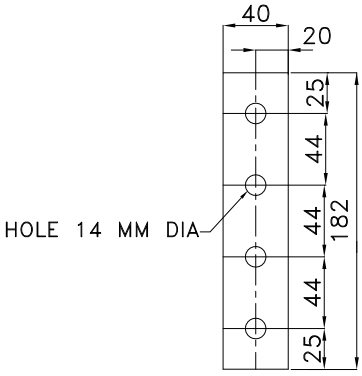
BHEL	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE–DG–435–507–E006
		SH 18 OF 20



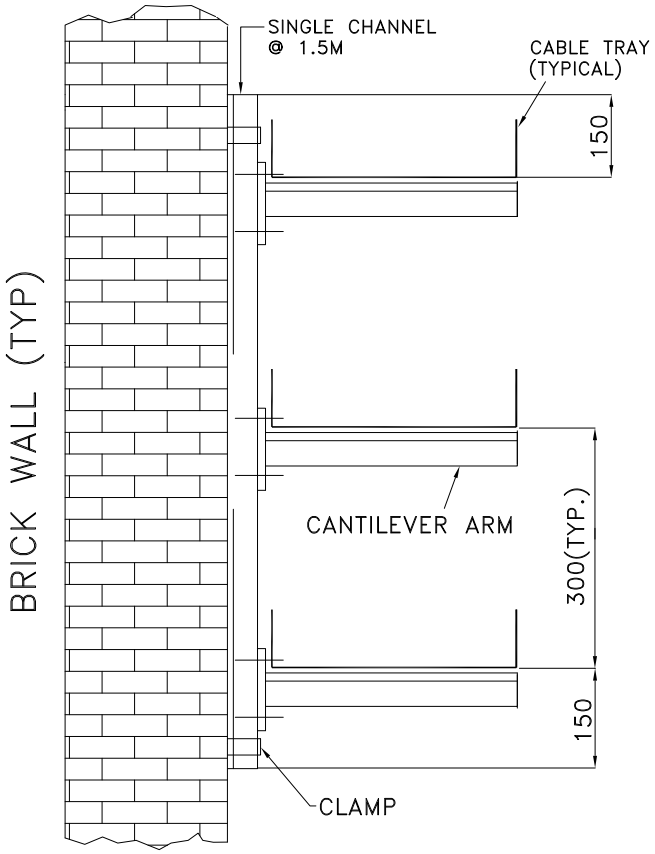
TYPICAL FLOOR SUPPORTED CHANNEL FRAME WORK (FOR BOLTABLE TYPE CABLE TRAY RISER)



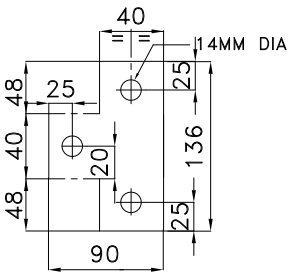
90 DEG. ANGLE FITTING
(6 MM THICK, 40 MM WIDE)



FLAT PLATE
STRAIGHT FITTING
(6 MM THICK)



TYPICAL CHANNEL SUPPORT
(ON WALL)



FLAT PLATE TEE FITTING
(6 MM THICK)

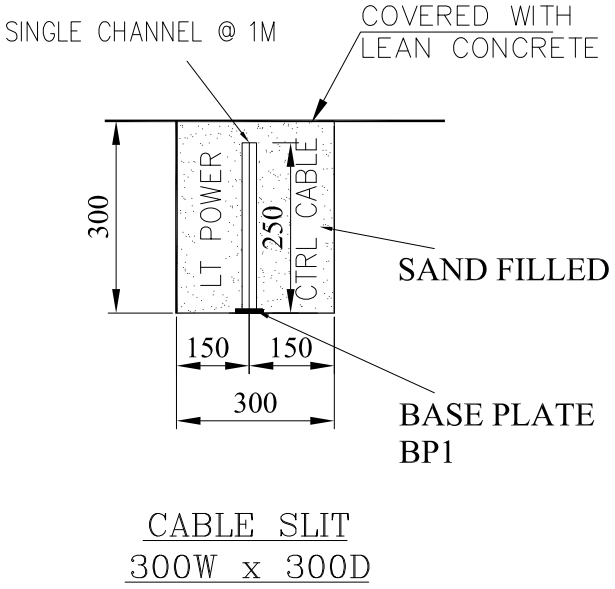
SEE GENERAL NOTES IN SHEET 17.

TITLE:

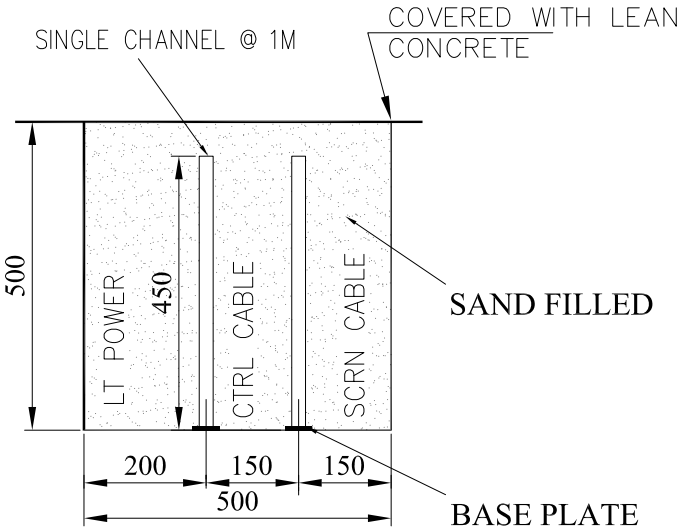
INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM

BHEL DRAWING NO.

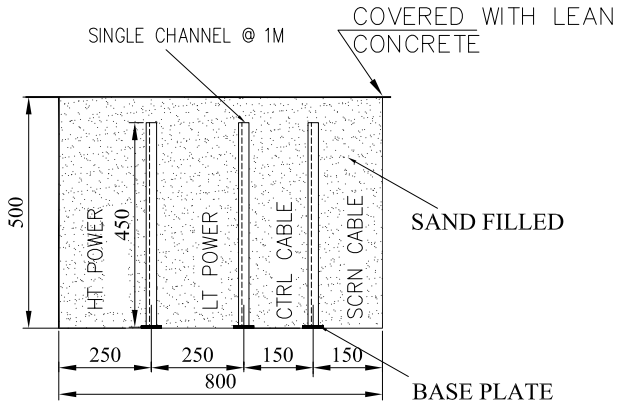
PE-DG-435-507-E006



CABLE SLIT
300W x 300D



CABLE SLIT
500W x 500D



CABLE SLIT
800W x 500D

TYPICAL CABLE SLIT ARRANGEMENT

SEE GENERAL NOTES IN SHEET 17.

	TITLE: INSTALLATION DETAILS FOR CABLE TRAYS SUPPORT SYSTEM	BHEL DRAWING NO. PE-DG-435-507-E006 SH 20 OF 20

TYPICAL ABOVE GRADE

GROUNDING DETAILS

PROJECT	2 X 660 MW UDANGUDI STPP STAGE–I	
	OWNER	TAMIL NADU GENERATION & DISTRIBUTION CORPOARATION LIMITED
	OWNER'S CONSULTANT	
	EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA

REV	DATE	ALTD	CHD	APPD

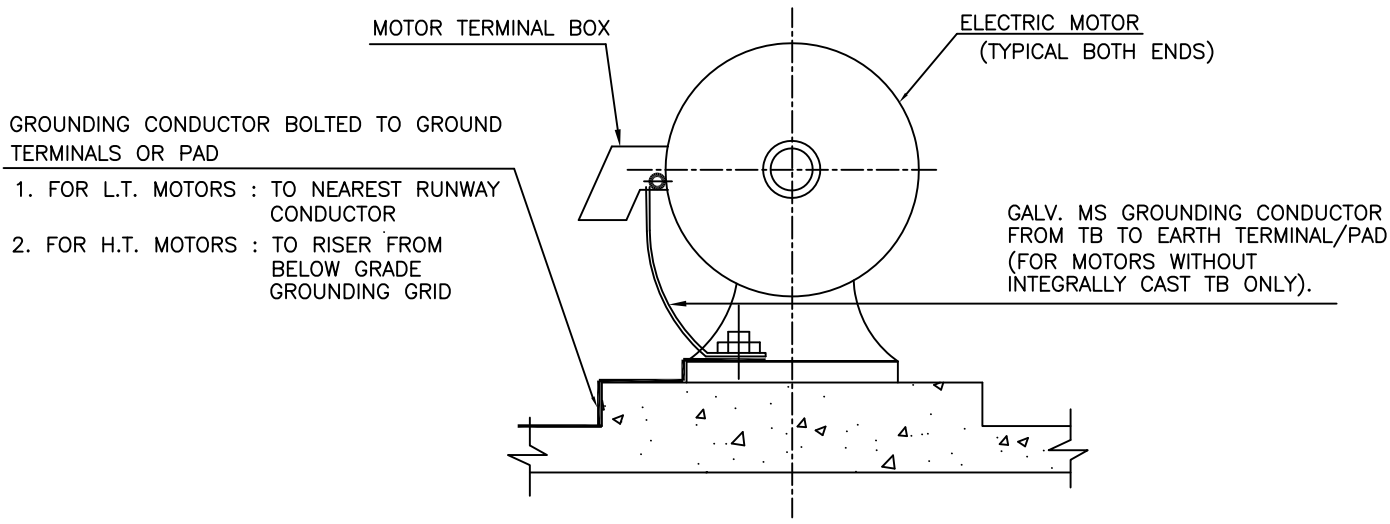
BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

DEPT CODE		NAME	SIGN	DATE
E	DRN	AAT	–S.D.–	
	DSGN	AAT	–S.D.–	19.03.18
	CHD	VY	–S.D.–	19.03.18
	APPD	SL	–S.D.–	19.03.18

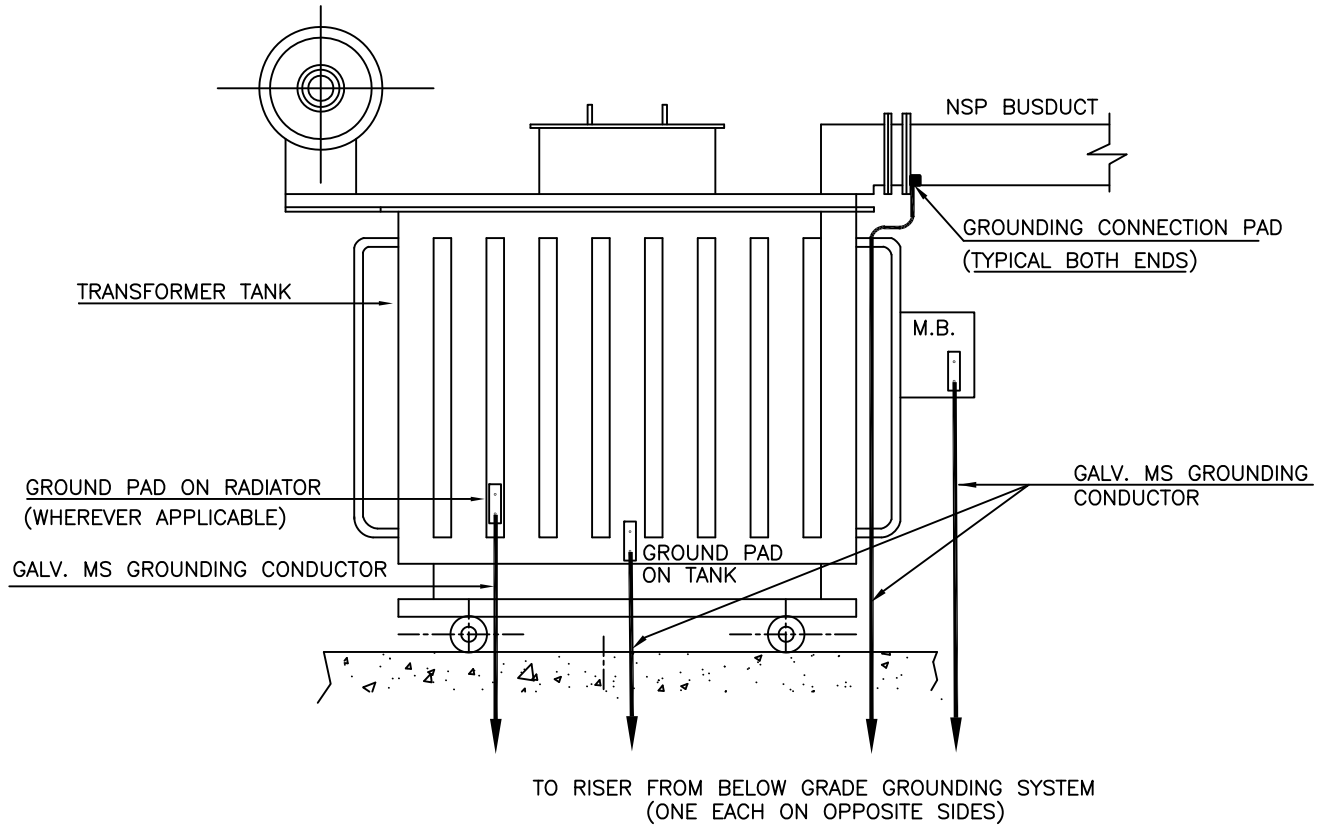
TITLE: TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS

DRAWING NO. PE–DG–435–509–E004

SHEET 1 OF 15 REV. 00



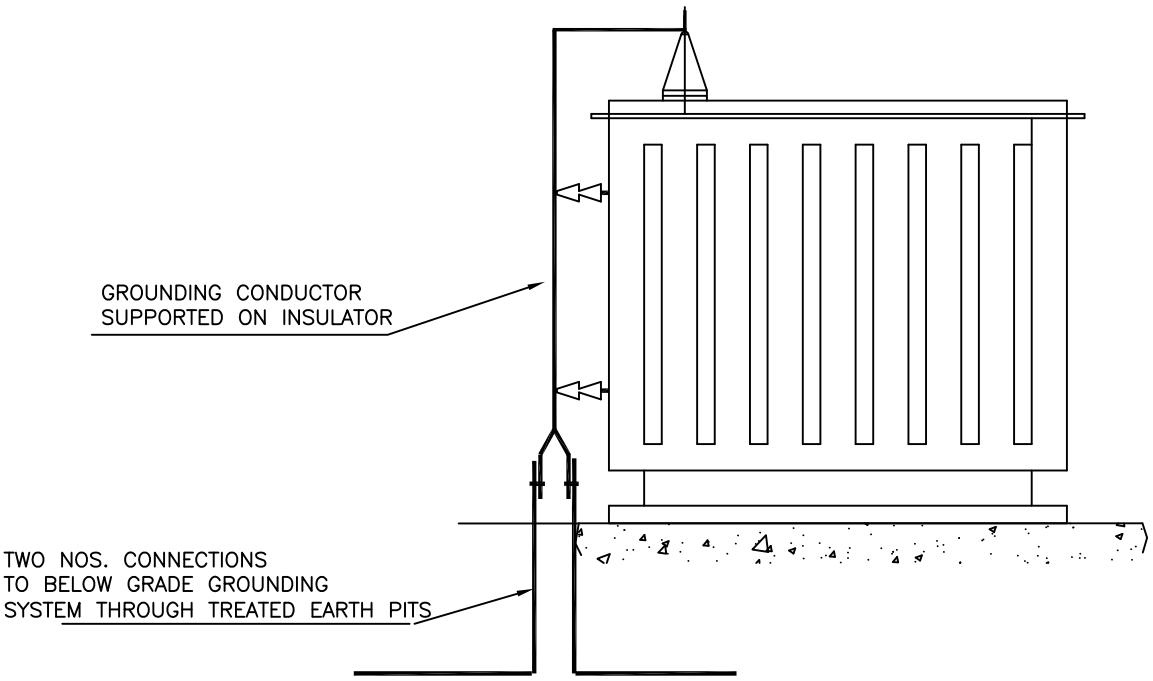
E1 : TYPICAL MOTOR GROUNDING DETAILS



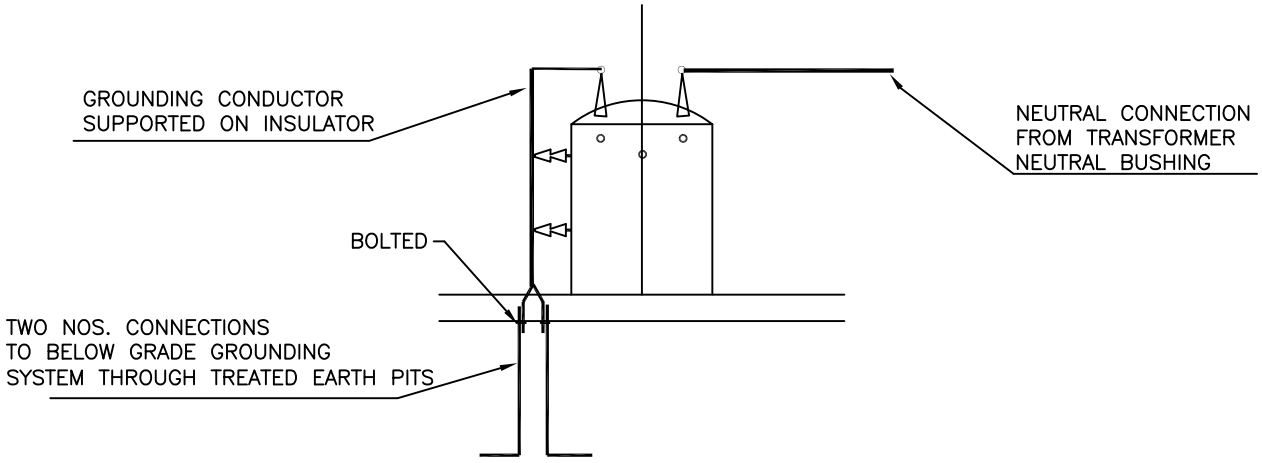
E2 : TRANSFORMER GROUNDING

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
	REV. No. 00
	SHEET 2 OF 15



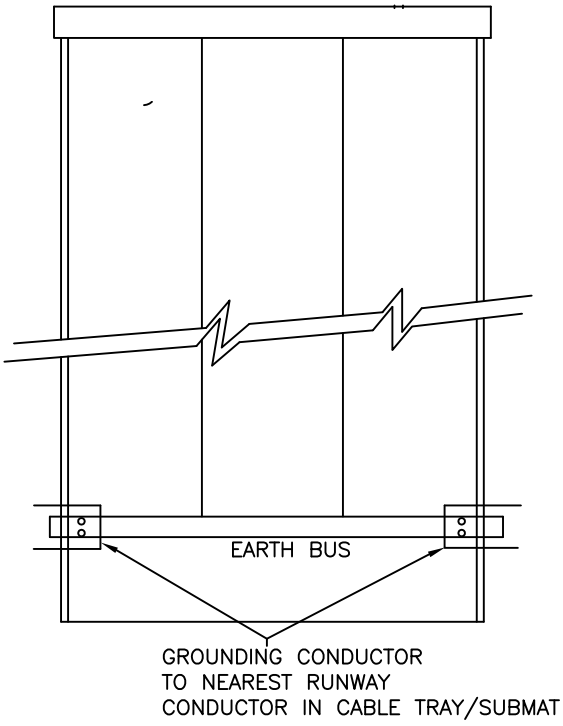
E3A : TRANSFORMER NEUTRAL EARTHING (DIRECTLY GROUNDED)



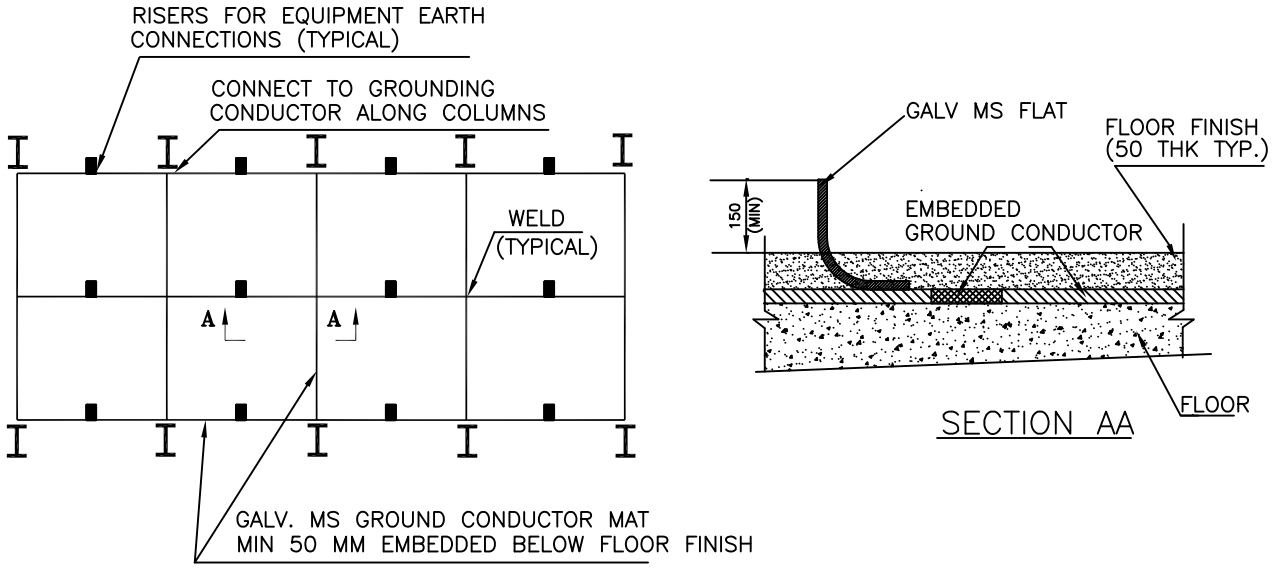
E3B : NEUTRAL EARTHING (THROUGH RESISTOR)

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
	REV. No. 00
	SHEET 3 OF 15



E4 : FLOOR MOUNTED PANEL GROUNDING

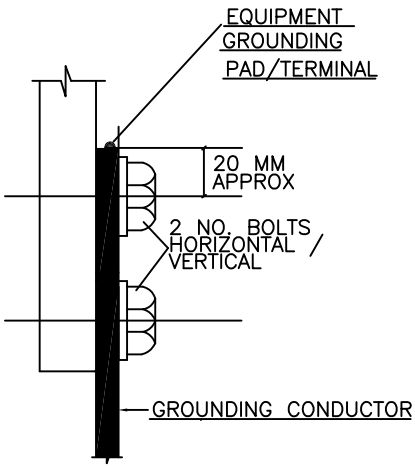


E5 : FLOOR SUBMAT TYPICAL DETAILS

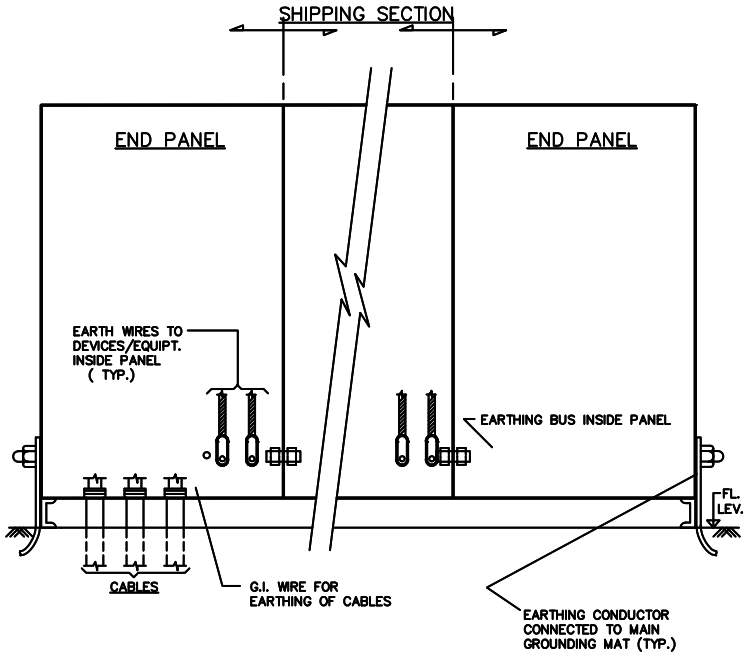
(TO BE PROVIDED ONLY IN ELECTRICAL SWGR ROOM)

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
	REV. No. 00
	SHEET 4 OF 15



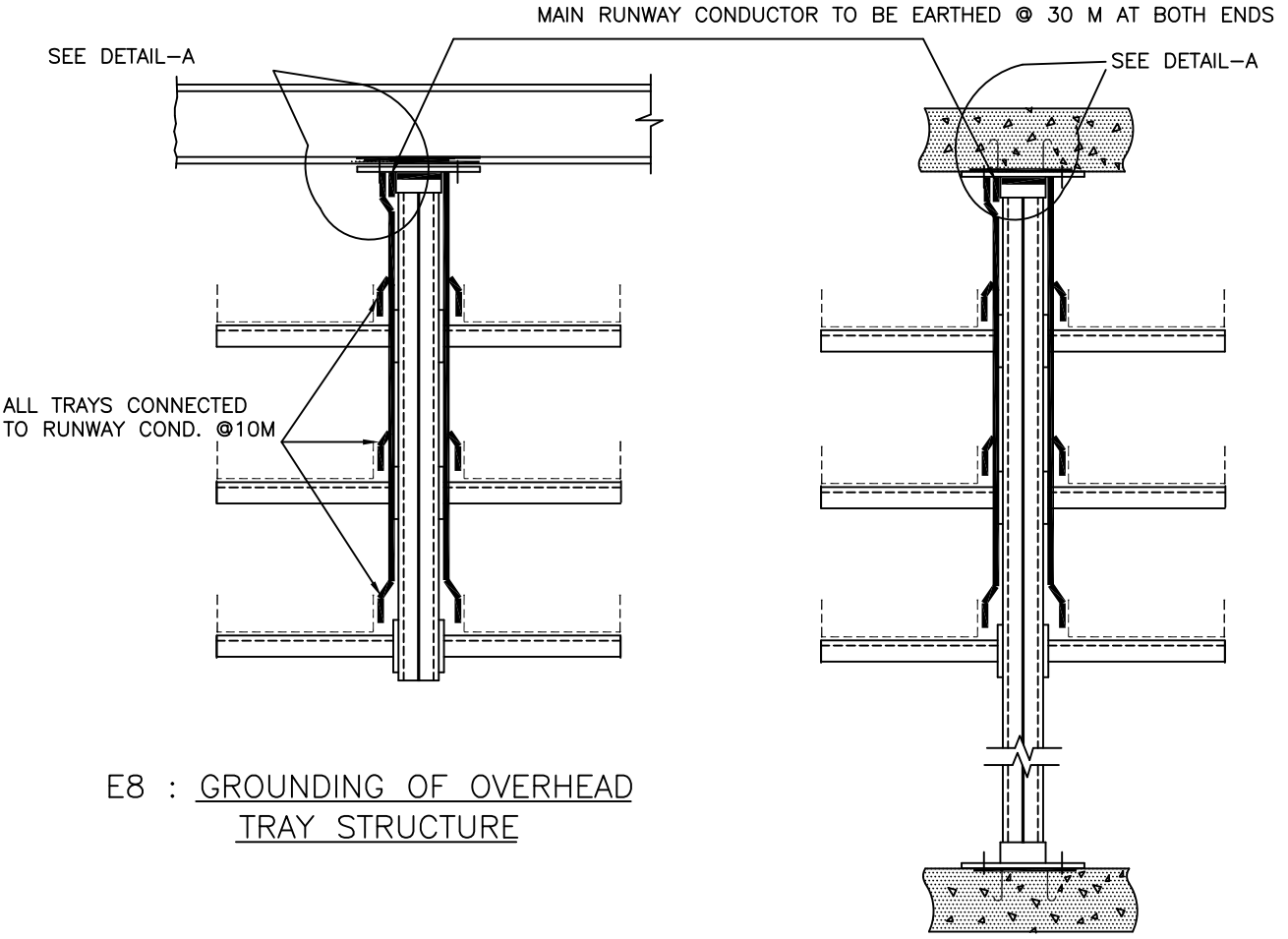
E6 : TYPICAL ARRANGEMENT BOLTED JOINT FOR EQUIPMENT GROUNDING



E7 : GROUNDING FOR ARMOURED CABLES

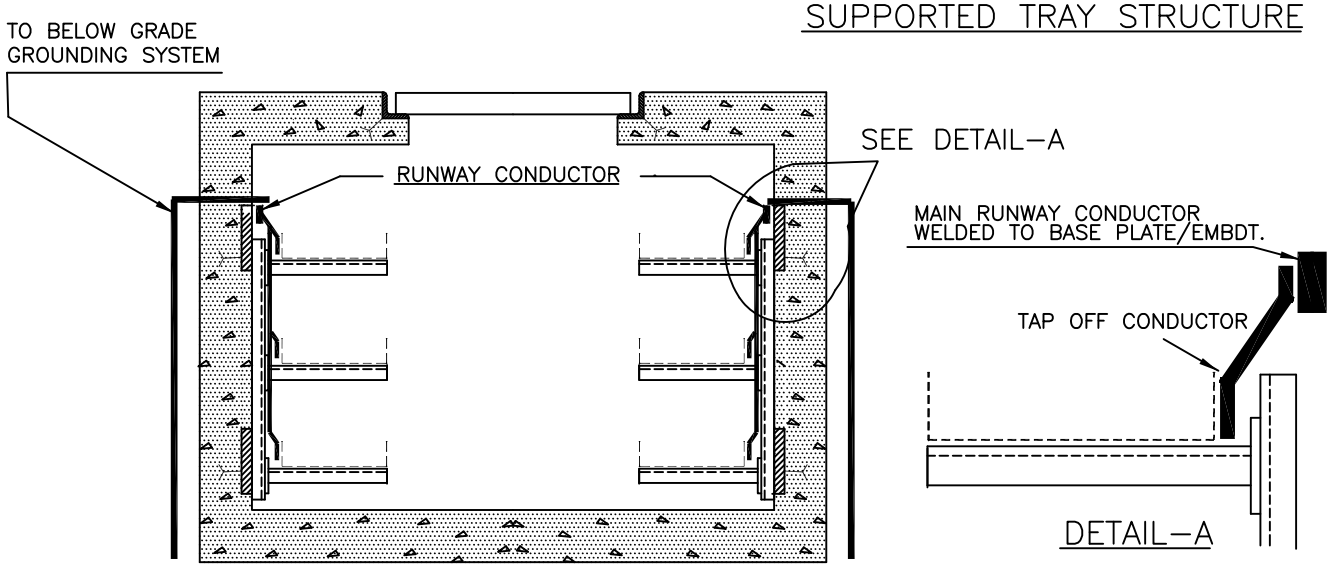
* ARMOUR OF SINGLE CORE HT & LT CABLE, GROUNDING WILL BE DONE AT ONE END ONLY

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
	REV. No. 00
	SHEET 5 OF 15



E8 : GROUNDING OF OVERHEAD TRAY STRUCTURE

E9 : GROUNDING OF FLOOR SUPPORTED TRAY STRUCTURE



E10 : GROUNDING OF TRAYS IN CABLE TRENCH

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE–DG–435–509–E004
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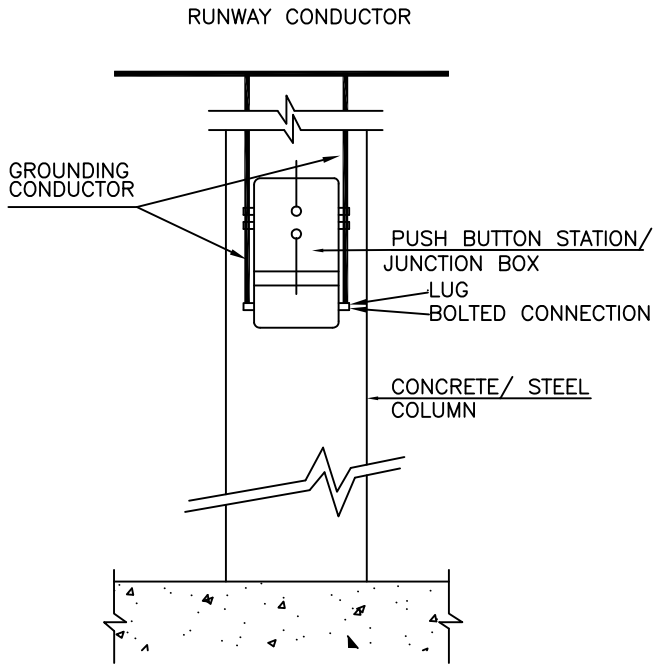
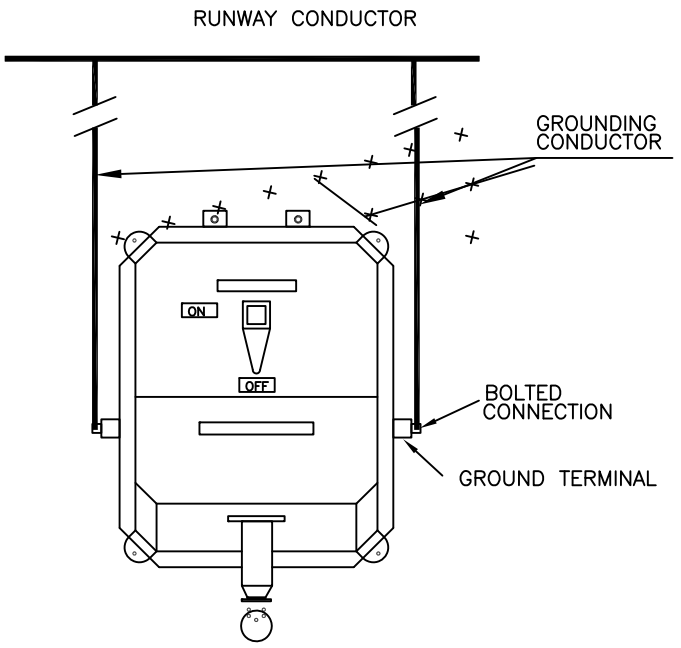
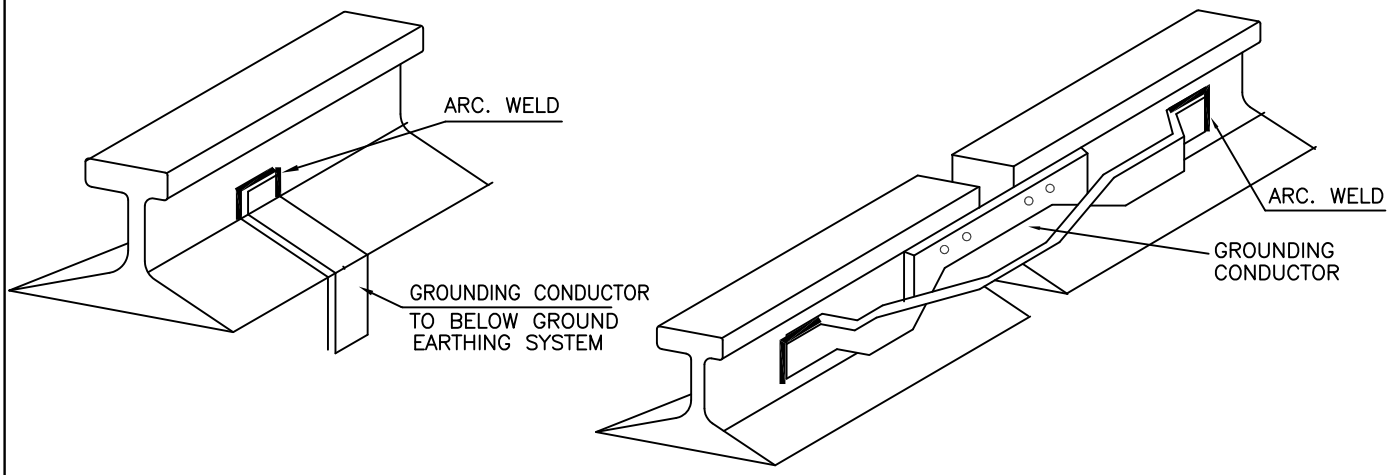
	SHEET 6 OF 15



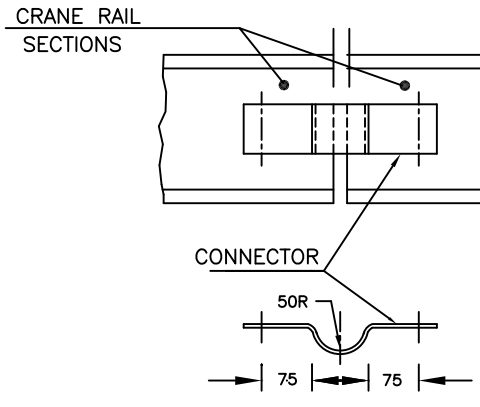
E11 : PUSH BUTTON STATION/ JUNCTION BOX GROUNDING



E12 : 3-PHASE WELDING RECEPTACLE GROUNDING



E13 : RAIL BONDING/ GROUNDING



E14 : BONDING OF CRANE RAIL

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
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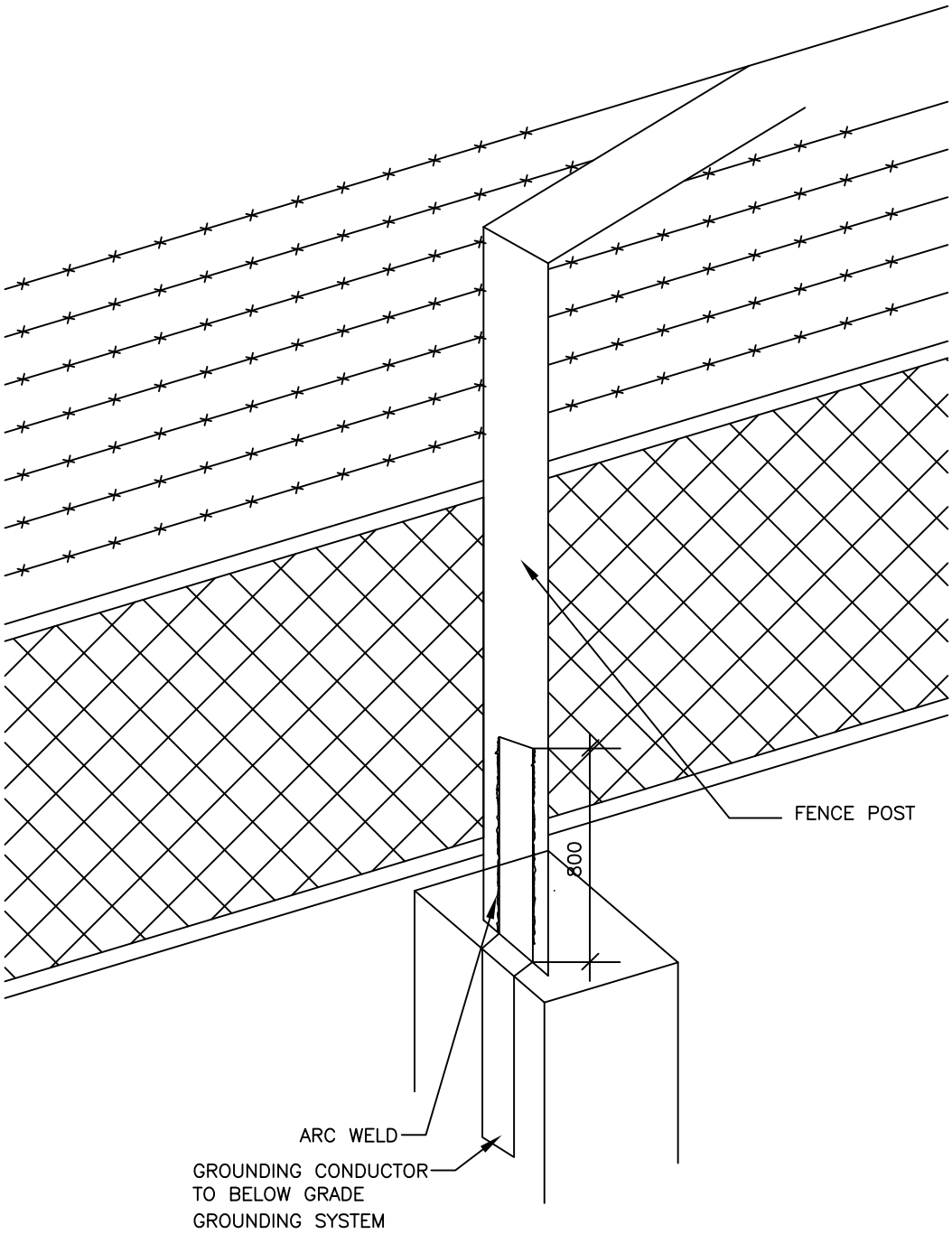
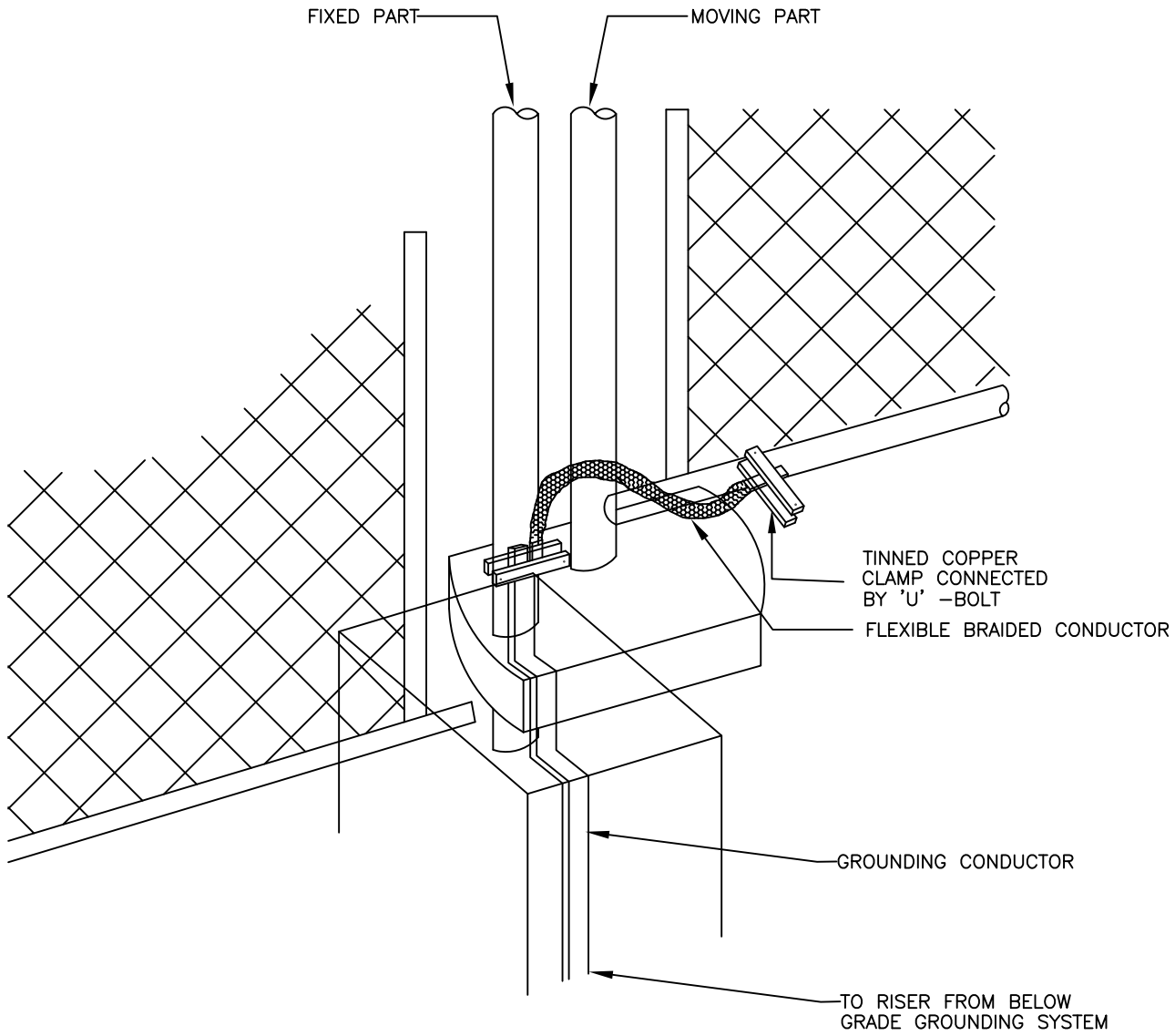


E15: FENCE GROUNDING

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
	REV. No. 00
	SHEET 8 OF 15



E16: FENCE GATE GROUNDING

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE–DG–435–509–E004
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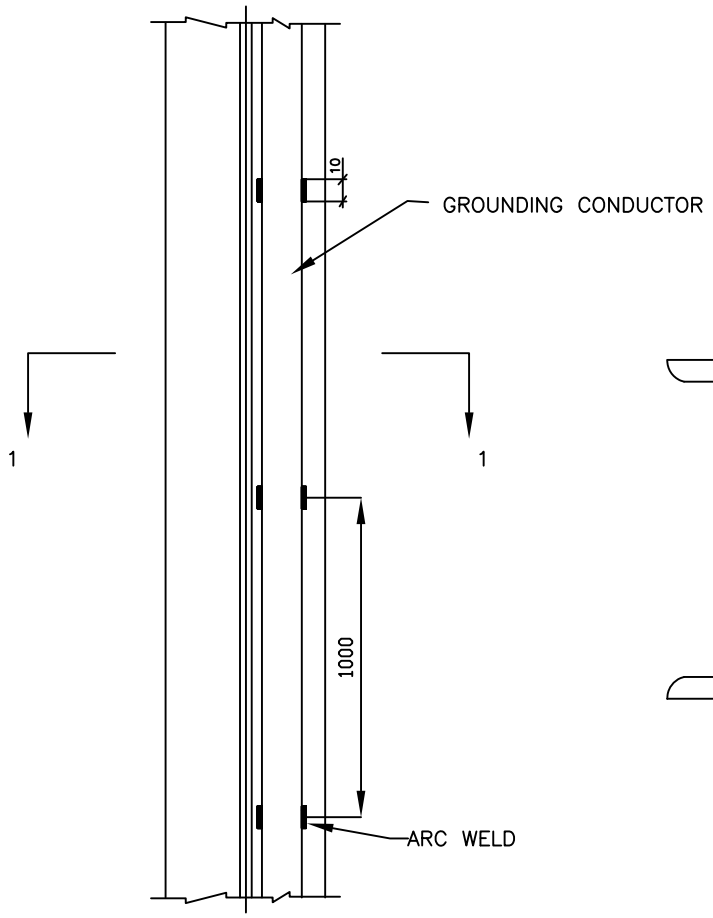

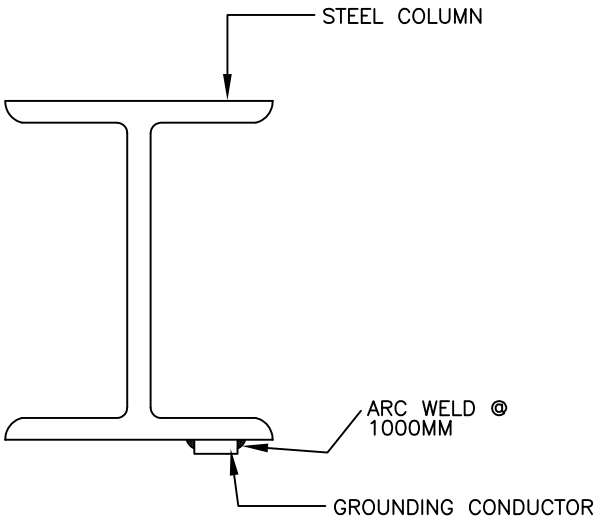

SECTION 1–1

E17: GROUNDING CONDUCTOR ALONG STEEL COLUMN

FOR GENERAL NOTES REFER SHT 13

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE–DG–435–509–E004
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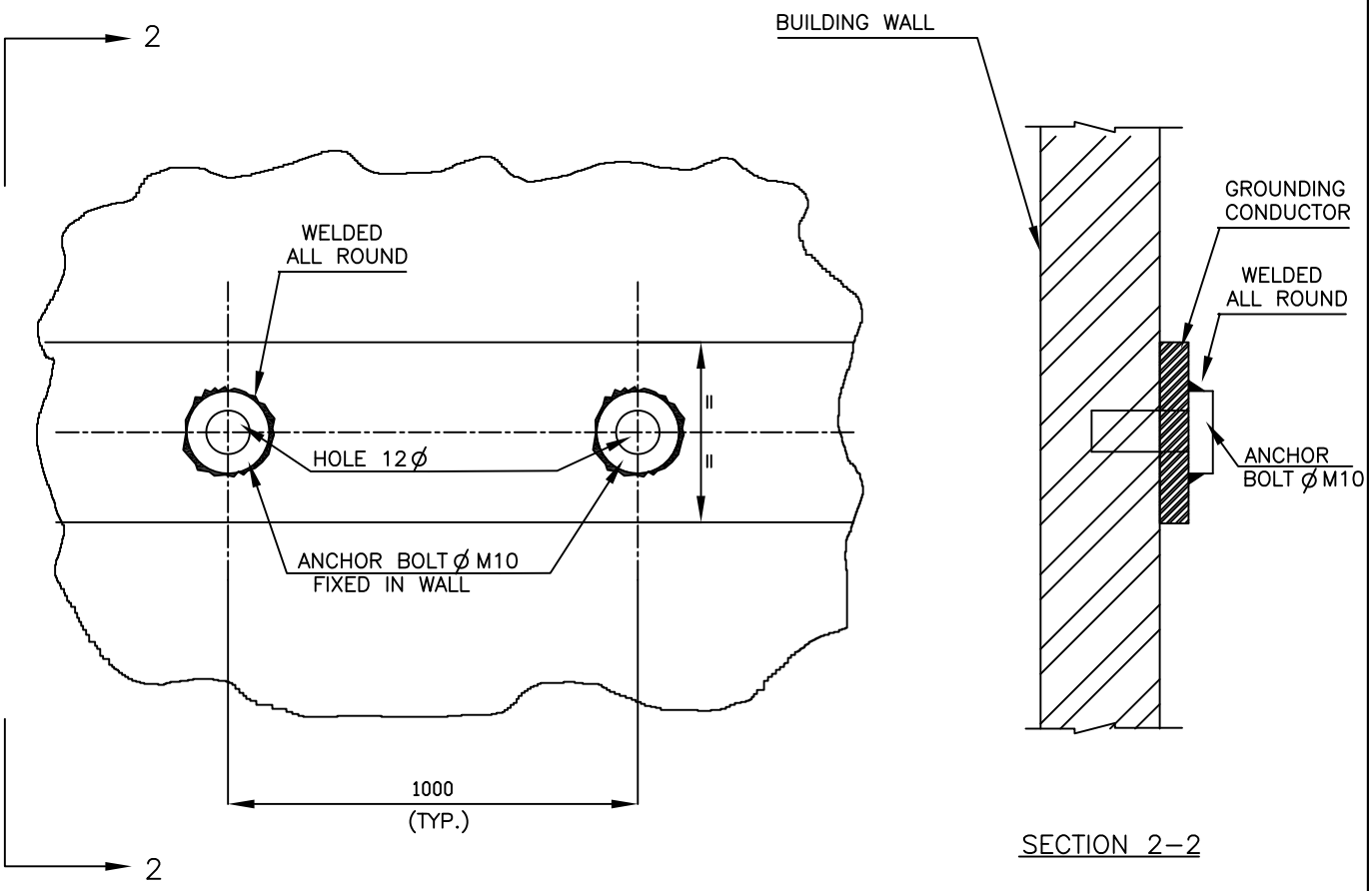
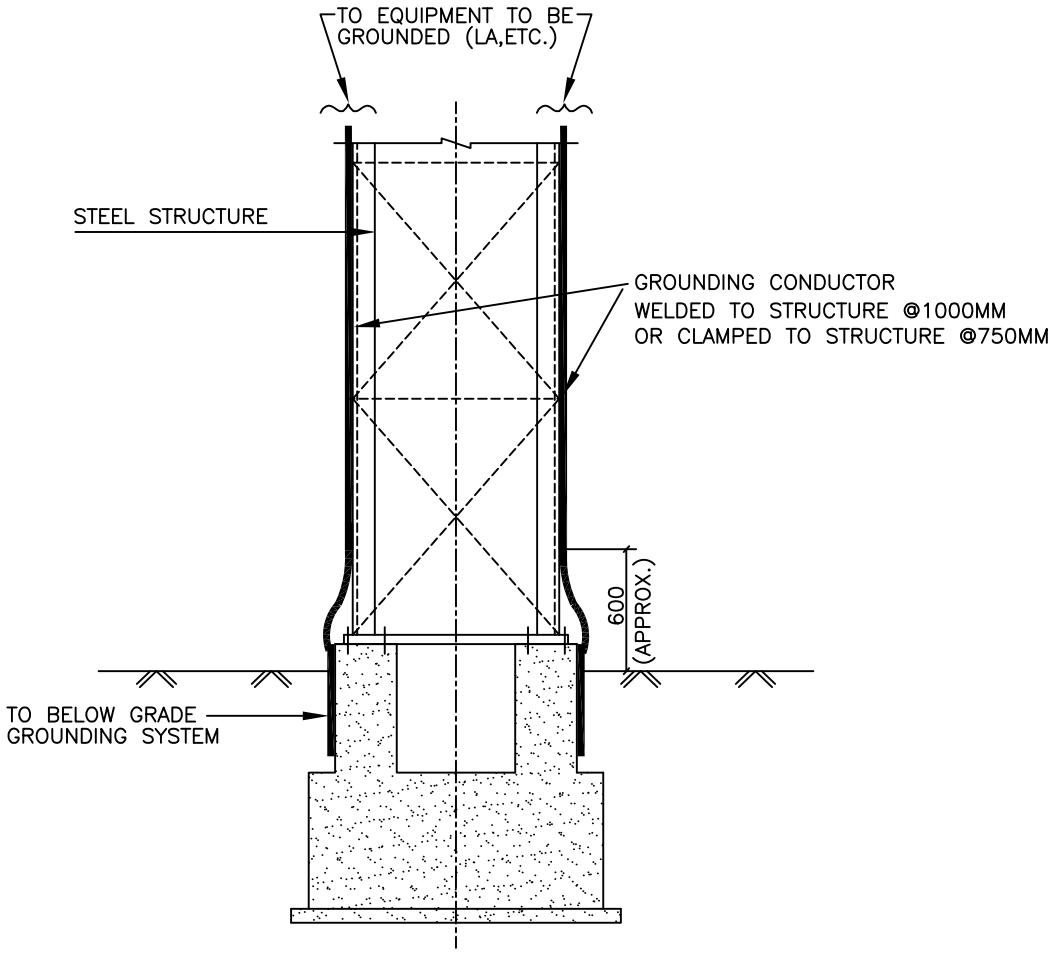
	SHEET 10 OF 15

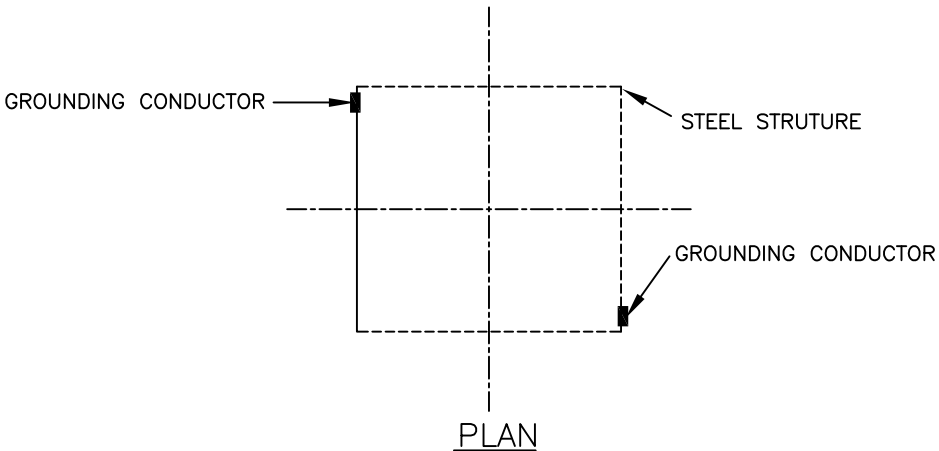


E18: GROUNDING CONDUCTOR ALONG BUILDING WALL

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE–DG–435–509–E004
	REV. No. 00
	SHEET 11 OF 15



SECTION



PLAN

STRUCTURE AND EQUIPMENT GROUNDING

TITLE	BHEL DRAWING No.
TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS	PE-DG-435-509-E004
	REV. No. 00
	SHEET 12 OF 15

GENERAL NOTES:

1. THE DETAILS SHOWN IN THIS DRAWING ARE APPLICABLE TO THE ABOVE GRADE LEVEL GROUNDING FOR MAIN PLANT AREA, AND AUXILIARY PLANTS IN BHEL SCOPE. FOR DETAILS OF EQUIPMENT GROUNDING IN SWITCHYARD AND FACILITIES WHICH ARE NOT IN BHEL–PEM SCOPE, SEPARATE DOCUMENTS SHALL BE REFERRED.

2. GALVANISED M.S. CONDUCTORS ARE USED FOR EQUIPMENT GROUNDING. SIZE OF GROUND CONDUCTOR SHALL BE AS PER TABLE–1 ON SHEET 15.

3. ALL GROUNDING CONDUCTOR CONNECTIONS AT EQUIPMENT ENDS ARE BOLTED.

4. ALL FASTENERS (NUTS/BOLTS/WASHERS) SHALL BE GALVANISED / ZINC PASSIVATED.

5. FROM BELOW GRADE GROUNDING SYSTEM, 65 X 8 MM GALVANISED MILD STEEL FLATS SHALL BE BROUGHT OUT FROM RISERS (40MM DIA ROD) AND CONNECTED TO MAIN GROUND CONDUCTORS (65x8 MM MS FLAT) RUN ALONG BUILDING COLUMNS/ WALLS & SECURELY FIXED TO THE SAME BY WELDING/ CLEATING AT INTERVALS OF 1000 MM. CONNECTIONS FROM EQUIPMENT GROUND TERMINALS, CABLE RACEWAYS RUNWAY CONDUCTORS, FLOOR SUBMAT, ETC. SHALL BE CONNECTED TO THESE MAIN CONDUCTORS.

6. A CONTINUOUS 50X6 MM. GALVANISED M.S. FLAT GROUND CONDUCTOR (RUNWAY CONDUCTOR) SHALL BE INSTALLED ALONG ALL CABLE RACEWAYS / RACKS, WHICH SHALL SERVE AS THE MAIN GROUNDING CONDUCTOR FOR RECEIVING INDIVIDUAL GROUND CONNECTIONS. ALL TRAY TIERS OF EACH SECTION SHALL BE CONNECTED TO THE RUNWAY CONDUCTOR AT AN INTERVAL OF ABOUT 10 M.FURTHER THIS FLAT SHALL BE EARTHED AT BOTH ENDS @ 30 M. THE RUNWAY CONDUCTORS AT DIFFERENT BUILDING ELEVATIONS SHALL BE INTERCONNECTED BETWEEN THE MAIN RISERS ALONG COLUMNS/WALLS & SHALL ALSO BE CONNECTED TO THE NEAREST RISER/ STRUCTURAL COLUMNS.

7. ALL ELECTRICAL EQUIPMENT AND ASSOCIATED NON CURRENT CARRYING METAL WORKS, SUPPORTING STRUCTURES, ETC. SHALL BE CONNECTED TO MAIN RUNWAY CONDUCTOR OR BELOW GRADE GROUNDING SYSTEM, WHERE AVAILABLE.

8. TWO SEPARATE AND DISTINCT GROUND CONNECTIONS SHALL BE PROVIDED FOR GROUNDING OF EACH ELECTRICAL EQUIPMENT FRAMEWORK.

9. ALL BUILDING STEEL COLUMNS, STRUCTURAL STEEL COLUMNS, METALLIC RAILING DEVICES SUCH AS JUNCTION BOXES, PULL BOXES, PUSH BUTTON STATIONS, LOCKOUT SWITCHES, CABLE END BOXES ETC. SHALL BE GROUNDED WHETHER SPECIFICALLY SHOWN IN THE DRAWING OR NOT.

10. GROUND CONDUCTOR CONNECTIONS ABOVE GRADE LEVEL SHALL BE GENERALLY MADE BY ELECTRIC ARC WELDING EXCEPT AT EQUIPMENT TERMINALS. RESISTANCE OF JOINTS SHALL NOT BE MORE THAN THE RESISTANCE OF EQUIVALENT LENGTH OF CONDUCTOR. M.S. GROUND CONDUCTOR ABOVE GRADE LEVEL & WELDS SHALL BE TREATED WITH ZINC CHROMATE PRIMER COATED WITH ZINC RICH PAINT TO PREVENT CORROSION. DAMAGED PORTIONS OF GALVANISED MS SHALL BE COATED WITH TWO COATS OF COLD GALVANISING AND ANTI–CORROSIVE PAINT AFTER WELDING.

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11. AT EQUIPMENT ENDS, ONLY BOLTED CONNECTION SHALL BE MADE FOR GROUNDING OF EQUIPMENT/DEVICES AND REMOVABLE STRUCTURES. THE CONTACT SURFACE SHALL BE THOROUGHLY CLEANED BEFORE CONNECTION TO ENSURE GOOD ELECTRICAL CONTACT. EQUIPMENT BOLTED CONNECTION AFTER BEING CHECKED AND TESTED SHALL BE PAINTED WITH ANTI-CORROSIVE PAINT COMPOUND.

12. EARTHING METHOD INSIDE THE SWGR ROOM SHALL BE IN THE FORM OF SUB-MAT (EARTHING GRID EMBEDDED IN THE FLOOR SLAB WITH APPROXIMATELY 50 MM OF CONCRETE COVER) OF GALVANIZED CONDUCTOR OF 50X6 MM . FURTHER IN CASE OF BUILDINGS HAVING MORE THAN ONE FLOOR, SWGR ROOM OF EACH FLOOR SHALL BE PROVIDED WITH SEPARATE EARTH GRID. THESE FLOOR EARTH GRIDS SHALL BE INTERCONNECTED. THIS SUB-MAT IS CONNECTED TO THE BELOW GRADE GROUNDING SYSTEM AT MINIMUM TWO POINTS THROUGH GALVANIZED FLATS. BEFORE FLOOR FINISHING IS DONE AND CONNECTED TO THE BELOW GROUND EARTHING SYSTEM THROUGH TWO RISERS LOCATED PREFERABLY DIAMETRICALLY OPPOSITE TO EACH OTHER, SUITABLE RISER STUBS SHALL BE PROVIDED ABOVE THE FINISHED FLOOR IF THE EQUIPMENT IS NOT AVAILABLE AT THE TIME OF LAYING THE MAIN GROUNDING CONDUCTOR.

13. GROUNDING INSTALLATION SHALL CONFORM TO THE FOLLOWING:
    (A) IS:3043
    (B) INDIAN ELECTRICITY RULES
    (C) BHEL DOCUMENT NO. PE-DC-435-509-E002 (GROUNDING SYSTEM DESIGN MEMORANDUM)

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TABLE-1

MATERIAL AND SIZES OF ABOVE GROUND EARTHING SYSTEM

SL.NO.	TYPE OF EQUIPMENT	SIZE (MM)	MATERIAL	NO. OF LEADS
1	INTERCONNECTION BETWEEN RISER AND STEEL COLUMN & ALONG COLUMNS	65X 8	GALVANISED MS FLAT	N.A.
2	SUB-MAT BURIED IN FLOOR FINISH	50X 6	GALVANISED MS FLAT	N.A.
3	RUNWAY CONDUCTOR	50X 6	GALVANISED MS FLAT	N.A.
4	11 kV / 3.3 kV SWITCHGEAR / BUSDUCT	65X 8	GALVANISED MS FLAT	TWO
5	LT TRANSFORMER (ENCLOSURE & NEUTRAL)	75X 8	GALVANISED MS FLAT	TWO
6	415 V DISTRIBUTION BOARDS , LT BUSDUCT	75X 8	GALVANISED MS FLAT	ONE FOR EACH SECTION
7	DG SET & FUSE DISTRIBUTION BOARDS	50X 6	GALVANISED MS FLAT	TWO
8	11 kV & 3.3 kV MOTORS	50X6	GALVANISED MS FLAT	TWO
9	415 V MOTORS: ABOVE 75 KW	50X 6	GALVANISED MS FLAT	TWO
10	415 V MOTORS: ABOVE 30 KW & UPT0 75KW	32X5	GALVAN ISED MS FLAT	TWO
11	415 V MOTORS: 9.3 KW UPTO 30 KW	25X3	GALVANISED MS FLAT	TWO
12	415 V MOTORS: BELOW 5.5, 5.5,7.5 kW	6/4/4 SWG	GI WIRE	TWO
13	CONTROL PANEL &CONTROL DESK	25X3	GALVANISED MS FLAT	TWO
14	PUSH BUTTON STATION & JUNCTION BOX	14 SWG	GI WIRE	TWO
15	RELAY PANEL	25X6	GALV MS FLAT	
16	CHARGER/UPS/ CT/PT JUNCTION BOX	50X 6	GALVANISED MS FLAT	TWO
17	LIGHTING/ CONTROL JUNCTION BOX	8 SWG	GI WIRE	TWO
18	RAILS & METAL PARTS, FENCE	25X6	GALVANISED MS FLAT	ONE
19	HT TRANSFORMER (ENCLOSURE & NEUTRAL)	65X8	GALVANISED MS FLAT	TWO
20	GENERATOR , LAPT,NGT, NGT NEUTRAL	50X6	GALVANISED MS FLAT	TWO
21	WELDING OUTLETS 3-PHASE RECEPTACLES	25X6	GALVANISED MS FLAT	TWO
22	LIGHTING DISTRIBUTION BOARD, LIGHTING PANELS	50X 6	GALVANISED MS FLAT	TWO
23	LIGHTING POLES/ LIGHTING MASTS	25X6 *	GALVANISED MS FLAT	ONE
24	FIXTURES &SOCKETS	8 SWG	GI WIRE	ONE

* 20 DIA ROD FOR BELOW GROUND EARTHING

TITLE

TYPICAL ABOVE GRADE LEVEL GROUNDING DETAILS

BHEL DRAWING No.
PE–DG–435–509–E004

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00

SHEET 15 OF 15

TYPICAL LIGHTNING PROTECTION DETAILS

PROJECT	2X660MW UDANGUDI STPP,STAGE-I	
	CUSTOMER	TAMIL NADU GENERATION & DISTRIBUTION CORPOARATION LIMITED
	EPC CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED POWER SECTOR PROJECT ENGINEERING MANAGEMENT NOIDA(U.P) INDIA

REV	DATE	DRN	CHD	APPD	REV	DATE	DRN	CHD	APPD

DOCUMENT TITLE:
TYPICAL LIGHTNING PROTECTION DETAILS

DPT CODE-E

	NAME	SIGN	DATE
DSN	AAT	-SD-	09.04.18
CHD	VY	-SD-	09.04.18
APP	SL	-SD-	09.04.18

DOCUMENT NO: PE-DG-435-509-E006

REV. 00

CONTENT SHEET

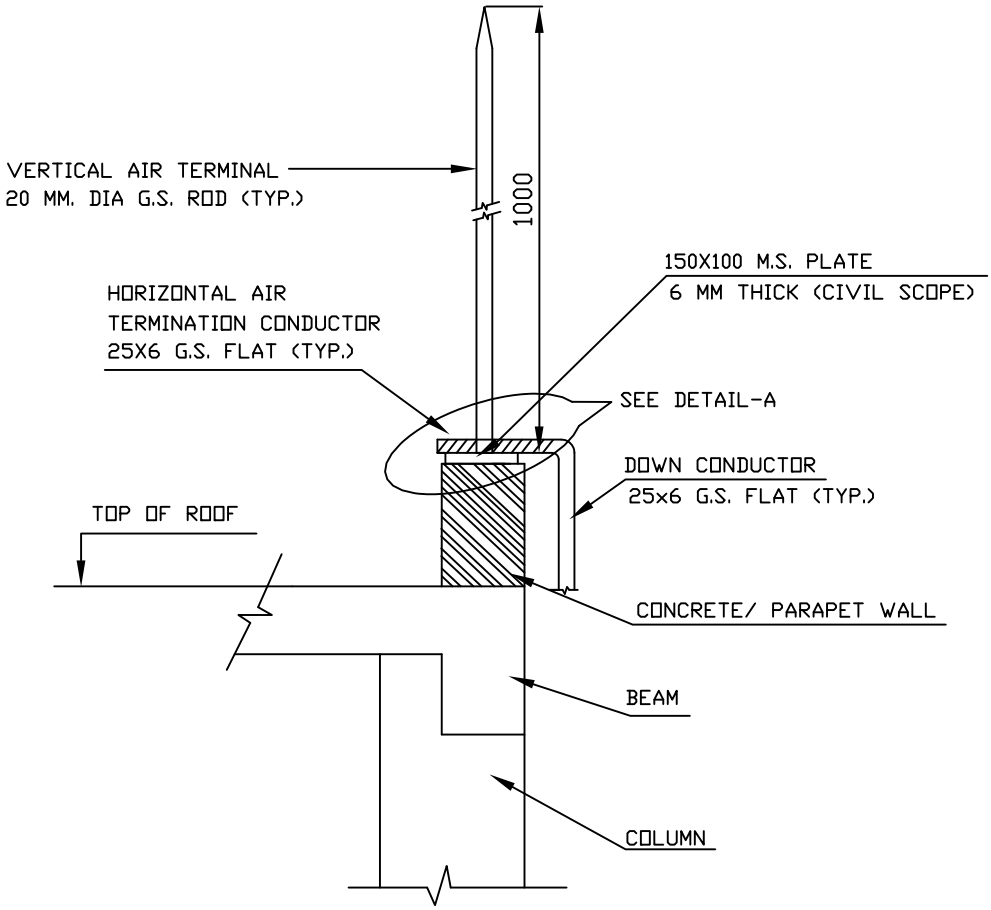
SL. NO.	DESCRIPTION	SHEET NO.
1.	TYPICAL FIXING/CONNECTION DETAILS OF VERTICAL AIR TERMINAL ROD ON THE ROOF OF BUILDING	3
2.	TYPICAL DETAILS OF CLAMPING HORIZONTAL AIR TERMINATION CLAMPING OVER ROOF	4
3.	TYPICAL DETAILS OF DOWNCONDUCTOR FIXING AND TEST LINK	5
4.	TYPICAL DETAILS OF CONNECTION AMONG HORIZONTAL AIR TERMINAL, DOWN CONDUCTOR AND RISER	6
5.	TYPICAL DETAILS OF CONNECTION AMONG HORIZONTAL AIR TERMINAL, DOWN CONDUCTOR FOR 'A' ROW CLADDING	7
6.	NOTES	8 & 9

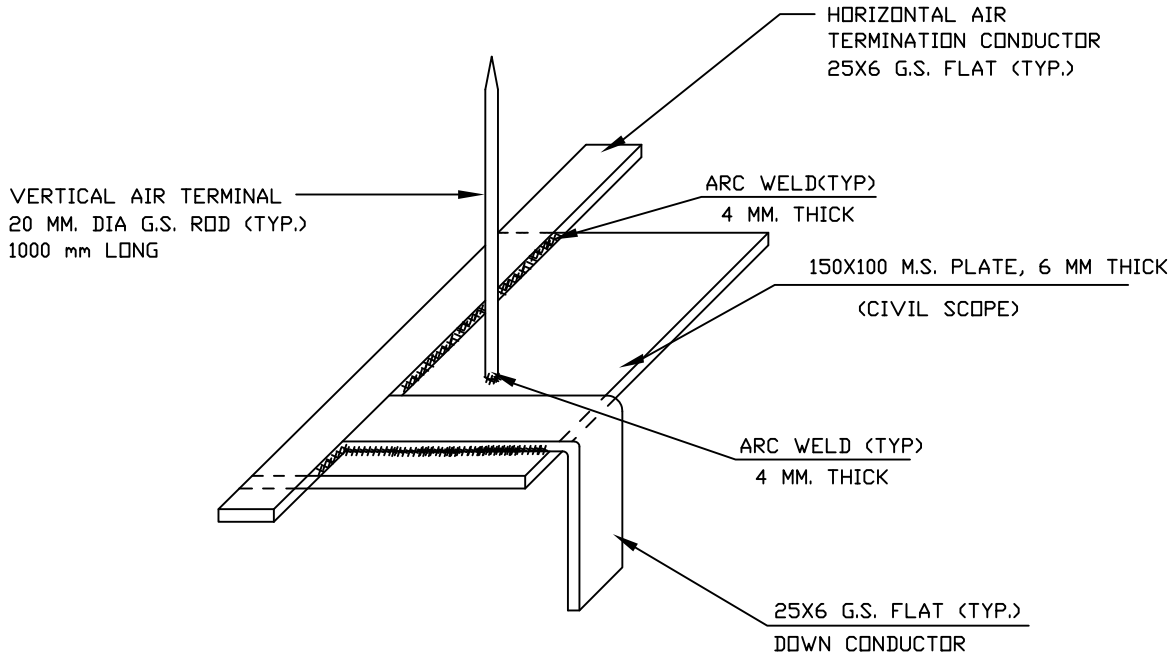
TITLE

TYPICAL LIGHTNING PROTECTION DETAILS

BHEL DOCUMENT No.
PE-DG-435-509-E006

REV. No. 00





DETAIL-A

TYPICAL FIXING/CONNECTION DETAILS OF VERTICAL AIR TERMINAL ROD ON THE ROOF OF BUILDING

TITLE	BHEL DOCUMENT No.
TYPICAL LIGHTNING PROTECTION DETAILS	PE-DG-435-509-E006
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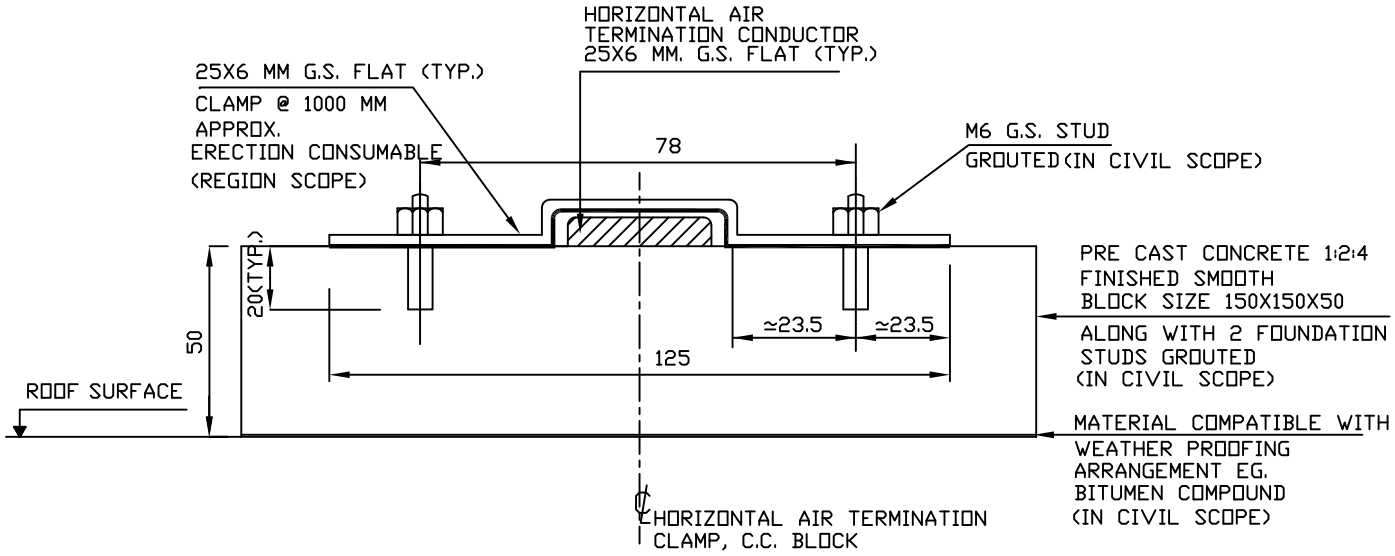
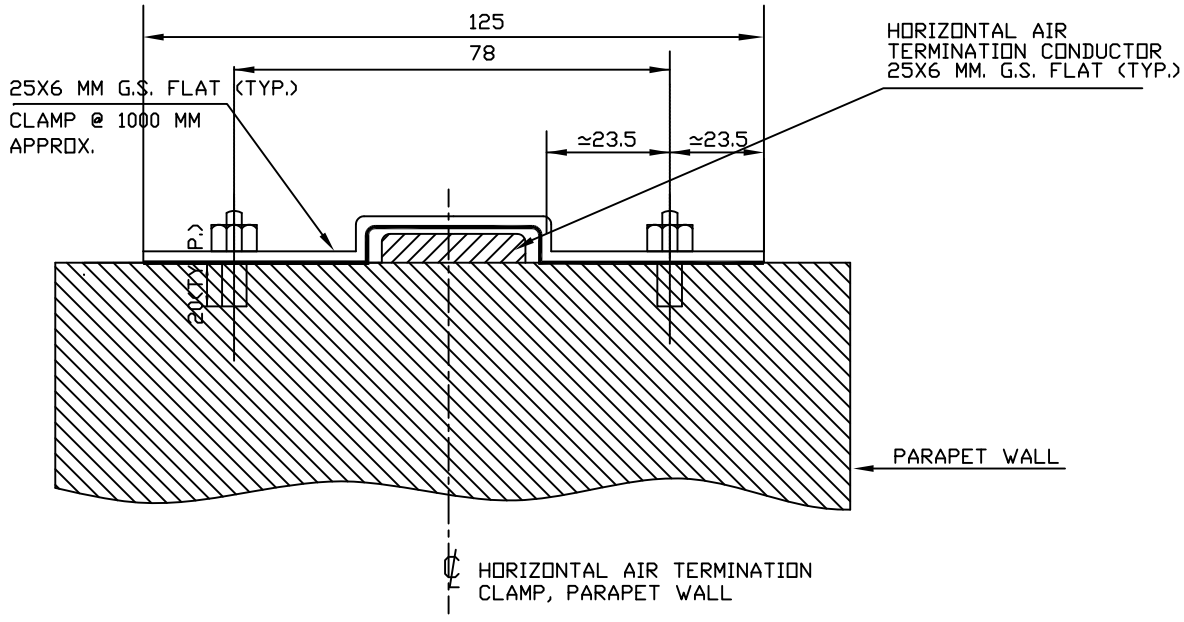


(A) OVER ROOF SURFACE



(B) OVER PARAPET WALL

TYPICAL DETAILS OF CLAMPING HORIZONTAL AIR TERMINATION

CLAMPING OVER ROOF

TITLE **TYPICAL LIGHTNING PROTECTION DETAILS**	BHEL DOCUMENT No. PE-DG-435-509-E006
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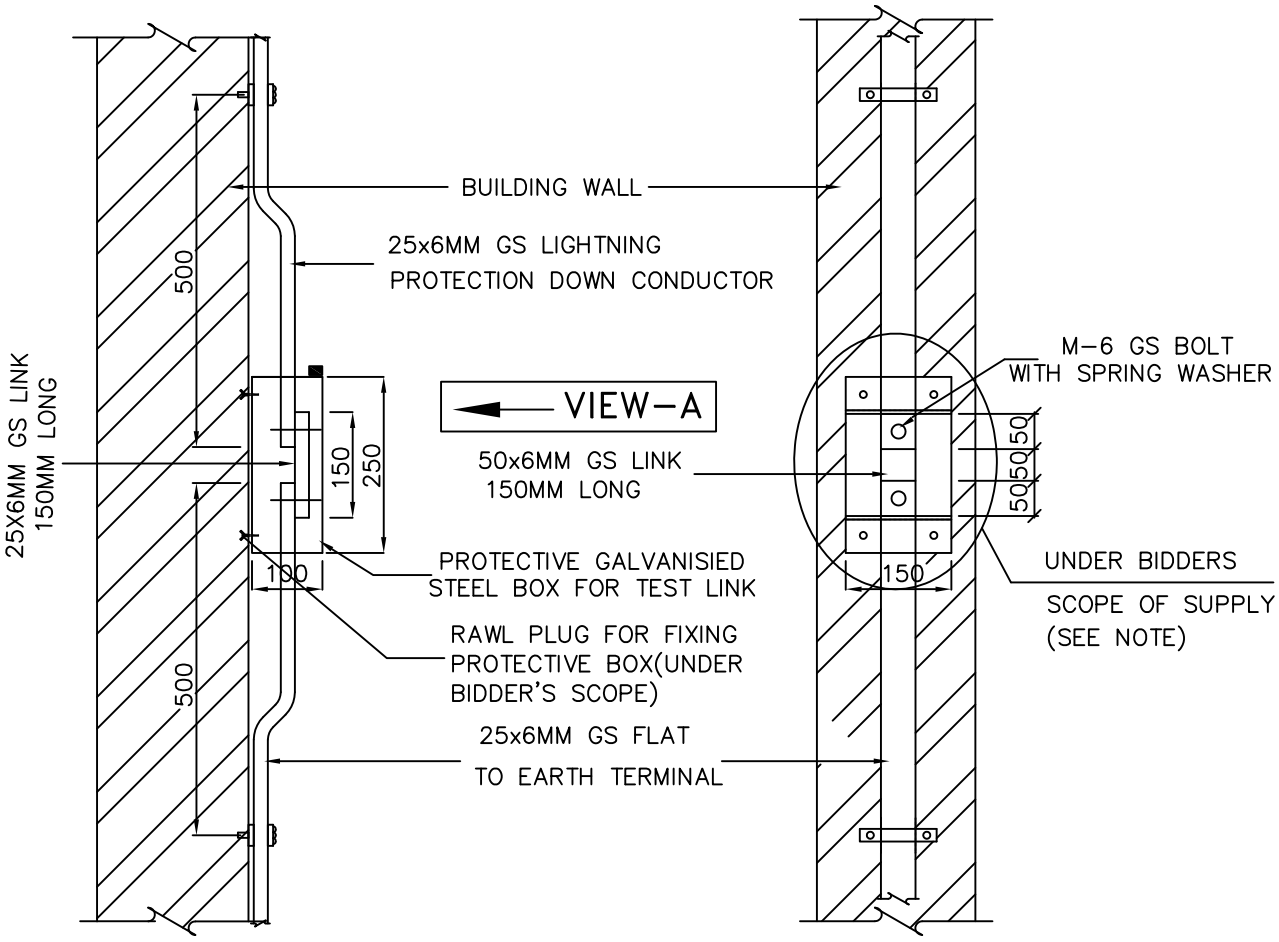

NOTE: BIDDER'S SCOPE INCLUDES THE 150 MM LONG 50X6MM GS LINK ALONG WITH HARDWARES (2 NOS. OF M–6 GS NUTS & BOLTS & 4 NOS. SPRING WASHERS) & 250X150X100 MM GALVANISED MS COVERING BOX (1.6 MM THICK) WITH 4 NOS. M12 SCREWS & RAWL PLUGS FOR FIXING OF THE SAME.

TYPICAL DETAILS OF DOWNCONDUCTOR FIXING AND TEST LINK

TITLE	BHEL DOCUMENT No.
TYPICAL LIGHTNING PROTECTION DETAILS	PE–DG–435–509–E006
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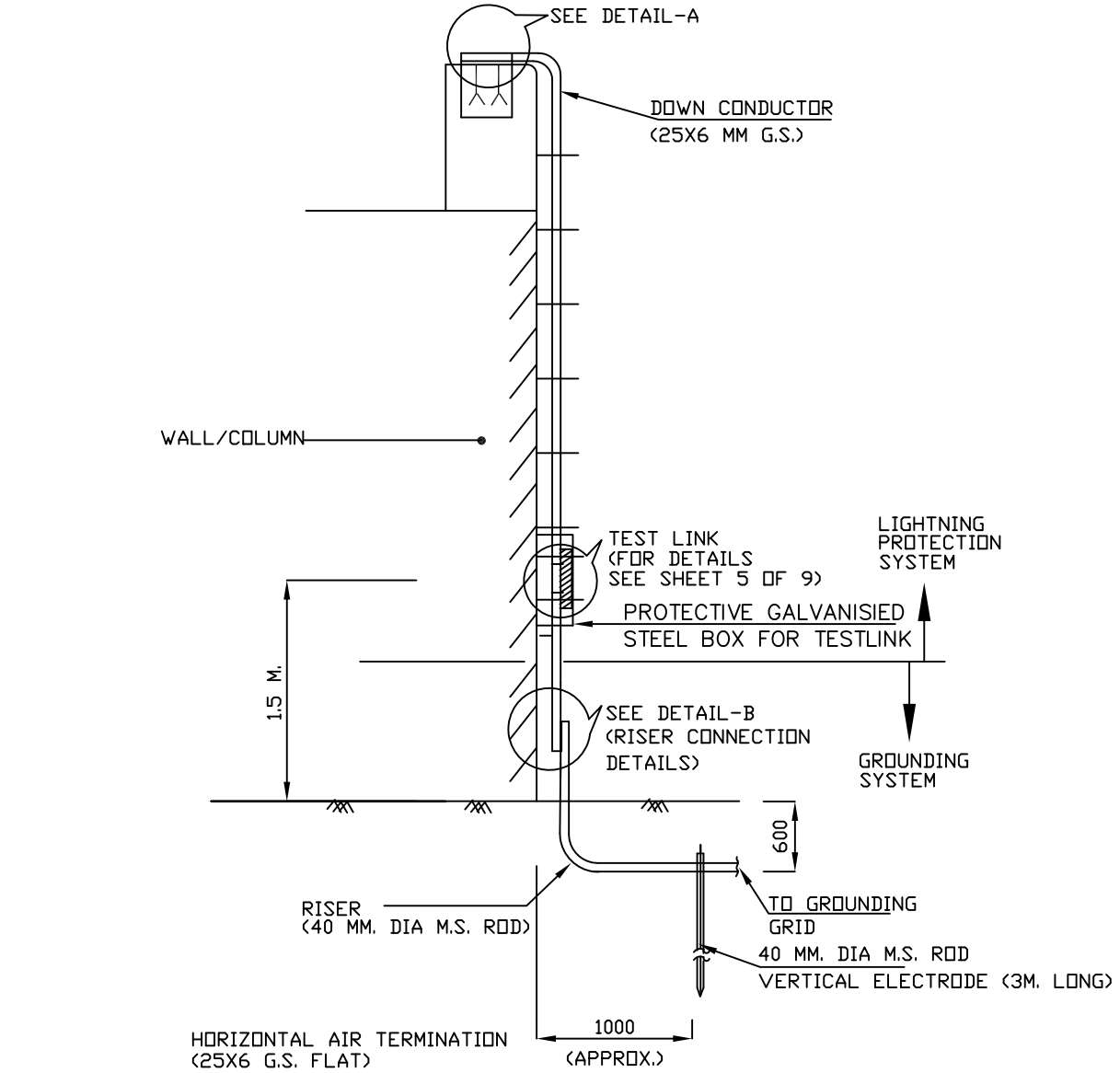
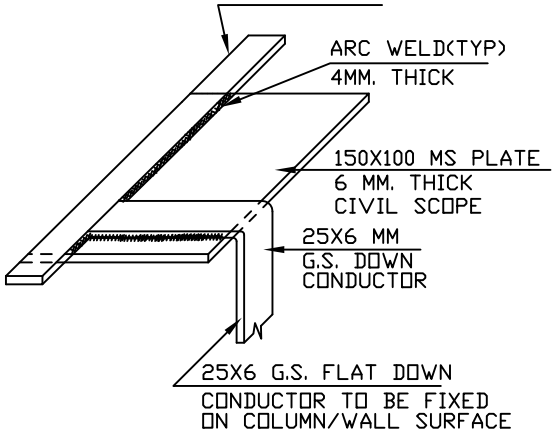
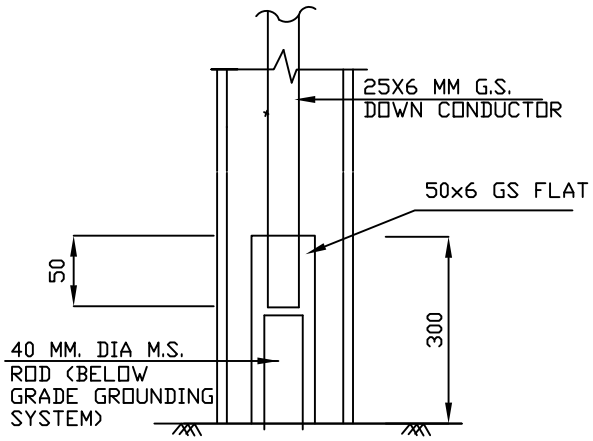




DETAIL-A



DETAIL-B

(RISER CONNECTION DETAILS)

TYPICAL DETAILS OF CONNECTION AMONG HORIZONTAL AIR TERMINAL, DOWN CONDUCTOR AND RISER

TITLE **TYPICAL LIGHTNING PROTECTION DETAILS**	BHEL DOCUMENT No. PE-DG-435-509-E006
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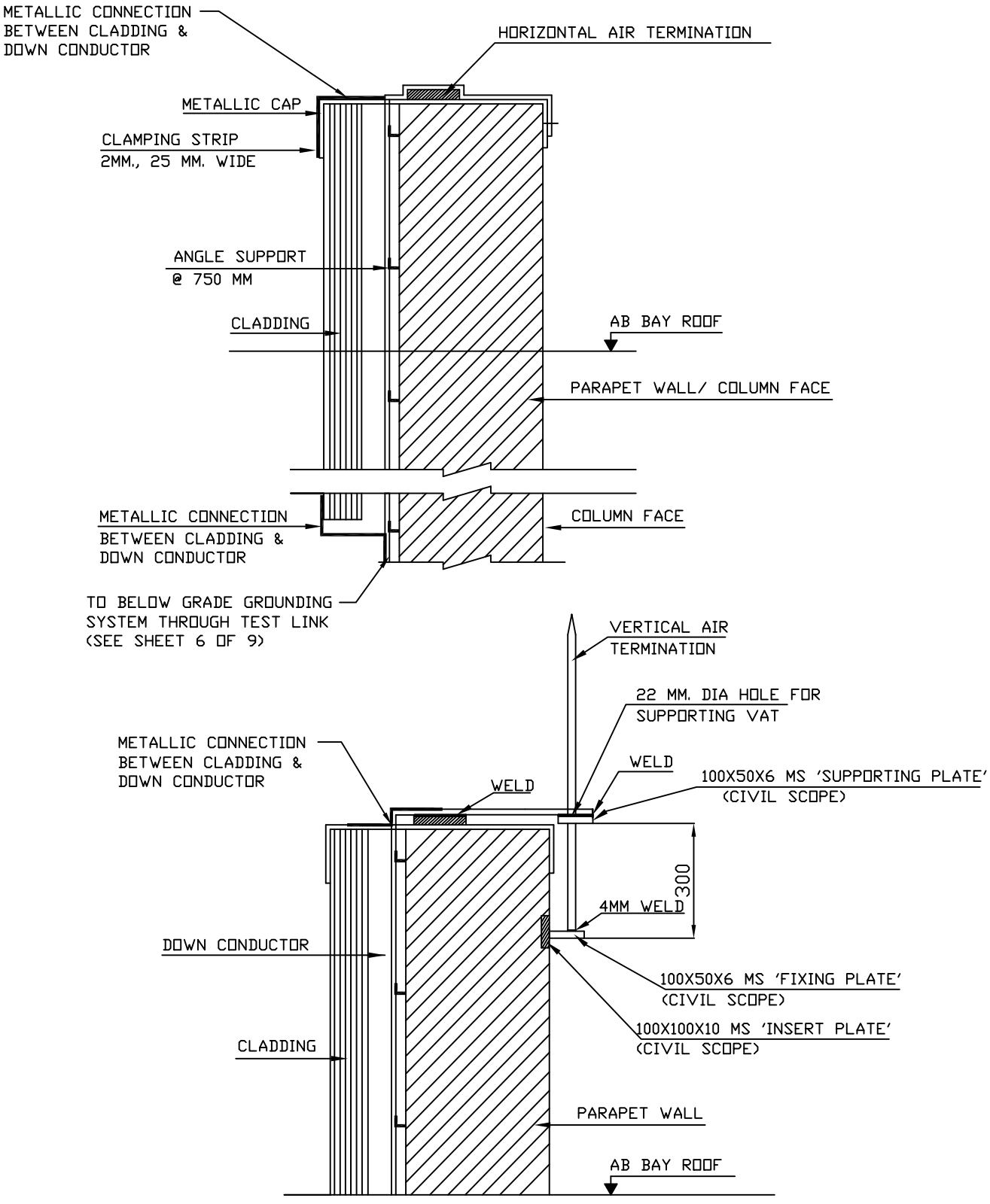

TYPICAL DETAILS OF CONNECTION AMONG

HORIZONTAL AIR TERMINAL, DOWN CONDUCTOR FOR 'A' ROW CLADDING

TITLE TYPICAL LIGHTNING PROTECTION DETAILS	BHEL DOCUMENT No. PE-DG-435-509-E006
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NOTES:–

1.0 AIR TERMINATIONS

1.1 HORIZONTAL/ VERTICAL AIR TERMINATION NETWORK WILL BE INSTALLED ON THE TOP OF ALL STRUCTURE/ BUILDINGS TO BE PROTECTED FROM LIGHTNING STROKES. THE INSTALLATION WORK SHALL BE DULY COORDINATED BY SITE WITH THE OTHER ACTIVITIES SUCH AS WEATHER PROOFING APPLICATION ON ROOF, ETC.

1.2 HORIZONTAL AIR TERMINATIONS SHALL BE OF 25MM x 6MM GALVANISED STEEL FLATS CLAMPED TO THE SURFACE AT EVERY 1000 MM. VERTICAL AIR TERMINATION'S SHALL BE 20 MM DIA GALVANISED MILD STEEL ROD 1000 MM LONG.

1.3 HORIZONTAL AIR TERMINATIONS NETWORK SHALL BE LAID AS PER IEC : 62305

1.4 THE VERTICAL AIR TERMINATION ROD WILL BE PROPERLY FIXED AS PER DETAILS GIVEN IN THE DRAWING ON THE TOP OF THE BUILDING/ STRUCTURE TO WITHSTAND VERY HIGH WIND PRESSURE. THE HORIZONTAL & VERTICAL AIR TERMINATIONS SHALL BE PROPERLY FIXED ON THE TOP OF ROOF OF THE BUILDINGS SUCH AS NOT TO MAKE THE PENETRATION IN THE WATER PROOFING LAYER

2.0 DOWN CONDUCTORS

2.1 THE DOWN CONDUCTORS SHALL BE 25MM X 6MM GALVANISED STEEL FLATS. ONE END OF DOWN CONDUCTORS SHALL BE CONNECTED TO THE VERTICAL/HORIZONTAL AIR TERMINATION NETWORK ON THE TOP OF ROOF/STRUCTURE AND THE OTHER END TO THE NEAREST EARTH TERMINAL. DOWN CONDUCTORS SHALL BE AS PER IEC : 62305

2.2 EACH DOWN CONDUCTOR WILL HAVE AN INDEPENDENT GROUND TERMINATION. IN NO CASE CONDUCTORS OF THE LIGHTNING PROTECTION SYSTEM WILL BE CONNECTED WITH THE CONDUCTORS OF THE GROUNDING SYSTEM ABOVE GROUND LEVEL.THE INDEPENDENT GROUND TERMINATION WILL COMPRISE OF A RISER CONNECTION FROM A 3000 MM LONG GROUND ELECTRODE (IN BHEL'S SCOPE) , WHICH IN TURN WILL BE CONNECTED TO THE BELOW GRADE GROUNDING SYSTEM. DETAILS OF THE ELECTRODE CONNECTION WITH EARTH MAT SHALL BE AS PER DRG No. PE–DG–435–509–E005 (TYPICAL BELOW GROUND EARTHING DETAILS).

2.3 THE CONNECTION BETWEEN EACH DOWN CONDUCTOR AND EARTH TERMINAL WILL BE MADE VIA A TEST LINK LOCATED AT APPROXIMATELY 1500MM ABOVE GROUND LEVEL.

2.4 THE DOWN CONDUCTORS WILL BE LAID STRAIGHT AND SHARP BENDS WILL BE AVOIDED AS FAR AS PRACTICABLE. THESE WILL BE FIXED ON THE OUTSIDE OF THE BUILDING WALL AND OR COLUMNS/STRUCTURES AT INTERVALS OF ABOUT 750 MM, AS INDICATED IN DRAWING.

TITLE	BHEL DOCUMENT No.
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2.5 ALL EXPOSED METALLIC PARTS OF A BUILDING WILL BE BONDED TO THE DOWN CONDUCTORS. SUCH PARTS WILL INCLUDE LADDERS, BALCONIES, CONDUITS, METALLIC SHEET CLADDING, ETC.

2.6 NO NATURAL DOWN CONDUCTOR SHALL BE CONSIDERED, DEDICATED DOWN CONDUCTORS SHALL BE CONSIDERED FOR LIGHTNING PROTECTION ARRANGEMENT.

3.0 JOINTING

3.1 MINIMUM NUMBER OF JOINTS IN THE LIGHTNING CONDUCTORS WILL BE PROVIDED.

3.2 ALL THE JOINTS WILL BE DONE BY ARC WELDING PROCESS. OVERLAPPING OF CONDUCTORS AT STRAIGHT JOINTS WILL NOT BE LESS THAN 150MM. THE CONTACT SURFACES WILL BE PROPERLY CLEANED BEFORE JOINTING.

3.3 THOSE PORTIONS OF GALVANISED STEEL FLATS, WHICH HAVE BEEN WELDED AT SITE, SHALL BE COATED WITH TWO (2) COATS OF RED OXIDE PAINT FOLLOWED BY TWO COATS OF ZINC PAINT.

3.4 THE VERTICAL AIR WILL BE COATED WITH WEATHER RESISTANT ANTI-CORROSIVE PAINT. (ZINC CHROMATE FOLLOWED BY TWO COATS OF ALUMINIUM PAINT)

4.0 LIGHTNING PROTECTION SYSTEM INSTALLATION SHALL CONFORM TO IEC : 62305 (INTERNATIONAL STANDARD FOR PROTECTION AGAINST LIGHTINING)

5.0 AS PER IEEE : 142, STEEL TANKS (CONTAINING FLAMMABLE LIQUIDS OR GASES) WITH STEEL ROOFS OR FLOATING METAL ROOF HAVING STEEL THICKNESS OF 4.76 MM OR MORE ARE TO BE CONSIDERED SELF-PROTECTING TYPE AGAINST LIGHTNING, & SHALL BE PROVIDED WITH MINIMUM TWO EQUALLY SPACED CONNECTIONS TO THE NEAREST BELOW GRADE GROUNDING SYSTEM.

6.0 CONDUCTORS OF THE LIGHTNING PROTECTION SYSTEM SHALL NOT BE CONNECTED WITH CONDUCTORS OF SAFETY EARTHING OF ABOVE GROUND LEVEL.

7.0 REFERENCE DRAWINGS:

6.1 TYPICAL ABOVE GRADE GROUNDING DETAILS, PE-DG-435-509-E004
6.2 TYPICAL BELOW GROUND EARTHING DETAILS, PE-DG-435-509-E005
6.3 DESIGN MEMORANDUM FOR LIGHTNING PROTECTION SYSTEM, PE-DC-435-509-E003

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TYPICAL LIGHTNING PROTECTION DETAILS	PE-DG-435-509-E006
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SECTION–3.23: ILLUMINATION SYSTEM

1.0.0 INTENT OF SPECIFICATION

This specification covers requirements of Illumination system.

2.0.0 SCOPE OF WORK

The scope of work shall include supply, installation, testing and commissioning of the following for all plant buildings, non plant buildings, watch towers, boundary wall, roads, parking areas, outdoor areas, etc.

a) Light pipe solar lighting system (100 nos.)
b) Lighting fixtures
c) Aviation obstruction lights for chimney & cooling tower
d) Lighting distribution boards
e) Lighting panels
f) Receptacle panels
g) Receptacles
h) Minimum 25 nos. Lighting mast (Winch operated)
i) Lighting poles
j) Switchboxes
k) Junction boxes
l) Hand lamp units
m) Conduits
n) 100 nos. wall mounted fans
o) Ceiling fans
p) 25 nos. pedestal fans
q) Wires
r) Commissioning spares and consumables
s) Mandatory spares
t) Tools & tackles
u) Any other equipment required for the system

3.0.0 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 Indian Standards, IEC publications and other standards as listed, except where modified and / or supplemented by this specification. The design and testing shall follow the following standards.

a)	IS: 1777	Industrial luminaire with metal reflectors.
b)	IS: 1913	General and safety requirements for Luminaires.
c)	IS: 10322-5-5	Luminaires- Flood lights
d)	IS/IEC 60079 -1	Equipment Protection by Flameproof Enclosures "d"
e)	IS: 2149	Luminaires for street lighting.
f)	IS: 2206	Flame proof electric lighting fittings
g)	IS: 4013	Dust-light electric lighting fittings.
h)	IS: 8224	Electric Lighting fittings for Div. 2 areas.
i)	IS: 9583	Emergency lighting units.
j)	IS: 9974	High Pressure sodium vapour lamps.

k)	IS: 10322	Specification for Luminaires
l)	IS: 732	Electrical wiring installation (system voltage not exceeding 650 V).
m)	IS:5216	Guide for safety procedures and practices in electrical works.
n)	IS: 12640	Residual Circuit operated Circuit breakers.
o)	IS/IEC: 60947-1	low-voltage switchgear and control gear.
p)	IS/IEC:60898-1	Miniature circuit breakers
q)	IS/IEC 60715	Dimensions of low-voltage switchgear and control gear.
r)	IEC: 60309-1	Plugs, socket-outlets and couplers for industrial purposes
s)	IS/IEC 60529	Degrees of protection provided by enclosures (IP code)
t)	IS: 694	PVC insulated cables for working voltages up to and including 1.1 kV.
u)	IS: 9537	Conduits for electrical installation.
v)	IS: 3480	Flexible steel conduits for electrical wiring.
w)	IS: 1239	Mild steel tubes, tubular and other wrought steel fittings. (for size above 63 mm dia of rigid conduits)
x)	IS: 14768	Fittings for rigid steel conduits for electrical wiring.
y)	IS: 3837	Accessories for rigid steel conduits for electrical wiring.
z)	IS: 14772	Boxes for enclosures of electrical accessories.
aa)	CIE-173	Tubular day light guidance system

4.0.0 LIGHTING DESIGN

4.1.0 The plant lighting system shall comprise following categories :

- Tubular day light guidance system
- Normal 230 V AC Lighting System
- Normal-cum-Emergency 230 V AC Lighting System
- Emergency DC Lighting System

4.1.1 Tubular daylight guidance systems are linear devices that channel daylight into the core of a building. They consist of a light transport section with, at the outer end, some device for collecting natural light and, at the inner end, a means of distribution of light within the interior. Collectors may be either mechanical devices that actively focus and direct daylight (usually sunlight), or be passive devices that accept sunlight and skylight from part or whole sky hemisphere. The transport element is usually a tube lined with highly reflective or prismatic material or may contain lenses or other devices to redirect the light. Light is distributed in an interior by output components, commonly diffusers made of opal or prismatic material.

4.1.2 Normal AC lighting shall be provided by lighting distribution boards and lighting panel distributed throughout the plant. Supply to these lights shall be ON as long as the station AC supply is available. AC lighting fixtures shall be fed from respective area lighting panels. If fault level at lighting panel is more than 10 kA, lighting distribution boards shall be fed through 415/433 V ratio lighting transformers.

4.1.3 Emergency AC lighting shall be provided by DG set through unit emergency switchgear and lighting distribution boards. In main plant area, about 20% lighting shall be fed from AC emergency source.

4.1.4 In main plant area and other auxiliary plants, emergency DC lighting shall be provided in control rooms, in critical operating area, and for safe exit in case of black out. These lights shall be fed from DC distribution board backed by DC batteries. These lights shall be of LED type. DC lights shall remain continuously ON along with AC lighting system.

4.1.5 For Off-site buildings, where DC supply is not available, Emergency lighting units with integral batteries shall be used. Offsite area building emergency DC lighting shall be provided by self-contained emergency lighting fixtures. Each emergency fixture shall provide emergency light for

3-4 hours when the normal power source is lost. Each emergency light fixture shall be provided with Ni-cd gel battery, battery charger and two CFL lamps.

4.2.0 Tubular day light guidance system

4.2.1 The sunlight is captured from a transparent dome on the rooftop of a building and then the light travels through a daylight pipe (by way of multiple reflections from the daylight pipe's specular inside surface) to inside the building where sunlight is delivered to the indoor spaces through diffusers.

4.2.2 The transparent dome collects sunlight from above the roof level and then the daylight pipe guides the same to the interior spaces of a building. So, at the interface with open sky, the light pipe is provided with a transparent dome having the following attributes: adequate impact strength, sufficient daylight capture surface, high transmittance for the visible spectrum i.e. 400–750 nm, surface designed to scatter light uniformly; fire resistance, U-V stabilized, U-V blocking (up to 380 nm) and capable of preventing the ingress of moisture, dust, anti-bird measures, etc.

4.2.3 The light pipe system should have the following features: high impact strength; high transmittance for visible portion of sunlight spectrum i.e. 400–750 nm; purest color rendition (no color shift); U-V stabilized; U-V blocking (up to 380 nm); fire resistance; low attenuation of solar radiation while traversing the length of light pipe and any bends therein; minimal transmission of heat along with daylight; (preferably) low aspect ratio (length : diameter); and arrangement for control of available sunlight. For negotiating non-straight paths, light pipe bends should also be available. The daylight pipe and associated items are required to be maintenance free.

4.2.4 The diffuser should be designed so as to achieve the following goals: transmittance of required amount of daylight and to spread it efficiently throughout the space to be illuminated; there should be no glare; visual comfort; 99% U-V blocking (up to 380 nm); resistance to impact; fire resistance; prevent ingress of moisture and dust; U-V stabilized; control of light output, including switching off the light during daytime.

4.2.5 While installing the daylight pipe, correct type of roof flashing should be used so that no ingress of water, dust, etc. takes place at the junction between masonry work and daylight pipe. The dome, light pipe and diffuser should be electrostatically neutral during installation.

4.3.0 Lighting shall be provided in all the areas of power plant. Lux level proposed are given below:

S. No.	Area	Lux level
1.	Turbine Hall (operating floor)	200
2.	Turbine Hall other floors	100
3.	Boiler Platforms & ESP platforms	100
4.	Switch gear /MCC rooms, Battery room, DG Room, Elevator machine room	200
5.	Transformer yard	50
6.	Gas insulated switchgear building	200
7.	Control room	400/500
8.	Control equipment room	300
9.	Office area	300
10.	Air compressor house	150

S. No.	Area	Lux level
11.	Crusher house, Transfer tower and other indoor areas of coal handling plant	150
12.	Pump houses, WTP area, Chlorination building, AHU room	150
13.	Sea water intake pump house	150
14.	Main Road	20
15.	Secondary Roads	10
16.	Cable galleries	100
17.	Stair cases, Passages, Toilets	100
18.	Stockyard	30
19.	Conveyors	50
20.	Tank area and outdoor equipment location	20
21.	Chimney platforms	100

4.4.0 For indoor Areas, average lumen method shall be adopted to calculate luminance. Lighting level design shall include a Maintenance factor as follows to account for lamp lumen depreciation, luminaries' surface dirt and room surface dirt, etc.

- Air-conditioned clean interiors such as office rooms, Control and Electrical room : 0.8
- Clean interiors such as office rooms, laboratories : 0.75
- Industrial areas with normal interiors such as workshops. : 0.7
- Industrial areas with dusty interiors : 0.6
- Industrial areas with very dusty interiors : 0.5

4.5.0 Lighting level design shall also include the coefficient of utilization factor as calculated from table of reflectance provided by manufacturer for respective type of fixture.

4.6.0 For Outdoor flood lighting design, 'point by Point' method shall be adopted based on computer aided design package of the Contractor software. Uniformity in horizontal illuminance Emin/Eavg should be greater than 0.25.

4.7.0 Lighting for chimney

4.7.1 Chimney shall be provided with aviation obstruction lights. Aviation obstruction lights shall meet the requirements of Annexure-14 of 'International Civil Aviation Organization' (ICAO). Lights shall be of high intensity type or combination of medium intensity and low intensity. In case of later option, day time marking shall be provided on chimney as per the requirements of ICAO.

4.7.2 Number of levels of installation for obstruction lights shall be provided as per ICAO. Four lights shall be spaced at quarter points around the chimney at each elevation level. Photoelectric lighting controls shall adjust the lighting to one of three illumination levels depending on ambient light conditions (daylight, twilight, or night). All obstruction lighting fixtures shall be suitable for lamp replacement from internal platforms. Necessary swing door arrangement shall be provided for aviation obstruction lights.

4.7.3 Temporary aviation lights shall be installed above the top most point of the obstruction as construction progresses. This arrangement shall continue to exist till permanent arrangement to provide such lights are completed.

4.7.4 Aviation obstruction lighting shall be powered from AC emergency power supply.

4.7.5 Lighting shall be provided for various platforms and ground floor. Lighting fixture with LED lamps shall be provided to have maintenance free installation.

4.8.0 Aviation obstruction lights for natural draught cooling tower (NDCT)

4.8.1 NDCT shall be provided with aviation obstruction lights. Aviation obstruction lights shall meet the requirements of Annexure-14 of 'International Civil Aviation Organization' (ICAO). Lights shall be of medium intensity type.

4.8.2 Number of lights at each level shall be provided as per ICAO. Photoelectric lighting controls shall adjust the lighting to one of three illumination levels depending on ambient light conditions (daylight, twilight, or night).

4.8.3 Temporary aviation lights shall be installed above the top most point of the obstruction as construction progresses. This arrangement shall continue to exist till permanent arrangement to provide such lights are completed.

4.8.4 Aviation obstruction lighting shall be powered from AC emergency power supply.

4.9.0 LIGHTING CONTROL

4.9.1 Switch control shall be provided for controlling lighting fixtures located indoor.

4.9.2 Electric power to light fixtures located outdoors shall be switched with photoelectric controllers and timers. Provision shall be made to bypass the photoelectric controller and timer. For Road lighting, alternative lighting fixtures shall be fed from different phases.

4.9.3 Load on each lighting circuit and single phase receptacle circuit shall be limited to about 1500 W and the number of luminaries connected to lighting circuit shall be limited to about fifteen (15).

4.9.4 Electronic ballasts shall be provided for fluorescent fittings. For main plant control room, low loss copper ballast shall be provided. All the fixtures shall be provided with rapid start lamps and long life ballasts.

4.9.5 At least one 6/16 ampere, 230 volt AC universal socket outlet with switch shall be provided in offices, cabins, etc. In service building, atleast 4 nos. 5 Amp plug points shall be provided in each cubicle. Receptacles with decorative cover plates shall be used in office / Control rooms.

4.9.6 20 Amp, 230 V, Single phase convenience receptacle with switch shall be provided in plant area. The convenience outlets shall be spaced to provide access to any point in the interior industrial areas with a 25 meter extension cord.

4.9.7 63 Amp, 415 V, 3 phase welding receptacle with switch shall be provided in plant area. The receptacles shall be provided in all the floors of power house building at 50 m interval along A-row and B-row. Further in Boiler at alternate floors, welding receptacles shall be provided. In ESP top platform welding receptacle at 100 m interval shall be provided. In chimney at alternate floors, welding receptacles shall be provided. In outdoor locations, in the vicinity of major equipment, welding receptacles shall be provided. 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. In Transformer yard, 4 nos. 63 Amp welding receptacle and 4 nos. 250 Amp receptacle with MCCB unit shall be provided to extend power for oil filtration units during maintenance.

4.9.8 Each receptacle panel shall be provided with one earth leakage circuit breaker rated 30 mA in outgoing circuits.

4.9.9 In areas with hazardous atmospheres such as Hydrogen generation plant, fuel oil pump house, oil decanting pump house, lighting and convenience outlets shall be flame proof type. Receptacles located in Conveyor galleries shall be flame proof type.

4.9.10 Wall mounted fans shall be provided for all cubicles of admin building, service building, laboratories and other non-plant buildings.

4.9.11 Search lights of halogen lamps having adequate coverage shall be provided in watch towers.

5.0.0 EQUIPMENT DESCRIPTION

5.1.0 LIGHTING FIXTURES

5.1.1 For all service building, admin building, laboratory, conference rooms, SWAS room etc., LED lamp light fittings shall be used.

5.1.2 For other buildings/installations having room height of up to 5 metre, Fluorescent light fittings of following types shall be used:

- Industrial trough type/Industrial General purpose Rail type for all industrial areas
- Corrosion proof type for battery room and chemical areas, etc.,
- Anti-glare mirror optic type for Control rooms housing VDUs.
- Mirror optic type for other Control rooms.

5.1.3 In false ceiling areas, type of light fixtures shall suit the type of false ceiling provided.

5.1.4 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 metre.

5.1.5 For high bay areas, light emitting plasma (LEP) light fittings shall be provided.

5.1.6 For outdoor areas involving road lighting and flood lighting, light emitting plasma (LEP) light fittings shall be provided.

5.1.7 Road lighting / Flood lighting poles shall be of galvanised steel pole. Each Street lighting pole/Flood lighting pole shall be provided with MCB protection.

5.1.8 Winch operated high mast lighting shall be provided in select outdoor areas such as transformer yard, switchyard, coal yard, stock yard, fuel tank farm etc.

5.1.9 For DC lighting LED lights shall be used.

5.1.10 Flame proof equipment shall be provided in H2 plant, coal tunnels, underground conveyor gallery, and Fuel Oil unloading & forwarding areas.

5.1.11 AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of ± 10%, frequency variation of ± 5% and combined voltage and frequency variation of absolute sum of 10%. DC lighting fixtures and accessories shall be suitable for operation on 220 V, DC with variation between 190 V & 240 V.

5.1.12 Power factor of fluorescent lamp fixtures shall be not less than 0.90. Suitable power factor improving capacitors shall be provided for this purpose. Capacitors shall be hermetically sealed in aluminium enclosures to prevent seepage of impregnate & ingress of moisture.

5.1.13 Luminaires shall meet atleast Electrical safety class-I as per relevant IEC.

5.1.14 The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

5.1.15 Twin fluorescent lamp fixtures shall be wired in lead lag circuit to minimise stroboscopic effect.

5.1.16 High bay fixtures shall be suitable for pendant mounting and provided with safety chains.

5.1.17 Fluorescent Tubular Lamp shall be 36 Watt rated, cool day light type with Triband Phosphor having lumen output of 3250 lumens.

5.1.18 High Frequency Electronic ballast shall be suitable for 1X36 Watt FTL / 2X36 Watt FTL. Operation at high frequency shall increase lumen output. It shall conform to IS 13021 (Part I). It shall have following features:

- System loss less than 4 Watt.
- Circuit power factor 0.95 or better
- No humming noise.
- Protected against mains disturbances.
- Automatic cut off protection for a de-activated tube.

5.1.19 Copper Ballast shall be low loss design, copper wound, silicon lamination, manufactured using Vacuum pressure impregnation technology. Winding temperature shall not exceed 70 degC over an ambient of 50 deg C.

5.1.20 Recommended luminaries at various places are listed below :

Sl. No.	Area	Type of Luminaries
1	Turbine Hall operating floor	LED high bay
2	Turbine building other floors	LED Medium bay/ well glass
3	Switch gear /MCC rooms	Fluorescent industrial fixture
4	UPS, Battery charger room,	Fluorescent industrial fixture
5	Lead acid battery Room	Corrosion proof fluorescent fixture
6	Boiler area/ESP area	LED well glass
7	Cable galleries	LED well glass fixture
8	Stair cases, Passages, Toilets	Fluorescent rail type fixture/Mini lights
9	Office	Mirror optics, decorative Fluorescent fixture
10	Chemical house/ Chlorination plant	Fluorescent Corrosion proof surface-bracketed mounted
11	Control rooms with PCs/VDUs	Mirror optics non-glare type Fluorescent fixture
12	Air compressor house	LED Medium bay
13	GIS building	LED Medium bay
14	Water treatment plant/ DM plant	Fluorescent industrial fixture / LED / well glass
15	Fuel oil Pump House	Flameproof luminaries
16	DG Room	LED well glass fixture

Sl. No.	Area	Type of Luminaries
17	Emergency 220 V DC Lighting	DC LED Lamps
18	Transformer yard / Outdoor Area	LEP plasma type flood lighting fixtures on steel poles / Masts
19	Pump houses	LED Medium/LEP plasma High bay
20	Roads	LEP plasma type street light fixtures on galvanized Steel poles

5.2.0 Lighting distribution board

Lighting distribution board shall comprise, TPN MCCB as incomer and required no.of TPN MCCB feeders as outgoing feeders to feed lighting panels and receptacle panels. Construction of lighting DB shall be similar to ACDB and is detailed in LV switchgear section.

5.3.0 Lighting Panels & Receptacle Panel

5.3.1 The panels shall be rated for 415 V, 3 phase, 4 wire, AC with neutral bus and suitable for either wall/column mounting. Indoor panels shall have degree of protection of IP 54 and outdoor type shall have degree of protection of IP 55 and shall have a sloping canopy. Panels shall be constructed from CRCA sheet. Sheet thickness shall be 2.0 mm.

5.3.2 Miniature circuit breakers (MCB) shall have thermal elements for overload protection and an instantaneous magnetic trip to protect against severe faults. All MCBs provided shall be suitable for breaking capacity of 10 kA (minimum) at 240 V AC.

5.3.3 Contactors shall be of the air break type fitted with arc shields. Time switch shall be suitable for automatic switching ON and OFF of street lighting / flood lighting circuits. Time switch has 00 - 24 hours clock base. Time switch shall indicate actual time and shall permit accurate time setting. Time switch shall be provided with Ni-Cd gel battery.

5.3.4 Lighting panel shall be provided with 415 V AC, 63 Amp, TPN MCB with ELCB as incomer, required nos. of 20 A, 240 V AC, single pole MCBs for outgoing circuits, Separate neutral at terminal block for each outgoing circuit.

5.3.5 DC lighting panel shall be provided with 220 V DC , 63 Amp, DP MCB isolator as incomer, required nos.of 20 A, 220 V DC, double pole MCBs for outgoing circuits.

5.3.6 Street lighting panel shall be provided with 415 V AC, 63 Amp, TPN MCB isolator as incomer, 63 Amp Three pole AC Contactor, 00 - 24 hours timer and a photo-electric switch for automatic switching of contactor, a by-pass switch for timer/photo switch, 6 Nos. 20 A, 415 V AC, TPN MCBs for outgoing circuits, Separate neutral at terminal block for each outgoing circuit. One number light sensor in weather proof enclosure having IP: 55 degree of protection shall be installed separately with necessary interconnecting cable for each street lighting panel. Additionally 100% sensors shall be supplied for future use

5.3.7 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.

5.4.0 Three Phase Industrial Receptacles

The receptacle shall be of 63 A, industrial heavy duty insulated type with 5 pin (with earth connection) suitable for 415 V, 3 phase, 50 Hz supply. The receptacle shall be switched and interlocked type with MCB and shall be housed in a thermoplastic enclosure of IP-55 protection

class. Socket shall be provided with safety cover. Terminal blocks of adequate rating shall be provided for incoming/loop-in-loop out connection.

5.5.0 Three Phase Flame proof Industrial Receptacles

The receptacle shall be of 63 A, industrial heavy duty insulated type with 5 pin (with earth connection) suitable for 415 V, 3 phase, 50 Hz supply. The receptacle shall be switched and interlocked type with MCB and shall be housed in a thermoplastic flame proof enclosure of IP-65 protection class. Socket shall be provided with safety cover.

5.6.0 Single Phase Industrial Receptacles

The receptacles shall be heavy duty type rated for 20 A, 240 V AC supply he receptacle shall be switched and interlocked type with MCB and shall be housed in a thermoplastic enclosure of IP-55 protection class. Socket shall be provided with safety cover. Terminal blocks of adequate rating shall be provided for incoming/loop-in-loop out connection.

5.7.0 Single Phase Flame proof Industrial Receptacles

The receptacles shall be heavy duty type rated for 20 A, 240 V AC supply. The receptacle shall be switched and interlocked type with MCB and shall be housed in a thermoplastic flame proof enclosure of IP-65 protection class. Socket shall be provided with safety cover.

5.8.0 Flush type indoor receptacles

Flush type 3 pin, 6/16 A, 240 V AC sockets shall be provided for office rooms and control rooms. The receptacle shall be complete with 16 A modular type switch & safety shutter. It shall be housed in suitable thermoplastic enclosure.

5.9.0 Lighting mast

5.9.1 Each Lighting Mast shall be 20 to 30 M high, complete with the following accessories.

- High mast shaft in two/three section, hot dip galvanised
- Head frame, steel wire rope & double drum winch.
- Galvanised Lantern carriage arrangement
- Integral power tool installed inside base compartment for its operation.
- Foundation bolts
- Luminaires
- Aviation obstruction light with 2 nos. LED lamps.
- Control panel
- Power & control cables and cabling accessories required for the installation.
- Special tools & tackles

5.9.2 The High mast shall be of continuously tapered, polygonal cross section, at least 20 sided, presenting a good and pleasing appearance and shall be based on proven design to give an assured performance, and reliable service. The entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform average thickness of atleast 85 microns.

5.9.3 An adequate door opening shall be provided at the base of the mast and the opening shall permit clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch.

5.9.4 A fabricated Lantern Carriage shall be provided for fixing and holding the flood light fittings and control gearboxes. The lantern carriage shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets.

5.9.5 The winch shall be completely self-sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, gravity activated PAWLS. Individual drum also shall be operated for fine adjustment of lantern carriage. The minimum-working load shall be not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers.

5.9.6 The suspension system shall essentially be without any intermediate joint and to consist of only non-corrodible stainless steel of AISI 316 grade. The breaking load of each rope shall not be less than 2350 kg, giving a factor of safety of over 5 for the system at full load. The thimbles shall be secured on ropes by compression splices.

5.9.7 A suitable, high-powered, electrically driven, internally mounted power tool with motor, with manual over ride shall be supplied for the raising and lowering of the lantern carriage for maintenance purposes. The power tool shall be of single speed, provided with a motor of the required rating. The power tool shall be supplied complete with suitable control.

5.10.0 Lighting poles

Lighting pole shall be octagonal type, galvanized steel, supplied with base plate, foundation bolts, and necessary fixing-bracket for fixing the luminaire. Street lighting pole shall have integral junction box. All poles shall be provided with heavy square nuts on the anchor bolts under the pole base plate and hex nuts on the top. GI conduits shall be embedded in muff for incoming and outgoing cables. Height of poles shall be about 10 m. Junction box shall be integral to the pole, supplied along with MCB and neutral link.

5.11.0 Wires

XLPE/PVC insulated wires shall have multi stranded copper conductor. Wires shall be of 1.5 sq.mm/2.5 sq.mm/4 sq.mm sizes. The insulation material shall be resistant to flame, oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling. Wires shall have following colors.

- Red for R phase
- Yellow for Y phase
- Blue for B phase
- Black for Neutral
- Yellow-Green for Earth wire
- Grey & white for positive and negative connections respectively.

5.12.0 Rigid Conduits and Fittings

Rigid conduits shall conform to the requirements of IS: 9537 (Part I & Part II). However conduits above 63 mm diameter shall conform to the requirements of IS: 1239. All conduits and pipes shall be of medium duty. The rigid conduits shall be hot dip galvanized inside and outside. Weight of zinc shall be as per IS: 4759. Conduits shall be thoroughly cleaned and pretreated, conforming to IS: 6005.

Conduit fittings shall be made out of tube or cast to the shape as to match with corresponding conduit sizes. All fittings shall be screwed type and hot dip galvanized inside and outside.

In corrosive areas, epoxy coated conduits shall be provided.

5.13.0 Flexible Metallic Conduits and Fittings

Flexible metallic conduits shall conform to the requirements of IS: 3480. Flexible conduits shall be made of strip steel which shall be of cold rolled mild steel. The strip shall be of uniform width and thickness throughout. The strip shall be electro galvanized to a minimum thickness of 25 microns. The surface of the strip shall be thoroughly cleaned before application of protective coating. Pretreatment, before galvanization, shall conform to IS: 6005. Flexible conduits shall be supplied with suitable end coupler nipple and check nut.

5.14.0 GI pipes shall be of medium duty as per IS: 1239

5.15.0 Hume pipes shall be of reinforced concrete conforming to class NP3 for road crossings as per IS: 458.

5.16.0 Switch Boxes

The switch boxes shall be of surface/flush mounting type with steel construction. Switch boxes shall have conduit knock out on the sides. The switches shall be of quick make and quick break type and shall be of modular type. Where required, 3 pin 240 V type receptacles shall be provided with safety shutter and modular switch in the switch box. The switch box shall be flush mounted in places such as control rooms and office rooms.

Switches furnished shall be 6 or 16 Amps, 240 Volt totally enclosed modular type with side connected screw type terminals, phenolic compound housing and operating levers, and single mounting yoke design.

Switches used for switching direct current shall be 10 amperes, 240 Volt T-rated AC/DC switches.

5.17.0 Lighting Junction Box

The junction boxes shall be of FRP weather proof type. 650 Volt grade multiday terminal blocks complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires in the junction boxes. The Junction box shall be suitable for mounting on wall/column/poles/masts.

5.18.0 Hand lamp units (24 V Supply Module)

Hand lamp unit shall comprise 240/24 V transformer with 3 pin 24 Volt hand lamp socket. Required MCB protection shall be provided at the incomer. The unit shall be enclosed in sheet steel enclosure. 24 V hand lamp with guard and flexible cord of atleast 15 Metre length shall be supplied as specified. Module shall be portable box type suitable for providing local lighting requirements during maintenance and inspection.

5.19.0 Fans

Ceiling fans shall be of reputed make, BIS approved, 1200 mm sweep complete with copper wound, class E insulated motor, and three nos. balanced blades, suspension rod, canopy and other accessories conforming to applicable IS. Ceiling fans shall be supplied with a wall mounted controller to turn the fan on and off and to vary the fan speed from 0 to 100%. Controller shall be Electronic type free from humming noise.

Pedestal fans shall be of reputed make, BIS approved, 500 mm sweep, complete with aluminium blades, cast iron base, copper wound, class E insulated motor, support column, control switch and other accessories conforming to applicable IS.

6.0.0 INSTALLATION

6.1.0 The bottom of wiring devices shall be mounted the following distances above the finished floor.

Wiring Devices	Location	Distance above Floor (minimum)
Receptacles	Offices and finished areas	500 mm
Receptacles	All other locations	900 mm
Switches	All locations	1500 mm
Ceiling fan control	All locations	1500 mm
Ceiling fans	All locations	2500 to 3000 mm

6.2.0 The location of the light fittings, receptacles, switches, etc. shall be such as to avoid interference with piping / ventilation ducts / busduct or other equipment and to avoid objectionable shadows and glare.

6.3.0 In false ceiling areas the switchgear and the conduits shall be recess mounted.

6.4.0 In all Office rooms & Control rooms conduit shall be concealed type. In, admin building, canteen, dispensary, , concealed conduit wiring shall be adopted.

6.5.0 Wooden plugs in walls and ceilings for fixing of lighting fixtures and accessories are not acceptable. Nylon rawl plug shall be offered.

6.6.0 In the rooms where false ceilings are provided, the lighting fixtures shall be supported separately by false ceiling grid over false ceiling if it is of steel structural or from ceiling or from cable trough / channel and not by the false ceiling board. The arrangement shall be to the approval of Owner.

6.7.0 A four (4) way terminal junction box shall be provided near each lighting fixture, for loop-in, loop-out and off connection of lighting wires or as required.

6.8.0 Conduit shall be routed at least 150 mm from the insulated surfaces of hot water, steam pipes and other hot surfaces. Where conduit must be routed parallel to hot surfaces, special high temperature cable shall be used.

6.9.0 Conduits supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm vertical runs.

6.10.0 Conduit shall be clamped on to approved type spacer plates or brackets by saddles or U-bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs.

6.11.0 Wiring for indoor Lighting installation shall be carried with insulated wire following sizes laid in Galvanised steel conduit of

- Lighting Panel to lighting Fixtures : 2.5 sq.mm copper
- Lighting Panel to Switch box : 2.5 sq.mm copper
- Switch box to lighting Fixtures : 1.5 sq.mm copper
- Lighting Panel to Sockets : 4 sq.mm copper

6.12.0 Voltage drop in the cable shall be limited as follows,

- Lighting panel to lighting fixtures :3%
- Switchbox to lighting fixtures :1.5%

- Lighting panel to socket :3%
- Lighting panel to switch box :1.5%

6.13.0 For outdoor lighting & road lighting, XLPE insulated, PVC inner sheathed, armoured, FRLS PVC outer sheathed cables shall be provided.

6.14.0 Wiring for lighting circuits of Normal AC system, Emergency AC System and DC system shall run in separate conduits.

6.15.0 Wiring for lighting fixtures and receptacle units shall be fed from different circuits and shall run in separate conduits.

6.16.0 Two different phase circuits shall not be laid in the same conduit.

6.17.0 Ceiling fans with variable speed electronic regulators shall be installed in the non-air-conditioned areas as specified.

6.18.0 Ceiling Fans & pedestal fans for of required size and quantity to be provided in individual rooms / areas like Workshop, Stores, Office building / areas, Service building, etc.

6.19.0 Receptacles and lighting circuits shall be fed from different circuits. The switch controlling these circuits shall be on the live side (phase wire) of the circuits.

6.20.0 Wiring shall be spliced only at junction boxes. Maximum two wires shall be connected at each terminal.

6.21.0 Lighting branch circuits, telephone circuits, and intercommunication circuits shall be routed in conduit. Lighting circuits shall be routed in electrical metallic tubing (EMT) for indoor areas, rigid conduit for hazardous and outdoor areas.

6.22.0 All conduit system shall be sized considering fill criteria specified in IS: 732.

6.23.0 Each lighting poles and lighting / lightning mast junction box shall be earthed by 25 x 3 mm GS flat bonded to one (1) 20 mm dia MS earth electrode of 3 meter length driven vertically in the ground.

6.24.0 The lights shall not be fixed at gantry. In buildings it shall be fixed with suitable fixtures and not directly on the walls.

6.25.0 One (1) no. of mini truck mounted with adjustable hydraulic lift for the maintenance of street lights.

6.26.0 For the maintenance of lighting fixtures within the high bay areas, four (4) nos. free standing adjustable aluminium ladder, adjustable from 5 m to 10 m shall be provided.

6.27.0 Three nos. Portable Aluminium Ladders of various sizes suitable for main control room, switchyard control room etc., shall be provided.

7.0.0 TESTS

Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. For the various bought out item test certificates from equipment Manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.

8.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

- Design basis report
- Illumination design calculation
- Tubular day light guidance system
- GA drawing and single line diagram of lighting distribution board
- GA drawing and single line diagram of lighting panel & receptacle panels
- GA drawing of poles and masts
- GA drawing of receptacles
- General arrangement drawings of lighting fixtures
- Lighting design software
- Technical data sheet
- Test reports
- Catalogues
- Illumination layout for Transformer Yard
- Illumination layout for GIS building
- Illumination layout for switchyard control building
- Illumination layout for Switchyard
- Illumination layout for Power house building
- Illumination layout for Boiler and mill bay
- Illumination layout for ESP
- Illumination layout for plant roads
- Illumination layout for Main control building
- Illumination layout for Control room
- Illumination layout for outdoor yards
- Illumination layout for coal handling plant
- Illumination layout for Ash handling plant
- Illumination layout for Water treatment plant
- Illumination layout for Chimney
- Illumination layout for Cooling tower
- Illumination layout for Sea water intake system
- Illumination layout for Fuel handling system
- Illumination layout for CWPH
- Illumination layout for Electro chlorination plant
- Illumination layout for other auxiliary plant buildings
- Illumination layout for Admin building
- Illumination layout for Service building
- Illumination layout for Watch tower
- Illumination layout for Boundary wall
- Illumination layout for other non-plant buildings
- Illumination and Small power distribution arrangement
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan

SUB-SECTION – IC

SPECIFIC TECHNICAL REQUIREMENTS (C &I)

SPECIFIC TECHNICAL REQUIREMENTS (C&I)
NATURAL DRAUGHT COOLING TOWER

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Specific Technical Requirements (C&I):

1.1 Bidder to supply the following items as a minimum

i) One no. Pressure Gauge and One no. Temp Gauge at Hot Water pipe header at T.P..
ii) One no. of Anemometer for measurement of wind velocity.
iii) One no. of Psychrometer.
iv) Removable type Pitot Tube at each hot water inlet- piping header to measure the flow (during performance Guarantee test only). The Pitot Tube shall be left with customer after the completion of the test.
v) Local Control Panel for Sump Pumps (Submersible Type).
vi) Level switches for sump/tank level high/normal/low/very low interlocks.

1.2 The detailed specification of instruments is given in detail as below.

1.3 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

1.4 Drawings/Documents and data to be furnished after award of the contract as per deliverables list.

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MEASURING INSTRUMENTS

1.1 All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anti corrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

1.2 All local gauges as well as transmitters, sensors and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance under the scope of specification shall be provided. The necessary root valves, impulse piping, drain cock, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting / erection of these local instruments shall be furnished even if not specifically asked for. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg / Cm2.

1.3 All primary instruments installed at “minus level or Floor” shall be with protection class of IP 68.

1.4 All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

1.5 All limit switch shall be conform to IEC-60947-5-1.

1.6 Field switches will be micro switch type with auto reset. Switches will have NO and NC contacts. Switch contacts shall be snap acting, 2 Nos of SPDT, hermetically sealed,potential-free with a minimum contact rating of 230 V AC 5A/ 24V DC 1A.

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1.7 All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).

1.8 All wetted parts of instrument shall be suitable for sea water application (Duplex stainless steel or better).

1.9 Painting of I & C equipment: Epoxy coating required for all I & C equipment.

2.0 All valve actuator shall be provided with conventional actuators with integral starter for ON/OFF valves. The detailed specification of actuator is given in detail as below.

2.1 These requirements are to be read in conjunction with detail Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre bid clarification. In absence of any pre bid clarification, the more stringent requirement as per interpretation of Customer shall prevail without any commercial implication.

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C&I DELIVERABLES LIST

C&I DELIVERABLES LIST FOR NDCT		
Sl.No.	**DRAWING NO.**	**DRAWING/DOCUMENT TITLE**
INSTRUMENTATION		
1	PE-V9-435-165-I901	INSTRUMENT DATA SHEETS
3	PE-V9-435-165-I903	INSTRUMENT QP / CHECK LIST
RELAY BASED LCP		
1	PE-V9-435-165-I950	LOCAL CONTROL PANEL DATA SHEET
2	PE-V9-435-165-I951	WIRING DIAGRAM
3	PE-V9-435-165-I952	PANEL GA DRAWING
7	PE-V9-435-165-I956	BILL OF MATERIAL
8	PE-V9-435-165-I957	LOCAL CONTROL PANEL QUALITY PLAN
9	PE-V9-435-165-I958	RELAY BASED PANEL O & M MANUAL

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FIELD & MEASURING INSTRUMENTS

1.0.0 TECHNICAL REQUIREMENT FOR INSTRUMENTATION

1.1.0 Field Instruments

a) Analog outputs signals from field instrumentation to the control systems are 4-20 Ma DC signals. Instrumentation can be self-powered, or loop powered from the control systems. Self-powered analog signals shall be true “isolated from ground” signals.

b) Field switches will be micro switch type with auto reset. Switches will have NO and NC contacts. Switch contacts shall be snap acting, 2 Nos of SPDT, hermetically sealed, potential-free with a minimum contact rating of 230 V AC 5A/ 24V DC 1A.

g) All instruments and analyzers shall employ EMI,RF protection in the system design**.**

h) Instrument tags should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire.

n) 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.

o) All field instruments junctions boxes & local panels located in hazardous area shall be explosion proof as per the relevant applicable standards.

f) Pressure gauges will be generally 150mm dial, solid front safety case type with blowout back, ½" NPT bottom connection, drawn stainless steel case, 316SS bourdon and socket, stainless steel movement, micrometer pointer. Pulsation dampers will be provided for pulsating pressure services. Liquid filled gauges shall be used for all pump discharges, vibrating or pulsating services. Pigtail ressu shall be used for the steam service where gauges are mounted close to the tap.

j) 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.

l) The switches shall have the following:.

Contact rating	:	230V AC, 5A / 24V DC 1A.
Repeatability	:	±0.5% FSR

m) Turn down ratio to be 100:1

n) Response time for pressure and differential pressure transmitter shall be 100 ms.

o) Protection for gauges fitted in the vibration lines/equipments shall be provided

1.1.2 Temperature Instrumentation

a) For temperature up to 300℃ 3-wire RTD duplex type, PT 100 type shall be used. For temperature beyond 300℃ thermocouples shall be used. 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℃≤ T < 850℃. R or S type for T> 850℃.

b) The Mv signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS

c) Thermocouples shall have duplex elements and ungrounded measuring junction.

e) RTDs of Duplex type furnished by the Supplier shall be of the three-wire type made with 100 ohm platinum resistance elements. They shall be certified to meet the requirements of the International Temperature Scale, calibrated to the IEC-751 standard (Alpha = 0.00385 Ohms/Ohm/℃).The RTDs shall be contained in an insulated material and a sheath or sleeve of stainless steel SS-316 and shall be so mounted that they can withstand the greatest shocks and vibrations that can be imposed upon them in the system piping without deterioration. Specific information shall be furnished concerning type and accuracy of bridge circuits to be used with the RTDs. RTDs shall be directly connected to DCS without any transmitters

f) Unless specified otherwise, each temperature element and thermometer shall be provided with a 1" socket weld type, 316 stainless steel tapered thermowell suitable for the requirements of the given application. Temperature element process connection shall be ½ NPTM.

h) Thermocouples will be of duplex MI type in ISA, K(chromel-Alumel), Platinum-Rhodium/Platinum with sheath OD 6 mm. RTD will be Duplex, Pt 100 ohm, 3 wire type as per DIN standard 43760 or equivalent. Thermo wells will be ASME PTC 19.3 latest revision with process connection M 33x2 for threaded connection and flanged connection for Air and Gas system & tanks.

i) Thermowell immersion length will generally be between 1/3 and ½ the distance to the center of the pipe. Where thermo wells are installed in lines smaller than 4 inches, the piping shall be expanded to 4 inch size to accommodate the thermo well. Thermowell shall be drilled from solid bar stock.

j) All thermo well in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermo wells that do not meet the acceptance criteria shall be resized or relocated as necessary.

k) Thermocouple extension wire is to be solid, shielded, twisted pairs.

m) Dial thermometers shall be bimetallic, minimum 150mm dial, every angle form, hermetically sealed with external recalibration adjustment, ¼" OD SS stem, ½" NPT connection and SS case.

o) Temperature gauges shall have ±1% accuracy and overage protection of 125%.

p) Switches shall have the following:

Max. contact rating	:	230V AC, 5A
Repeatability	:	±0.5% FSR
Contact type	:	snap acting

Over all accuracy 0.1% of calibrated span

q) Protection for gauges fitted in the vibration lines/equipments shall be provided

1.1.4 Level Instrumentation

a) Differential pressure type level transmitters are electronic, analog 2-wire transmitters with isolated 4-20 Ma dc output signals. Radar and ultrasonic level transmitters will be 24V DC powered, with isolated 4-20 Ma dc output signals powered from the transmitters.

b) Constant head chambers shall be furnished for all differential pressure-type level transmitters used with ressurized vessels. Reservoir piping connections shall be ½ inch outlet and a ½ inch inlet socket-welded type suitable for the pressure and temperature encountered.

c) Transparent gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves, including a safety ball check.

d) Level switches shall generally be cage float / Displacer type, rated for ANSI B31.1 requirements.

e) Non contact type level measurement shall be provided for CW sumps and for CW make-up applications.

f) Electronic level indicator of discrete type based on electric conductivity of water and steam 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**.

D. CONTROL BOARD

I. Control ~~Desk / Console /~~ Panel Construction

01.	Applicable for	:	Indoor Panel, Desk & console.
02.	Material of construction	:	Cold rolled steel sheet (Metal and plastic - Heat resistant, shrinkage free for mosaic tiles).
03.	Thickness of Sheet	:	a) 3.2 mm for faces supporting instruments / terminals. b) 2 mm for other sides and top.
04.	Construction	:	Welded throughout as per (metallic parts) approved National Standards.
05.	i) Corners	:	7 mm inner radius
	ii) Dimensional Tolerances	:	a) In height & length - 3 mm b) In height between adjacent sections - 2 mm. c) Total for a group - 6 mm
06.	Doors	:	Double, recessed, turned back edges
	i) Thickness of Sheet	:	2 mm
	ii) Hinges	:	Stainless steel
	iii) Door latches	:	Three point type
	iv) Door gaskets	:	Neoprene rubber on fixed frame to result dust proof / weatherproof enclosure.
	v) Opening of the doors	:	Outward
	vi) Louvers	:	With removable wire mesh to ensure dust and vermin proof.
07.	Color of interior	:	Glossy white
08.	Colour external	:	IS 5 No. 628 (Typical) [To be decided later]
09.	Protection of painting	:	Plastic peel coating
10.	Gland plates	:	Removable 4 mm thick (bottom)
11.	Cable entry	:	Bottom
12.	Hardware	:	a) Vibration dampeners b) Predrilled base channel ISMC - 100 or equivalent for all sides. c) Stainless steel buff- finished 2 mm thick kick plate for all sides. d) Stainless steel scratch strips along desk edges fixed with pan-head recessed screws. e) Rubber strips to ensure air tightness between kick plate and finished floor. f) Power supply points 5/15 A plug point with indication lamp 5 Nos.

Panels shall be freestanding type and fabricated preferably from 2.5 mm thick cold rolled steel sheet. Angle iron framework shall use a minimum section of 50 × 50 × 6 mm angle. The finish shall include sand blasting, grinding, chemical cleaning, and surface finishing by suitable filter and two coats of high-grade lacquer with wet sanding between coats. Two coats of paint in panel color shall be given for non-glossy high stain finish. Panel face final color in general shall be RAL 7035. A final coat of paint shall be given at site. Panels shall have removable hinged doors, generally at the back for easy maintenance and accessibility of the instruments. Doors shall be double leaved type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 230V, 50Hz A.C.
The local panel construction shall be suitable for the site condition and shall meet IEC requirements in accordance with electrical area classification.
Pressurization or purging shall be as per NFPA 496 or equivalent.
No process fluid except air shall be piped to the control panel.

E. Pressure Gauge and Differential Pressure Gauge

01.	Type	:	Bourdon/Bellows/Diaphragm
02.	MOC Sensing & Socket	:	AISI-316 SS
03.	Movement Material	:	AISI-304 SS
04.	Case Material	:	Stainless steel casing bayonet type. Enclosure IP-65.
05.	Dial Size	:	Generally 150 mm (100 mm for SWAS gauges)
06.	Scale	:	Black lettering on white background in 270 Deg. arcs.
07.	Window	:	shatterproof toughened glass
08.	Range Selection	:	Normal process pressure – 50 ~ 70 % of range (approximately).
09.	Over-range Protection	:	125% of maximum range by internal stop. External stop at zero
10.	Adjustment	:	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
11.	Element Connection	:	Argon welding
12.	Process Connection	:	1/2" NPT (M) Bottom connection for local mounting, back connection for panel mounting.
13.	Performance	:	Accuracy of ± 1.0 % of span or better for Pressure gauge

			Accuracy of ± 1.6 % of span or better for Differential Pressure gauge
14.	Operating ambient Temperature	:	0 - 50 ^{O}C
15.	Safety Feature	:	Blow out disc. /diaphragm at the back
16.	Accessories	:	a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel 316 Diaphragm with Teflon coated seals for corrosive, viscous and solid-bearing or slurry type process fluids. c) 3-Way stainless steel Gauge cock for pressure gauges. Process connection ½" NPT. d) 5-valve SS316 manifold constructed from barstock for differential pressure gauge. Process connection ½" NPT. e) Union, nut & tail piece and other Installation accessories as required.
17.	Applicable standard	:	IS-3624 / 1996
18.	Electrical Contact rating	:	240V, 5A AC/ 220V, 0.5A DC (for gauges with alarm contact). Number of Contacts:2 SPDT
19.	Nameplate	:	Tag number, service engraved in stainless steel tag plate

D. Level Switch

01.	Type	:	External cage float operated. Magnetically coupled.
02.	Float Material	:	AISI-316 stainless steel
03.	Other wetted parts	:	AISI-316 stainless steel
04.	External Cage	:	Carbon steel / Stainless steel as per process requirements, welded type / flanged construction. Cage pressure rating shall equal or exceed the rating of the main vessel.
05.	External cage mounting	:	Side – Side with drain valve.
06.	External cage connection	:	25 NB socket weld to vessel or RF flanged.
07.	Switch housing	:	Epoxy coated die-cast aluminum alloy with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
08.	Type of switch Configuration	:	2 SPDT (two nos.) Snap acting magnetically operated hermetically sealed.
09.	Contact rating	:	5A, 240V/AC, 0.5A, 220V DC
10.	Accessories	:	a) Counter flange, nuts & bolts, suitable gasket etc. b) Steel globe type drain valve. c) ¾ " ET cable gland d) Stainless steel alpha-numeric engraved for service and tag.
11.	Preferred feature	:	Switch operating point marked on cage
12.	Temperature rating	:	As per application

E. Conductivity Type Level Switch

01	Type	:	Conductivity discrimination.
03	Mounting	:	Flanged – on standpipe.
04	Probe MOC	:	Stainless steel with high purity ceramic.
05	Probe rating	:	> Maximum design pressure of vessel.
06	Input	:	four independent channels with selectable switching threshold for water conductivity.
07	Relay Output	:	Four isolated output relays for HI, LO, HI-HI, LO-LO.
08	Contact type & rating	:	2SPDT @ 0.5A 220V DC / 5 A 240V AC
09	Local Display	:	Colored LEDs for HI, LO, HI-HI, LO-LO. Power & fault.
10	Power supply	:	Dual (90-250) V AC, 50 Hz, 1Ph.
11	Enclosure	:	IP–65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12	Accessories	:	Teflon (PTFE) cable having Teflon wrapped individual cores and necessary sheathing shall be used to connect the probe with electronics
13	Test pressure	:	Two times rated pressure
14.	Cable connection	:	¾" ET Compression gland

F. Capacitance Type Level Switch

01	Type	:	Capacitance type
02	Probe	:	a) Rod or suspended electrode b) Rope type probes may be used only where required probe length is greater than 3 meters.
03.	Probe Mounting	:	Stainless steel 1 ½" ANSI RF Flange / ¾ "NPT (M)
04.	Material of construction	:	316 SS
05.	Insulation	:	PTFE Part/Full as per service.
06.	Enclosure	:	Powder/Epoxy coated Die cast Aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07.	Ambient temperature	:	0-60 ºC.
08.	Mounting	:	On Tap
09.	Supply voltage	:	(90-250) V AC, 50 Hz / 18-36 V DC
10.	Relay output	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
11.	Response time	:	100 msec or better
12.	Cable connection	:	¾" ET Compression gland
13.	Accessories	:	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

G. Level Switch (Ultrasonic Type)

Ultrasonic type level switch, IP-65 protection; Switch with 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC; Accuracy ±0.25%; Resolution 1mm; Repeatability ±0.1%; Linearity ±1%; Response time 150ms; Beam angle <12º; Auto false echo-suppression; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, digital panel meter, name plate & metal tag; the material of accessories will be SS.

H. Level Switch (Radar Type)

Radar type level switch, top mounted, IP-65 protection; Switch with 2 nos. of SPDT contacts (1 NO and 1 NC) rated for 0.2 A, 220 V DC, Accuracy ±1%; Resolution 0.04"; Repeatability ±0.04"; Linearity ±0.01%; Beam angle <20º; Accessories like integral cable between sensor and transmitter unit with connectors on both side, gasket and cable gland, name plate & metal tag; the material of accessories will be SS.

I. Conductivity Type Electronic Level Indicator

01	Type	:	Conductivity discrimination.
02	No. of Probes	:	14, 16 or 32 as per application.
03	Probe Mounting	:	Screw type / Flanged – on standpipe.
04	Probe MOC	:	Stainless steel with high purity ceramic.
05	Probe rating	:	> Maximum design pressure of vessel.
06	Input	:	Independent channel with selectable switching threshold for water conductivity.
07	Relay Output	:	Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
08	Contact type & rating	:	2 SPDT @ 0.5 A 220V DC / 5A 240V AC
09	Current output	:	Isolated 4-20 mA DC & HART
10	Local Display	:	Red, Green and flashing yellow LED's for steam, water and fault indication respectively.
11	Remote Display	:	Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.
12	Power supply	:	Dual (90-250) V AC, 50 Hz, 1Ph.

2. Resistance Temperature Detector

01.	Type	:	Platinum (Duplex), ungrounded class 'A'
02.	Resistance	:	100 ohm at 0 ^{O}C
03.	Base	:	Wound on ceramic (anti-inductive)
04.	Wiring	:	3 Wire
05.	Protecting Tube :-		
	i) O.D.	:	8 mm (approx).
	ii) Material	:	SS-316, Seamless
	iii) Filling	:	Magnesium oxide (Purity above 99.4%).
	iv) Length	:	As per application
06.	Response time	:	a) 1 to 2 seconds
07.	Head:		
	i) Type	:	IP-65 universal screwed type. (Explosion proof for NEC Class-1, Division 1 area)
	ii) Material	:	Die cast aluminum or better
	iii) Terminal blocks	:	Nickel plated Brass-screw type / silver plated
	iv) Cable connection	:	3/4" ET gland and grommet.
	v) Others	:	Terminal head cover with SS chain and suitable gasket
08.	Accessories	:	a) Adjustable nipple-union-nipple with thermowell connection b) Compression fittings/unions c) Flanges etc. (for flanged connections only) d) SS 316 forged thermowell as per ASME PTC code.
09.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
10.	Standard	:	Standard DIN 43760
11.	Limit of error	:	@ 0 Deg C $\pm$ 0.06 Ohm @ 100 Deg C + 0.13 Ohm @ 200 Deg C $\pm$ 0.20 Ohm @ 300 Deg C $\pm$ 0.27 Ohm

4. Thermo Well

Thermo wells Pipe/equipment mounted temperature test wells of 316 SS with a process connection of M33x2 thread or 150 RF flanged and instrument connection of ½" NPT (F) in general or 150 RF flanged.. Accessories like name plate, plug with chain, etc. shall be provided. Material of accessories shall be SS. Thermowell shall be hex head of barstock assembly. In case flanged wells are required for any specific application, the same shall be supplied as required. The thermo well construction shall meet the ANSI 19.3 (latest) requirements. Thermo well shall be designed such that the resonant frequency is above the exciting frequencies generated by vortex shedding in the process fluid. All Test thermo well shall have the plug of SS316.

For measurement of pulveriser outlet temperature tungsten carbide block thermowells abrasion resistant not tungsten carbide coated thermowell shall be used. Also the terminals of Thermocouple shall not be at the top of Mills itself. The thermocouple wires are to be laid up to JB through SS tubing of required diameter and the head shall be placed nearer to the JB. Compensating cable exposed to atmosphere in the conventional method melts away due to high temperature at the top of Mill.

For measurement of sea water temperature SS with titanium sleeve thermo wells or better, shall be used.

6. Temperature Gauge

01.	Type	:	Mercury filled-in remote mounting system Capillary armoured / rigid system type (backward entry / bottom entry)
02.	Sensing Element Material	:	Bourdon - AISI-316 SS
03.	Capillary Armoring	:	Stainless steel flexible
04.	Movement Material	:	AISI 304 SS / Direct Bourdon tip connection to pointer spindle
05.	Bulb Diameter and Length	:	As required
06.	Bulb Material	:	AISI 316
07.	Capillary	:	Stainless Steel
08.	Thermometer	:	M 20 x 1.5 Male adjustable gland on stem to suit associated Thermowell
09.	Case Material	:	Stainless steel bayonet type with clear glass cover conforming to IP-65.
10.	Dial Size	:	150 mm in general (100 mm for SWAS gauges)
11.	Scale	:	Black lettering on white background in 270 Deg. arc.
12.	Mounting	:	Surface/Panel
13.	Over range Protection	:	125 % of range or more
14.	Instrument connection	:	Bottom connection for local mounting and back connection for panel mounting.
15.	Range	:	50% ~ 70% range of operating temperature of application approximately.
16.	Compensation	:	Case compensation
17.	Zero adjuster	:	Micrometer screw adjustable from front.
18.	Window	:	Shatterproof toughened glass.
19.	Performance	:	Accuracy of ± 1 % of full-scale deflection or better.
20.	Enclosure Class	:	IP-65
21.	Capillary	:	5 meters (local)/15.0 meters (local panel) - armored stainless steel
22.	Preferred Feature	:	Capillary Compensation
23.	Accessories	:	a) Forged SS 316 thermowell weldable or screwed as per ASME PTC code b) Installation accessories as required.
24.	Nameplate	:	Tag number, service engraved in stainless steel tag plate
25.	Immersion length	:	Adjustable up to 300 mm including bulb length or as per application

G. ELECTRICAL SYSTEMS METERS AND ACCESSORIES

A. Push Button

01.	Type	:	Shrouded square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC
04.	Contact Addition	:	Add-on block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500V / 10 A

07.	Utilization Category	:	AC11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 million operations
10.	Construction	:	Aluminum shrouding with plastic lens
11.	Colors	:	Red, Green, Yellow, Black, etc.
12.	Connection	;	Screw terminals
13.	Enclosure Class	:	IP-52
14.	Legend	:	Engraving

B. Illuminated Push Button

01.	Type	:	Square format
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	2 NO + 2 NC (minimum)
04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contacts
05.	Contact Material	:	Hard Silver Alloy
06.	Contact Rating	:	500 V/ 10A
07.	Utilization Category	:	A C11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 Million Operations
10.	Lamp	:	LED with built-in resistors as required
11.	Lamp Rating:-		
	a) Voltage	:	240 V AC
	b) Watt	:	2 Watt (approx.)
12.	Lamp and Lens Replacement	:	From front
13.	Construction	:	Transparent Plastic Lens
14.	Color	:	Red, Green, Amber, Yellow etc.
15.	Connection	:	Screw terminals
16.	Enclosure Class	:	IP-52
17.	Legend	:	Engraving

C. Selector Switch

01.	Type	:	2/3/4 position stay put type with rotary lever actuator.
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Contact Configuration	:	4 pair of contacts
04.	Contact Addition	:	Add-on-Block up to 4 each with 2 pairs of contact
05.	Contact Material	:	Hard silver Alloy
06.	Contact Rating	:	500 V / 10 A
07.	Utilization Category	:	AC11 / DC11
08.	Insulation Voltage	:	2 KV for 1 minute between terminals and earth
09.	Mechanical Life	:	1 million operation
10.	Construction	:	Aluminum shrouding
11.	Connection	:	Screw terminals
12.	Enclosure Class	:	IP-52

D. Indicating Lamp

01.	Type	:	LED with built-in resistor (LED must not glow if the voltage is less than 180 V)
02.	Face Dimension	:	32 x 32 mm (maximum)
03.	Voltage	:	230 V, 50 Hz, 1 Phase
04.	Watt	:	2.5 Watt (approximate)
05.	Lamp and Lens Replacement	:	From front
06.	Construction	:	Transparent Plastic lens
07.	Color	:	Red, Green, Amber, Yellow etc.
08.	Connection	:	Screw terminals

09.	Legend	:	Engraving

E. Indicating Meters (A.C)

01.	Type	:	Rectifier type taut band
02.	Face Dimension	:	96 x 96 mm
03.	Scale	:	Radial arc of 240 Deg.
04.	Accuracy	:	1.5% of full scale. ±0.5 Hz for frequency meter
05.	Input	:	0-1/0-5A for current measurement, 0-240V, 50 ± 2.5 Hz for voltage measurement
06.	Zero Adjustment	:	Screw on meter face
07.	Enclosure	:	Shielded Case IP-52
08.	Mounting	:	Flush Panel
09.	End Scale Suppression	:	6 times the measuring range only for motor ammeters

F. Indicating Meters (D.C)

01.	Type	:	Taut band moving coil
02.	Face Dimension	:	96 x 96 mm
03.	Scale	:	Radial arc of 240 Deg.
04.	Accuracy	:	1.5% of full scale
05.	Input	:	0-75 mV for current measurement. Direct reading for voltage measurement.
06.	Zero Adjustment	:	Screw on meter face
07.	Enclosure	:	Shielded case IP-52
08.	Mounting	:	Flush Panel
09.	End Scale Suppression	:	2 times the measuring range only for motor ammeters.

G. Auxiliary Relay

01.	Type	:	Plug-in type with base/DIN rail Mounted
02.	Coil voltage	:	230 V, 50 Hz, 1 Phase
03.	Contact Configuration	:	2 NO & 2 NC (Minimum), additional contacts as per requirement
04.	Contact rating	:	250V/5A (A.C/D.C.)
05.	Operating range	:	80 to 110% of rated voltage
06.	Insulation	:	2 KV for 1 minute between terminals & earth.
07.	Mechanical life	:	20 million operations
08.	Enclosure	:	Transparent cover
09.	Connection	:	Screw terminals.
10.	Mounting	:	Projection mounting inside panel /DIN rail mounting

H. Coupling Relay

01.	Type	:	Miniature plug-in type/ DIN rail Mounting
02.	Coil voltage	:	24 V D.C. / 48V DC
03.	Contact	:	2 NO & 2 NC (Minimum)-Additional contact as per requirement
04.	Contact rating	:	250 V/5A (A.C)/220V/2A (D.C)
05.	Operating range	:	70 to 110% of rated voltage.
06.	Insulation	:	2 KV for 1 minute between terminal & earth.
07.	Mechanical life	:	20 million operations
08.	Coil protection	:	Diode
09.	Indication	:	Coil on LED
10.	Enclosure	:	Transparent cover
11.	Connection	:	Screw terminals.
12.	Mounting	:	Projection mounting inside panel / DIN rail mounting

I. Distribution Boards

01.	Type	:	Fixed, Modular.
02.	Power distribution	:	Through MCCB
02.	Enclosure	:	Sheet Steel, IP54
03.	Mounting	:	Free standing (Can be attended from both front & back)

J. Electrical Junction Box

01.	Type of Enclosure	:	Dust tight, Weatherproof and Waterproof, generally conforming to IP 65.
02.	Material	:	16 SWG sheet steel hot-dip galvanized / Cast aluminum LM6.
03.	Type of Cover	:	Solid unhinged with retention chain
04.	Number of Paint	:	One base + two finish coatings of anti corrosive epoxy
05.	Mounting	:	Surface
06.	Cable Entry	:	Conduit Knockout/Threaded Hub
07.	Gasket	:	Neoprene
08.	Grounding	:	Brass earth lug with green screw head External-2 Nos, Internal-1no.M6.
09.	Number of Drain Holes	:	Two at bottom capped.
10.	Tag Plate	:	a) JB Number b) Cable Numbers on top c) Cable numbers with ferrules (side)
11.	Accessories	:	a) Rail mounted Terminal blocks with makers b) Cable gland

K. Cable Gland

01.	Type	:	Double compression
02.	Entry Thread	:	ET
03.	Material	:	Brass
04.	Finish	:	Cadmium Plated.
05.	Protection	:	IP – 54 or better
06.	Accessories	:	Neoprene gasket, locknuts, reducers etc.

L. Cable Tray

01.	Material	:	Mild steel
02.	Thickness	:	not less than 2.5 mm
03.	Finish	:	Hot dip galvanized
04.	Perforation	:	As per MFR standard.
05.	Cover	:	Suitable for tray

2. Instrumentation Pair Signal Cable

01.	Conductor type	:	Stranded (7) annealed tinned copper
02.	Conductor size	:	0.5 Sq.mm
03.	Resistance	:	39 Ohms / Km (max.) at 20 ^{O}C
04.	Conductor Insulation	:	HRPVC Type-C (IS-5831,1984) 0.6 mm thick
05.	Voltage grade	:	600V (peak value.)
06.	Twisting	:	Twin twisted with lay of 75 mm
07.	Twisting Direction	:	All pairs in the same direction. Lapped to form bunch with mylar tape.
08.	Individual Pair & Overall Shield	:	Aluminium myler tape with a thickness of 2.35MIL and 25% overlapped edges.
09.	Drain wire	:	Annealed Tinned copper wire, Stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)
10.	Inner Sheath	:	Extruded FRLS PVC Type ST2 of IS-5831,1984 Thickness as per IS-1554 Part-I 1976
11.	Armoring	:	G.I. Wire/Strip as per IS-3975
12.	Outer Sheath	:	Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) Type ST2 of IS-5831, 1984 Thickness as per IS-1554, Part-I 1976
13.	Rip Cord	:	Yes
14.	Temperature Range	:	85 ^{O}C
15.	Insulation at 20 Deg.C	:	100 MOhms/Km [Min]
16.	Capacitance at 800 Hz	:	70 nf/km [Typical]
17.	Codes & Standards	:	a) IPCEA-S-61-402 b) IEC 332-1 c) ASTM-B-33 d) IS-8130-1984

18.	Tests	:	a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863) b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I c) Temp Index: Min 250 ^{O} C at 21Oxy. Ind. (ASTM-D-2863) d) Smoke Density Rating: Max.60% (ASTM-D-2843). e) Flammability Test: as per IEC 332 Part-I f) Swedish Chimney Test-S-424-1475 g) Insulation Test Core to core: 1.0 KV r.m.s for1 Min h) Insulation Test Core to armour: 1.0 KV r.m.s for1 Min i) Insulation Resistance 100 M Ohm / Km Min j) Type test for material k) Fire resistance test to IS 5831 for 20 Minute CPVC insulation & sheath of electrical cable. l) Rodent & termise proof m) Thermal Stability of 200 OYC to IEC 54o for 100 Nos.

1.3.0 Process Impulse Lines /Tubes & Fittings

Impulse lines for instruments shall be ½" OD tubing of SS316 material according to ASTM A-269. All fittings to be used for tubing shall also be SS316, double compression type of standard make. Impulse pipes for high pressure applications shall be 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. Compression tube fittings are used in low pressure process systems. Socket weld tube fittings shall be used in high pressure process systems

For impulse pipes/tubes and fittings, IBR certificate shall be provided as applicable. The bidder shall provide thermal insulation (preferably mineral wool) for sampling pipes for the purpose of personnel protection so that temperature outside the insulation is 60 deg. C. Tubing shall be complete with union connections and end fittings at supply and receiving ends. Nipple shall be provided for root valves size more than ½" and the nipple size shall be same as the root valve size. Reducer / adapter shall be provided to suit instrument connection, where nipple, root valve size is more than ½". Bulk head fitting socket welded type to be provided at instrument rack/enclosure.

Impulse pipes, fittings and air supply and signal piping/tubing shall be supplied for all the instruments under the scope of this specification. Instrument piping shall be designed for maximum design pressure and temperature of the process. Pressure measurement connection shall be ½'' or 12mm pipe depending on the temperature and pressure conditions of the fluid. Instrument on Vacuum system at CEP inlet should have vent lines connected to high point in the condenser. Instrument air tubing shall be SS.

Minimum bending radius of instrument sensing line is 3 times the tube diameter. Independent impulse lines shall be installed between the flow elements and the transmitter in case of dual/triple redundant

Instrument sensing lines are sloped in their horizontal runs, a minimum of ½" per foot. In general, liquid and steam lines slope from their process tap connection down to the instrument. In general, gas and non-condensing vapor lines slope from their process tap connection up to the instrument.

Instrument sensing lines shall be routed as directly as practicable from the process root valve to the instrument. The length of instrument tubing from the root valve to the instrument shall be limited to maximum of 12 meters for compressible fluids and 15 meters for non-compressible fluids. Wherever it is not possible to access the main root valve a additional root valve shall be provided near to the instrument.

Instrument sensing lines shall be grouped together as much as possible to benefit from the use of common support members and to present a finished installation that is routed in a neat and orderly manner.

The maximum process temperature for all transmitters shall be limited to 80℃. To dissipate the excess heat, a minimum of 1 meter of tubing for each 30℃ of excess heat shall be installed to isolate the process media from the instrument. An additional isolation valve shall be used at the instrument for isolation on those instruments without valve manifolds

Funnel with drain header shall be provided in the racks for blowing/draining out the process fluid in the impulse tubings. The size of the drain header shall be 1". When instruments are mounted local to the tapping point and are not mounted in the rack, or panel or enclosure, the drains shall be connected to the nearest floor level or plant drain.

The erection hardware shall meet the following specifications:-

	Item	Specification
a)	Impulse Piping	
i)	High pressure and high temperature services (Medium: Steam & Water and furnace region)	Seamless Alloy Steel Piping to ASTM A335 GR.P22 (schedule 160 for high pressure & high temperature)
ii)	Low pressure and low temperature services Gr.B (Medium: Steam & Water)	Seamless carbon steel piping to ASTM A106
iv)	Steam and Water Analysis system	Seamless stainless steel piping to ASTM A312 Gr. TP-321
v)	Seamless copper tubing	ASTM B-75
b)	Fittings	
i)	Material for socket weld fittings	ASTM A105 ASTM A182 Gr. F22 6000/3000 lbs
ii)	Dimensions of fittings	ANSI B16.11
iii)	Fittings for steam and water analysis	ASTM A182 Gr. F-321

1.5.0 Instrument Support / Structural Steel

Bidder shall supply instrument stands (stanchions) and other structural steel material required for supporting the Junction boxes, cable trays, impulse lines and instruments.

All field mounted instrument tubing shall be supported with steel angles/channels of a minimum 1/8" thickness fabricated to present a neat appearance. Sharp corners in the support material to be avoided

1.8.0 Junction Boxes

Bidder shall supply junction boxes wherever required. These shall be of Industrial grade Fibre glass Reinforced Polyester (FRP) to weather proof, with cable entering on bottom and side entry shall be provided.

These boxes shall have terminals suitable for min 2.5 mm² cable termination (klip on) mounted on rails. 30% spare terminals shall be supplied in each junction box.

Junction box shall be provided with double compression glands.

Telephone socket shall be provided in junction boxes. Each junction box shall have a minimum of 20% or 2 nos., whichever is more, spare entry duly provided with plugs (weather proof/explosion proof, as applicable). Protection class shall be IP-65 minimum for JB and enclosures.

In general junction boxes shall be designed in accordance with NEC, Article 370, paragraphs 18, 19 and 20 or equivalent standards. Junction boxes for use in outdoor or damp locations shall be galvanized malleable iron or steel coated inside and outside. The enclosure shall conform to NEMA-4 with hinged door lockable type. Conduit and cable shall enter the lower portion of the box in such a manner that all terminals strips are above conduit entry points.

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LOCAL CONTROL PANEL

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1998	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 2007	:	Colors for ready mixed paints and enamels.
c)	IS-1248:2003	:	Direct Acting Indicating Analog Elec Measuring Instruments.
d)	IS/IEC 60947:Part 1:2004	:	Low Voltage switchgear & control gear: Part-I (General Rules)
e)	IS-8828:1996	:	Circuit breaker for household and similar installations.
f)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
g)	ISA-18.1:1979	:	Annunciator Sequences and Specification
h)	NFPA-496:2003	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.
The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 50 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type.

Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. 00 DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT	■2.5 mm	
		OTHER	■ 2.5 mm	
		DOOR	■ 2.5 mm	
		OTHER	■ Load bearing sheet front shall have 2.5mm thickness	
TECHNICAL	INPUT POWER SUPPLY * (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		☐ 240V 50 Hz AC ☐ 220V DC ☐ 415V 3 PHASE 3W ☐ 415V 3 PHASE 4W	
	NO. OF FEEDERS		☐ ONE ■ TWO	
	STARTER WITH MCC (CHECK WITH MAUX/ELEC)		■ REQUIRED ☐ NOT REQUIRED	
	IPR POSITION		☐ MCC ■ RELAY PANEL	
	CONTACT RATING OF RELAY		☐ 5 Amp, 230 V AC ☐ 0.25 Amp, 220V DC	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ☐ Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		☐ REQUIRED ■ NOT REQUIRED	
	PAINT TYPE		■ EPOXY	
	MIMIC (TYPE OF MIMIC- MATERAIL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		☐ REQUIRED ☐ NOT REQUIRED	
	PANEL COLOUR (EXTERNAL)		☐ LIGHT GREY (Shade 631 IS-5) ☐ OPALINE GREEN (Shade 275) ■ RAL 7032/RAL7035 (This shall be decided by BHEL during detailed engg.)	
	FINISH (EXTERNAL)		☐ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL)		☐ WHITE ☐ CREAM ☐ OFF WHITE ■ GLOSSY WHITE TWO COATS/ RAL 7035 WITH FIRE RESISTANT PAINT (This shall be decided by BHEL during detailed engg.)	
	FINISH (INTERNAL)		☐ MATT ■ GLOSSY ☐ SEMI GLOSSY	

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. 00 DATE:
		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	CLASS OF PROTECTION	☐ IP-42 (FOR INDOOR SERVICE) ■ IP-55 (FOR OUTDOOR SERVICE) ☐ ANY OTHER	
	CONTROL HARDWARE	■ RELAY BASED	
	FOUNDATION ARRANGEMENT	☐ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)	……..(Vendor to specify)	
	PANEL TYPE	☐ PRESSURISED ☐ UNPRESSURISED As per Requirement	
	CABLE GLAND	☐ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT, IF REQUIRED)	☐ 1 Amp CT ☐ 4-20 mA	
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	☐ APPLICABLE ☐ NA	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME:
DESIGNATION				
SIGNATURE				SIGNATURE:
DATE				DATE:

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. 00 / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ☐ WELDED (As per requirement EDN)	
	ENCLOSURE SHEET THICKNESS	FRONT		
		OTHER		
		DOOR		
		HEIGHT		
		OTHER		
TECHNICAL	INPUT POWER SUPPLY			
	NO. OF FEEDERS			
	CONTACT RATING OF RELAY			
	TEMP SCANNER			
	CONTROL SUPPLY			
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)			
	PAINT TYPE			
	PANEL COLOUR (EXTERNAL)			
	FINISH (EXTERNAL)			
	TYPE OF MIMIC MATERIAL OF MIMC THICKNESS OF MIMIC			
	PANEL COLOUR (INTERNAL)			
	FINISH (INTERNAL)			
	CLASS OF PROTECTION			
	CONTROL HARDWARE			
	FOUNDATION ARRANGEMENT			
	WEIGHT OF PANEL (Kg.)			

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. 00 | DATE:
		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

	PANEL TYPE		
	CABLE GLAND		
	AMMETER (TYPE OF INPUT)		
	SCOPE OF SUPERVISION		

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME:
SIGNATURE				SIGNATURE:
DATE				DATE:

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MOTORISED VALVE ACTUATOR

FORM NO. PEM-6666-0

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 01 DATE: 06.08.18
		SHEET 1 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

GENERAL*	* PROJECT	2 X 660 MW UDANGUDI TPP	
	OFFER REFERENCE		
	* TAG NO. SERVICE		
	* DUTY	☐ ON / OFF ☐ INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL		
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY	
	* OPENING / CLOSING TIME		
	* WORKING PRESSURE		
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to70 DEG C AND RELATIVE HUMIDITY OF 0-95%IN HOT HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST	
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY	
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY	
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY	
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF,DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL	
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.	
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.	
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM.**	
HANDWHEEL	* REQUIRED	■ YES ☐ NO	
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED	
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.		
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY	
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY	
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE	
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) A: ☐ DRG. NO. 3-V-MISC-24227 R00 B: ☐DRG. NO. 3-V-MISC-24550 R00 C: ■ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram	
	COLOUR SHADE	☐ BLUE (RAL 5012) ■ SIEMENES GRAY RAL 7030	
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ■ EPOXY ☐	
	SHAFT RPM	BIDDER TO SPECIFY	
	OLR SET VALUE	BIDDER TO SPECIFY	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY	
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY	
	@ PWR SUPP TO MTR / STARTER	415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%	
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ■ 110 V	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: VOLUME II B SECTION D REV. NO. 01 DATE: 06.08.18 SHEET 2 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

	@ ENCLOSURE CLASS OF MOTOR	☐ IP 68 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS(Reversing type) ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN-STOP-CLOSE PB(running open/close LED) THREE POSITION SELECTOR SWITCH	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■REQUIRED ☐ NOT REQUIRED	
	LOCAL-OFF- REMOTE S/S(THREE POSITION SELECTOR SWITCH)	■REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (MOTOR THERMOSTAT TRIPO/L RELAY OPERATED, CONT. /POWER SUPPLY FAILED, S/S IN LOCAL/REMOTE/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD.)	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐INTERPOSING RELAY ■OPTO COUPLER ☐ EITHER	
	QUANTITY	■ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	10A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	■2 Nos. / 2 nos(adj) / 1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	10A 240V AC AND 0.5A 220V DC	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 01 DATE: 06.08.18
		SHEET 3 OF 4

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	REQUIRED for regulating/inching duty only.	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) contactless inductive type	
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	240V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@■ IP 68 @☐ NEMA6	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	■ REQUIRED ☐ NOT REQUIRED☐ ■ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:----------	
	@ SPACE HEATER CABLE GLAND	SIZE:----------	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	1 no suitable for 8P X 0.5 sq mm Additional 1 no suitable for 2P X 0.5 sq mm(inching duty only)	

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 01 / DATE: 06.08.18
		SHEET 4 OF 4

Data Sheet A & B

DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)

WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.

2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722

3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.

4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.

5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.

6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.

7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

8. IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.

9. POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL

10. WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.

11. THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE AND RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.

12. THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE.

13. THE 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.

14. THE REMOTE COMMAND SIGNAL (OPEN-STOP-CLOSE) FROM DCS/RESPECTIVE CONTROL SYSTEM/CONTROL PANEL SHALL BE ISOLATED FROM CONTROL ELECTRONICS THROUGH OPTO-ISOLATOR.

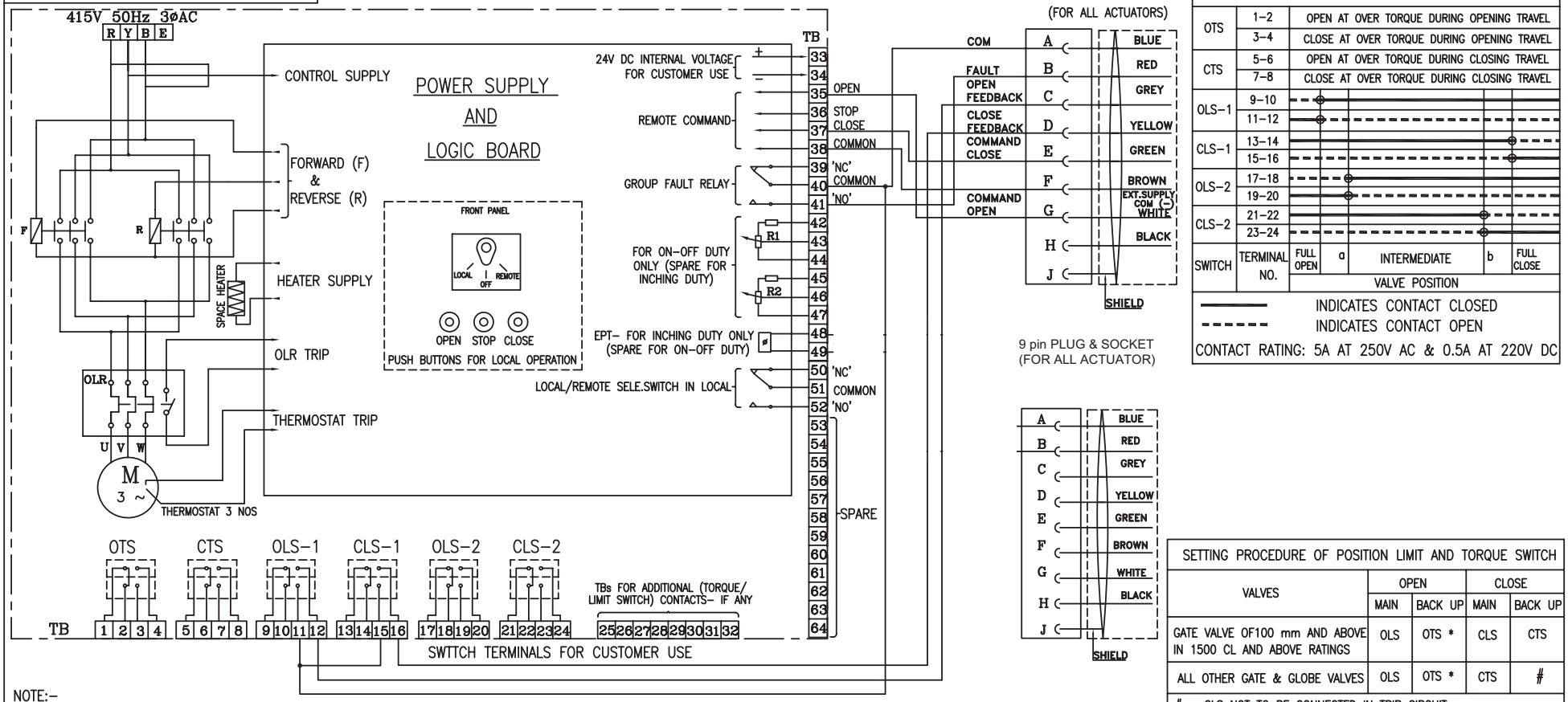
15. THE FOLLOWING INDIVIDUAL STATUS ANNUNCIATION LED'S (COLOUR-GREEN) SHALL BE PROVIDED LOCALLY (INTEGRAL TO ACTUATOR) TO ANNUNCIATE THE FOLLOWING FOR EASY LOCAL MONITORING.
    ACTUATOR IN LOCAL MODE
    ACTUATOR IN REMOTE MODE
    ACTUATOR RUNNING IN OPEN DIRECTION
    ACTUATOR RUNNING IN CLOSE DIRECTION
    ACTUATOR IN INCHING MODE.
    ACTUATOR IN SELF-RETAINING MODE
    LIMIT SWITCH OPEN TRIP
    LIMIT SWITCH CLOSE TRIP
    CONTROL VOLTAGE AVAILABILITY

16. AUTOMATIC PHASE CORRECTION FACILITY AND POTENTIAL FREE CONTACT FOR ANNUNCIATION OF POWER FAILURE SHALL BE PROVIDED.

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.

DRAWING NO. 3-V-MISC-24283



CONTACT DEVELOPMENT DIAGRAM

OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL
CTS	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL
	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL
OLS-1	9-10	
	11-12	
CLS-1	13-14	
	15-16	
OLS-2	17-18	
	19-20	
CLS-2	21-22	
	23-24	

SWITCH / TERMINAL NO. — FULL OPEN | a | INTERMEDIATE | b | FULL CLOSE — VALVE POSITION

INDICATES CONTACT CLOSED
INDICATES CONTACT OPEN

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#

\# - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT
* - BYPASS OTS FOR INITIAL 5% OF TRAVEL(FOR GATE VALVES ONLY)

NOTE:-

1. ALL TORQUE AND LIMIT SWITCHES (OTS,CTS,OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE. ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
2. CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
3. OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
4. OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
5. CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
6. EPT - ELECTRONIC POSITION TRAMSMITTER (CONTACTLESS TYPE, FOR INCHING DUTY)
7. R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
8. FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
9. M - MOTOR 3ø 415V 50 Hz AC SUPPLY
10. TORQUE SWITCH BYPASS WITH LIMITSWITCH BOTH ON OPEN & CLOSE DIRECTION TO BE DONE INTERNALLY.

REV	DATE	ALTERED
		CHD & APPD

CAUTION: The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company.

TYPE OF PRODUCT: ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS
2 X800 MW UPPUR TPP
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

BHARAT HEAVY ELECTRICALS LTD.,
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI-620014.
365-121

	NAME	SIGN	DATE	NO.OF VAR.
DRN	N.P.ESWAR	N.P	17.03.05	-
CHD	D.DINAKARAN	D.D	17.03.05	
APPD	K.ARUNACHALAM	K.A	17.03.05	

DEPT	SCALE	WEIGHT (KG).	REFERENCE INFORMATIONS	NO. OF ITEMS
VL	NTS	-		-
CODE -				

TITLE: WIRING DIAGRAM (TERMINAL PLAN)
FOR ACTUATOR WITH INTEGRAL STARTER WITH PLUG & SOCKET

CARD CODE: U 01

DRAWING NO.: 3-V-MISC-24283

REV: 0

Size A3

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SUMP PUMP

	CONTROL WRITE-UP FOR SUMP PUMPS SYSTEM **PROJECT:** 2X660 MW TANGEDCO UDANGUDI STAGE-I STPP	DRAWING NO: REV. NO. 00 | DATE: SHEET 1 OF 2

CONTROL & INSTRUMENTATION FOR SUMP PUMP SYSTEM

Introduction- Sump pumps are used to dewater various sump pits to nearest surface drain in the power house and other plant areas to ensure general housekeeping.
The system shall normally have 2 pumps. The measuring instruments recommended are level switches(float/displacer type) for level measurement and control of the system and pressure gauges at pump discharge for local pressure measurement. Any other instruments can be included dependent on the requirement or if demanded by the customer.
The sump pumps can be fixed submersible type where the pumps are fixed and submerged or can be portable submersible type where the pumps are trolley based and can be moved as per the need. In fixed type the level switches can be mounted at a suitable mounting place while in portable type the level switches are ported to the sump along with the pumps. The mounting of switches and location of LCP shall be chosen so as to have minimum cable length between the level switches and the LCP.

CONTROL WRITEUP

The operation of Sump pumps(fixed and portable type) shall be as follows:

Sump Pumps shall be controlled through a starter cum control panel. The local control panel shall be front opening, relay based. The starter cum control panel shall be suitable for indoor or outdoor as per the location of the sump pumps. Normally one pump will be running and the other shall be on auto standby. The following controls/interlocks shall be provided in the local control panel.

Controls philosophy

CONTROLS

(a) Start/stop facility for each pump from LCP.

(b) Selector switch for main/standby selection.

(c) Auto/Manual selector switch for each pump.

AUTO START/STOP

a) One number level switch (high level) provided in the sump shall start one number sump pump in the event of high water level in the sump.

b) One number level switch (very high level) provided in the sump shall start second sump pump in the event of very high water level in the sump.

c) One number level switch (low level) provided in the sump shall stop the running pumps in the event of low water level in the sump.

d) If any of the working sump pumps trips the standby sump pump will come into operation automatically provided the very low level signal is not present.

Indications

a) Sump pumps status (ON/Off/Trip).

b) Level indications(Low,High,V.High)

General requirements for measuring instruments

Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experience manufacturers (from BHEL/customer approved vendor list) of specified type and range of equipment.. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/ numbers as approved by BHEL during detailed engineering.

1. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a ground terminal and shall be suitably connected to panel grounding bus.
2. The necessary root valves, impulse pipings and all the other accessories required for mounting/erection of local instruments shall be furnished even if not specifically asked for.
3. Instruments shall be terminated up to LCP with control cable (1.5sqmm). The LCP shall be fully wired. All the necessary cables, flexible conduits, junction boxes and accessories for the above purpose shall be included.

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QUALITY PLAN/CHECK LIST

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics

$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.

1 - BHEL 2 - Vendor 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant IS	Relevant IS	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	3 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
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REV. NO.	01 DATE: 22-02-2008
SHEET	4 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	5 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	6 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

At Random by BHEL, based on 100 % internal test reports by Mfr.

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MI - Minor characteristics

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V - Agency Verifying the Test.

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2 - Vendor
3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	7 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
13.	TYPE TEST	Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	BHEL approved spec., drg relevant IS-13947 Part-1, IS-2148.	Type Test Certificate	3	---	1	
14	ROUTINE TEST	IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant IS.	BHEL approved spec., drg., BOM & relevant IS.	Test Report	2	1	1	
15	FUCTIONAL TEST	1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		2. Instrument Calibratio	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1	
		3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant IS.	BHEL approved spec/drg & relevant IS.	Inspection Report	2	1	1	

LEGEND:
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MA - Major characteristics
MI - Minor characteristics

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2 - Vendor
3 - Sub-vendor

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST			P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. IBR certificate to be provided if called for in specn.
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR PRESSURE & DP GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR FLOAT OPERATED LEVEL SWITCH

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	MODEL NO/TAG NO						
	TYPE						
	END CONNECTION						
2	ON/OFF DIFFL			P	W	V	
3	REPEATABILITY			P	W	V	
4	IR TEST			P	W	V	
5	HV TEST			P	V	V	
6	PR. TEST ON CHAMBER	SEE NOTE-5		P	V	V	
7	MATL. TC FOR CHAMBER & FLOAT	FOR LOT	---	V	V	V	
8	CONTACT CONFIG. & RATING FOR MICROSWITCH	FOR LOT	---	V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST	---	V	V	V	
10	MANUFACTURER TO ENSURE WELDING PROCEDURE,WELDERS & NDT AS PER ASME FOR PR >40 KG/CM2		---	P	V	V	
11	CHECK FOR TEMP. SUITABILITY FOR MICROSWITCH AND LEAD WIRE	SEE NOTE-1 BELOW	---	V	V	V	
12	ACCESSORIES AS APPLICABLE		APPROVED SPEC./ DATA SHEETS	V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. When material corelation is not available, MFR's compliance to be provided
5. IBR certificates shall be provided wherever required.
6. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

1.0.0 ERECTION, FIELD TESTING AND COMMISSIONING

1.1.0 The Bidder shall select and adopt methods and procedures for equipment erection to suit the nature of equipment and erection, involved according to the best modern industrial practice and his own experience.

1.2.0 The Bidder shall arrange for the transportation and handling of cabinets and desks from stores to work site suitably without any damage. If any damage is observed before handling, this shall be brought to the notice of the OWNER

1.3.0 Before installation of cabinets and desks, the necessary openings and inserts required to be made on the floor by the Bidder shall be checked and then after proper alignment, the cabinets and desks shall be installed on the floor by the Bidder. All necessary civil work to be carried out for this shall be in Bidder's scope of supply. The cabinets and desks shall be cleaned by blowing air to remove dust or foreign particles.

1.4.0 Nameplates shall be installed for all the I&C equipments bearing the service description, instrument number and calibrated range.

1.5.0 The data base covering the instrument No. type, application, process parameters, range, set point, calibrated/feasible range & span, maximum admissible value, recommended periodicity of calibration, other information for all the instruments, final control elements etc., for the unit, BOP, etc., shall be given in soft form.

1.6.0 All cables shall be tested for insulation level. Cable ends shall be properly cleaned. The entry to and exit from pipes shall be smooth and free from burr where cables are run through pipes. Cable shall be pulled into the pipes in such a way that there shall be no damage to the cables. Flexible conduits shall be provided wherever necessary. Cable in hot areas shall have proper heat protection. A minimum distance of 300 mm shall be kept between instrument / signal cables and power cables. Each tray shall be filled with a maximum of two layers for instrument and control cables and one layer for power cables providing 20% spare space in the number of layers specified. Instrument Cable Trays, shall be erected vertically as far as possible to avoid dust accumulation. All the cables laid shall be tied individually to the Tray. Thermocouple cables shall be run completely independent of all other cables with minimum separation as per relevant standard and with cross over at right angles. The cabling accessories shall include terminal blocks, splicing materials, crimping tools, cable support grips, insulating tapes, GI flexible conduits, conduit fittings, GI perforated covered trays, supports, accessories, and cadmium plated trays & cable glands.

1.7.0 The Bidder shall get prior approval as per approved quality assurance plan of the Owner Representative before any installation work starts. If any work is carried out by the Bidder before prior approval from Owner Representative and modification is sought by Owner Representative later, then the work shall be redone by Bidder without any cost / material implications to the Owner Representative. Impulse / sample piping, air supply and pneumatic tubing, cable trays and equipment shall be supported rigid enough to prevent vibration and anchored sufficiently to prevent strains on equipment installed. Supporting clamps shall be provided at least at every one meter distance for better rigidity. Impulse / sampling piping shall be provided with adequate slope, (preferably 1:10). Hanger and supports shall be so installed as not to interfere with free expansion and contraction of the piping and tubing between anchors. Suitable vibration dampeners, etc., shall be provided wherever necessary. In addition, care shall be taken that the arrangement of impulse / sampling piping, air supply and pneumatic tubing from detrimental sagging, mechanical injury, abuse due to unusual

service conditions from sources other than those due to pressure, temperature and vibrations. All impulse lines of joints shall be welded type unless otherwise specified.

1.8.0 The Bidder shall set up his own instrument laboratory. The calibration equipment shall cover complete range and shall have the desired accuracy of less than 0.1% or better. The Bidder shall follow the standard procedures for calibration of various instruments and as set by the manufacturer of instruments and as instructed by the Owner including any requirements of field calibration. First, the calibrations shall be carried out independently by the Bidder and later in the presence of Owner who shall certify the same. Proper documentation in this regard shall be maintained and handed over to the Owner

1.9.0 All the instruments shall be calibrated for the entire range of the instrument for which it is designed. Calibration shall include test for repeatability. After first commissioning, the instruments shall be tested for calibration again to check whether the instrument maintains its zero and maximum of the range. All instruments and control equipment shall be calibrated to read correctly to the satisfaction of Owner. All switches shall be tested for the actuation of both normally open and normally closed contacts at the desired set points and also for the fixed / differential settings. All the float / displacer operated level switches shall be tested for the movement of the float and linkages to make to break the switch contacts by filling up with water before installation. For such tests, necessary testing set up required shall be arranged by the Bidder. Air leak tests shall be performed on all flue gas impulse / sample lines, air supply and pneumatic lines. Necessary equipment such as portable compressor, connecting pipes, materials, cables and test gauges shall be provided by the Bidder. All the welding shall be carried out as per the relevant codes with electrodes approved by the Engineer-in-Charge. Only qualified welders approved by the Engineer-in-charge shall carry out the welding. IBR grade of welder will be required wherever IBR grade welding is involved. After IBR welding, radiography as per the required standard to be done by qualified welder. All threaded joints shall be jointed using teflon tapes and no other pipe jointing compound shall be used except on higher temperature services where graphited sealing compounds shall be used. Brand of Teflon tape, insulation tape, graphite compound is to be approved by the engineer in charge. Tubing shall be bent with correct size tubing bender whenever possible to avoid the use of fittings. Tubing cutter shall always be used to cut tubing. The use of short length of tubing in long runs shall be avoided. All tubing shall be run in such a manner as to give the maximum protection against mechanical damage. Tubing runs shall be grouped together where possible. Tubing shall be arranged so that couplings can be tightened without disturbing lines. Pipes or tubes installed but not connected, shall have the ends closed in an approved fashion to prevent the entry of foreign material such as caps or plugs. All cables finally entering JBs / cabinets shall run through flexible PVC conduits for approximately 500mm. Field mounted instruments shall be mounted on brackets, subpanels, or placed on a suitable pedestal. They shall be easily accessible from grade, ladder or platform. All local indicators shall be readable from grade or operating level, and if used for manual control, shall be visible from the related valve. Wherever possible, local mounted instruments shall be mounted at approximately 1.35 meters (4' 6") above the platform or floor in an accessible position. When an instrument is located at a distance of 2.5 meters or more from its pressure connection, an additional block valve and a vent valve shall be provided adjacent to the instrument. Vent valves shall be arranged, if necessary, with drain lines to ensure that operation of these valves does not create a hazard. If the pressure piping is of such length that the isolating valve is inaccessible from the instrument location, a suitable valve shall also be fitted at the instrument itself. All pressure instruments shall be installed vertically. Those for steam must be tapped directly from above, for pressure transmitters and switches, there shall also be a condensing leg. The same applies to gas and vacuum measurements, but adequate provision should be made to ensure no condensation can take place along the line, i.e. the slope shall be adequate to drain any condensate back to the main lines (sloping upwards from the sensing point). Tapping points for liquids shall made at an angle of 45° from the bottom of the main pipe and these are to be sloped downwards from the sensing point. An exception is made in the case of the tapping point for fuel oil or corrosive fluid in which the pressure instrument shall not have direct contact with the process fluid. Glycerine or other suitable liquid shall be used as a medium to separate the fuel oil from the pressure instrument. When the pressure impulse line

is liquid filled, the measuring unit shall be compensated for static head. The head correction shall be stated on the unit.

1.10.0 Pipes shall be bent using pipe benders and any hot bending will be totally rejected. Pipe shall be cut, using pipe-cutting devices. Hot cutting will not be allowed.

1.11.0 Hydro test shall be performed for all other impulse lines / sampling lines / sensors. Necessary equipment such as hydro test pumps and temporary piping to the required point, fill pump etc., materials such as temporary gaskets, miscellaneous fasteners, etc. tools and tackles including test pressure gauges, etc. are to be provided by the Bidder. For all electrical actuators of the valves, functioning, setting and performance of limit switches / torque switches of various positions shall be checked before and after installation of the actuators. The position transmitters for inching applications shall also be calibrated. Pneumatic actuators shall be calibrated at site. PG test points shall be provided on the process line at various location by the Bidder.

1.12.0 Chipping of foundations, alignment, as required for instrumentation installations.

1.13.0 Fabrication and erection of stanchions/supports for all local instruments, junction boxes, etc. Fabrication and erection of suitable supports for surface mounted instruments.

1.14.0 Fabrication and erection of structural steel plates, angles, pipes, required for supporting ducts, trays, local instruments, etc., complete with bolts and nuts. (GI bolts and nuts shall be used wherever applicable or directed).

1.15.0 Painting of all stanchion/structures meant for instrumentation work (ducts, trays, pipe/ angle, supports, etc. as per specification). Colour and codes shall be strictly followed as per guidelines/ specifications as per direction of the Engineer-in-charge.

1.16.0 Earthing of the Instrumentation panels on the separate earthing pits (by others).

1.17.0 Double compression cable glands, cable lug, ferrules, cable identification tags, trefoil clamps for single core cables, cable dressing materials etc.

1.18.0 Cable sealing compound to prevent water entry wherever cables enters from outdoor to indoor areas.

1.19.0 Supporting structures for cable trays, cable racks, etc. using mild steel sections like channels, angles, flats, chequered plates etc. shall be in bidder's scope

1.20.0 Excavation & refilling of soil for buried cable trench / earthing with necessary materials.

1.21.0 GI Cable tray with all accessories and its MS supports.

1.22.0 Minor civil works like drilling, chipping and punching holes and openings in concrete floors, slabs, brick walls, fabrication of supporting structures, drainage of water from cable trenches and cleaning of all debris due to instrumentation installation.

1.23.0 Primary impulse tubing, laying of all types of cables, glanding and wiring and all kinds of pipe/tube fittings.

1.24.0 Fabrication and installation of primary tubing for pressure and differential pressure instruments complete with manifolds as per standards.

1.25.0 Erection & supply of the PVC instrument ducts(if required for the internal wiring of GCP cables), and perforated cable trays generally as per drawing including bends, tees, supports and opening wherever required, including provision of covers wherever required. No jumping of cables will be allowed.

1.26.0 Laying of multi-core / pair cables for all applications on perforated trays with proper tagging, dressing clamping, glanding and terminations (including proper termination of shields) at both the ends.

1.27.0 Laying of multi/single pair cables in trenches wherever required.

1.28.0 Interconnection wiring/tubing of various field mounted instruments, viz., transmitters, transducers, positioners etc.

1.29.0 Identification of each cable by proper tags at every 10 meters on the main tray as per cable schedule.

1.30.0 Fabrication of nipples from pipes and threading of the same wherever required.

1.31.0 Tapping/threading of coupling wherever required for special instruments.

1.32.0 Welding electrodes required for the complete of the job shall be in bidder's scope..

1.33.0 Completion/updating of Owner's drawings/documents as per the work done at site. This should be done before applying for completion certificate.

1.34.0 Pre-commissioning service and commissioning assistance during start-up of plant, wherever required.

1.35.0 Provision of copper wire, GI wires to panel earth bus, laying and grounding of the same to the system earth pits.

1.36.0 Fabrication and erection of canopy (single) for instruments, wherever required.

1.37.0 Minor modifications/repairs required to be done on the existing instruments namely, replacement of damaged signal tubes, tapping of damaged threads on couplings, tees and other fittings.

1.38.0 Identification of each cable by proper tag plate/ferrules at instrument ends, inside junction boxes and inside control room outside JB's by tagging the cables with SS tags as per the cable schedule.

1.39.0 Drilling holes on all Panels etc. for cables/ glands/ grommets, if required, after obtaining approval from the owner. Unused holes to be plugged after completion of job.

1.40.0 Grounding of shield for all shielded cables to respective instrument earth bus provided in the thermocouple head/junction boxes.

1.41.0 Sealing of switches with standard lead seals after final setting in the presence of Engineer-in-charge.

1.42.0 Painting of welded joints etc. as per the engineer in charge's instruction.

1.43.0 Excavating roads, laying cable road crossing sleeves and refilling and finishing wherever required.

2.0.0 LOOP TESTING

2.1.0 The action of the controller is set as prescribed. Controller settings for various modes of operation (Proportional band, reset and rate action) are at nominal value. For current signals, 4 – 20 mA shall be injected and checked the loop for 0%, 25%, 50%, 75% and 100% of full-scale inputs. For temperature loops with thermocouples, a known milli volt signal shall be injected and the output display shall be checked for input signals of 0%, 25%, 50%, 75% and 100%. For temperature loops with RTDs, a known resistance shall be injected in the control cable through decade resistance box and Output display shall be checked for 0%, 25%, 50%, 75% and 100%. For field mounted switches for alarms / interlocks, the action shall be simulated by disconnecting the wires / shorting the terminals and the function of the associated system shall be checked. Any equipment required by the Bidder for testing, calibration and commissioning shall be brought by the Bidder at site. The list of such equipment shall be furnished along with the offer

2.2.0 Prior to taking the instruments in service, all impulse lines, sampling lines and air supply lines shall be blown as required with the establishment of adequate line pressure and temperature conditions to keep the lines thoroughly clean. On-line i.e., without removing control valves from the pipe, calibration of the positioners and stroking of control valves / control dampers shall be carried out as required during control system tuning. Pre-commissioning checks, individuals loop checks, power initialisation, verification of system functioning, trouble shooting final solutions to application and / or instrument problems, etc., is Bidder's responsibility. All the required software and hardware changes shall be incorporated as required for successful commissioning to Owner satisfaction. Any other tests as may be directed by the Owner Representative. After delivery of the equipment, the Bidder shall locate all the equipment including electronic cards in its final position, check all the power wiring, grounding and interconnection cables, all in accordance with manufacturer's recommendations. The Bidder shall perform initialisation of system power, field loading of system configuration / software and data base, demonstration of system functionality to verify conformance with manufacturer's instructions and specifications, tuning of control loops, implementation of any configuration changes including hardware, software and additional tapping's / instruments, cabinets as required and providing general trouble shooting and final solutions to application and / or instrument problems.

2.3.0 The Bidder shall take care to complete all pre-commissioning activities and simulation tests after erection to suit the over all start up of respective plant equipment. The controllers shall be tuned as per the process requirement. The list of set points, alarms / Interlocks, settings for the controllers shall be furnished in the standard format and handed over to the Owner.. Control loops shall be put in auto mode as per the operational requirement of different phases. Processor, Bus Worst loading conditions calculation and other control system performance requirements shall be proved at the time of commissioning. Before taking over of the plant by the OWNER , all the system and auto control loops shall run satisfactorily for at least one month at varying loads without disturbing any adjustment. During this period, supervision and maintenance of the system shall be the scope and responsibility of the Bidder. The performance test shall be carried out for the system offered and certificates to these effects shall be approved by the OWNER .

3.0.0 INSPECTION, TESTING, GUARANTEE & SPECIAL TOOLS / TACKLES

3.1.0 After manufacturing all the I&C equipments / instruments shall be factory tested and calibrated. All the required test certificates, calibration certificates for the I & C equipments / instruments to be submitted to the Owner for approval before the dispatch of the same is allowed from the factory. As a minimum hydro-test, accuracy & repeatability test, over-range test, leak test, HV test, insulation test, functional tests, temperature rise test shall be conducted as applicable for the instruments and the control system. The electronic equipments shall be subjected to burn in test and tests as per IEC 68. The details of the test to be carried out for the I & C equipment shall be submitted for the Owner consent/approval

before proceeding with the test. Bidder shall submit a detailed quality assurance program for individual I & C equipments / instruments for Owners for approval.

3.2.0 Tests for DCS / SG control / STG control / PLC system will include the following:

3.2.1 Factory Acceptance Test (FAT):

To be carried out at BIDDER's / Sub-Vendor's works and witnessed by Owner/Engineer, successful completion of which will be the basis for 'Authorization for Shipment to Site'. FAT shall be a complete integrated test of the system and carried out at BIDDER's / Sub-Vendor's works on completion of manufacturing of the system. The test shall be performed with the completely assembled system and performing all the functions, it is expected to perform while in actual service. The BIDDER shall submit a detailed "Factory Acceptance Test Procedure" in line with the above specified guidelines for Owner approval. The FAT shall be conducted as an integrated test of plant I&C system integrating the control system supplied by Other Vendors.

FAT shall be preceded by a 'Pre- FAT Inspection/ Test' to be carried out by Bidder/Vendor. Pre-FAT inspection / test shall be carried out as per approved FAT procedure detailed above and shall submit 'Pre- FAT Inspection/ Test' report for Owners review and approval. Owner shall witness the actual FAT on the basis of successful completion of 'Pre- FAT Inspection/ Test'.

3.2.2 Site Test (SAT):

Involves tests for site commissioning, calibration of monitoring and control equipment, Integrated loop test wiring, Trial Operation of the system functioning. Site guarantee tests for system performance & availability to be conducted in the presence of Owner. The reliability run shall be conducted for one month period. During the reliability run if the I&C system fails to meet the specific requirements, then the Bidder shall take immediate remedial actions and the procedure shall be restarted again for the reliability run. After the competition of the reliability run with full satisfaction of the Owner, the system shall be deemed for take over and this shall mark the commencement of warranty period.

Special tools and equipment for the maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Bidders in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman.

The special tools and equipment for maintenance and repair shall be delivered by the bidder in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes

The I&C systems offered by the Bidder shall be provided with guarantee period which will start from the date of handing over to the owner and Bidder to indicate the same in his offer.

Latest version of hardware and software available at the time of system designing shall be provided. In case of future up-gradation of software, Bidder shall remain committed to upgrade the supplied system with the new version within the warranty period. Beyond the warranty period and during the remaining life of the plant, any up gradation in hardware and software shall be brought to the notice of Buyer. Bidder shall ensure that supplied controls & instruments should be supported by the supplier such that spare parts are guaranteed to be available for purchase for a period of 15 (Fifteen) years. Similarly the service shall also be guaranteed for a period of 15 (Fifteen) years.

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MANDATORY SPARES

2x660 MW UDANGUDI TPS STAGE-I - EPC		
MANDATORY SPARES FOR CONTROL & INSTRUMENTATION		
SI. NO.	**PARTICULARS**	**QUANTITY**
1	RTD's of each type and length(with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length, whichever is more
2	Thermocouples of each type like K-type, R-type, metal etc. (with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length which ever is more
3	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	10% or 2 no. of each make, model and type whichever is more and for each plant (to be divided to various ranges in proportion to main of all make, model, type population)
4	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	5% or 1 no. of each type and model whichever is more
5	**POWER SUPPLY SYSTEM – 24 VDC (To be provided for each system)**	
	Silicon controlled thyristors, diodes, power transistors	100%(1 Lot)
	Capacitors	1 set
	Filter regulators	20% of each model or 2 nos. whichever is more.
6	**INSTRUMENTATION CABLE, INTERNAL WIRING & ELECTRICAL FIELD**	
	Pre fabricated cable of each type.	10% of installed quantity
	Pre fabricated cable connector of each type	10% or 1 no. of each type and model, whichever is more.
	Other cables	5% of each type, pair and size of actual installed quantity
7	**Electrical actuator, complete assembly, of each rating**	**2 Nos.**
Note: Mandatory Spares mentioned here are inline with spares list received from PG vide email dated 23.03.2018. Quantity mentioned is considered for 2 Units		

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SUB VENDOR LIST

PACKAGE WISE REGISTERED SUPPLIER LIST AS ON 18/05/2018		
Package Name	**Supplier Name**	**Supplier Communication Address**
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	BOSE PANDA INSTRUMENTS PVT.LTD.	Mr. Partha Bose 44, Saheed Hemanta Kumar Bose, Sarani, Kolkata Phone- +91 33 2548 7220 Pincode : 700074 Email : parthabosebpi@gmail.com; bosepanda@vsnl.net
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com
PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
TEMPERATURE GAUGE	FORBES MARSHALL (HYD) LTD.	MR SAILESH PATALAY/MR. M K SRINIVASAN PLOT NO.A-19/2, & T-4/2, IDA, NACHARAM, HYDERABAD Phone- 9849913704 Pincode : 500 076 Email : mksrinivasan@forbesmarshall.com
TEMPERATURE GAUGE	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
TEMPERATURE GAUGE	H.GURU INSTRUMENTS (SOUTH INDIA) P. LTD	32,INDUSTRIAL SUBURB YESWANTHAPUR BANGALORE Phone- 080-23370300, Pincode : 560022 Email : info@hgurusouth.com
TEMPERATURE GAUGE	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
TEMPERATURE GAUGE	H.GURU INDUSTRIES	Mr. G. D. Hazra/Mr. P. K. Mitra 10 B, HO-CHI-MINH SARANI, KOLKATA Phone- 033 2282 2463 / 1637 Pincode : 700071 Email : mguru@vsnl.net
TEMPERATURE GAUGE	GOA THERMOSTATIC INSTRUMENTS PVT.LTD.	FLAT -B , GF, HILL CROWN APTS., COLLEGE ROAD, MAPUSA Phone- Pincode : 403525 Email : gtilworks@pyro-electric.in
TEMPERATURE GAUGE	A.N. INSTRUMENTS PVT. LTD.	MARKETING DIVISION, 5th FLOOR, 59-B, CHOWRINGHEE ROAD, KOLKATA Phone- 24757784,22472509 Pincode : 700020 Email : anidel@bol.net.in
TEMPERATURE GAUGE	PRECISION MASS PRODUCTS PVT. LTD.	Mr. Nishit Patel/Mr. Anuj Verma Plot No.2306, Phase II, GIDC Chhatral Kalol Phone- 9999464663 Pincode : 382729 Email : sales@precisionmass.com
TEMPERATURE GAUGE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
LEVEL GAUGE	TOSHNIWAL BROTHERS PVT.LTD.	WORKS:TOSHNIWAL IND.PVT.LTD, INDUSTRIAL ESTATE MAKHUPURA, AJMER Phone- 441171 Pincode : 305002 Email : toshniwalprocess@gmail.com
LEVEL GAUGE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com

Package Name	Supplier Name	Supplier Communication Address
LEVEL GAUGE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
TEMP. ELEMENT	PYRO ELECTRIC INSTRUMENTS GOA PVT.LTD.	M. D. BICHU/R. M. BICHU G.B, HILL CROWN APARTMENTS, COLLEGE ROAD, MAPUSA Phone- 9326114601 Pincode : 403507 Email : priyanka.marketing@pyro-electric.in
TEMP. ELEMENT	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
TEMP. ELEMENT	DETRIVE INSTRUMENTATION & ELECTRONICS LTD.	320, TV INDUSTIAL ESTATE, OFF.DR.A.BESANT ROAD, BEHIND GLAXO, WORLI, MUMBAI Phone- 24934125,24938403 Pincode : 400025 Email : trivtech@vsnl.com
TEMP. ELEMENT	Nesstech Instruments Private Limited	26/2, G Type, Global Industrial Park Near Nahuli Railway Crossing, Valvada Vapi Phone- 9920576002 Pincode : 396105 Email : sales@nesstech.co.in
TEMP. ELEMENT	Thermal Instrument India Pvt. Ltd.	Mr. Raghavendra M. Kulkarni 194/195, Gopi Tank Road Behind Citylight Cinema,Mahim Mumbai Phone- 09322664709 Pincode : 400016 Email : ramk@giconindia.com
TEMP. ELEMENT	GAUGE BOURDON INDIA PVT. LTD.	194/195, Gopi Tank Road, Off Pandurang Naik Marg, Mahim Mumbai, Phone- 011-41607463, Pincode : 400016, Email : gicdelhi@general-gauges.com,
TEMP. ELEMENT	GOA INSTRUMENTS INDUSTRIES PVT.LTD.,	D2/5, Mapusa Industrial Estate, Mapusa, Goa, Phone- 09326054551, Pincode : 403507, Email : sumukh@goainstruments.com,
TEMP. ELEMENT	TOSHNIWAL INDUSTRIES PVT. LTD.,	Industrial Estate, Makhupura, Ajmer, Phone- 9352009000, Pincode : 305002, Email : info@tipl.com,
TEMP. ELEMENT	Tempsens Instrument (I) Pvt Ltd	MR. V.P.RATHI/MR. HEMANT RATHI B-188A ROAD NO.5 , M.I.A UDAIPUR Phone- 09352420069 Pincode : 313003 Email : info@tempsens.com
TEMP. ELEMENT	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com
JUNCTION BOX	SUCHITRA INDUSTRIES	NO-2,OPP-27 AECS LAYOUT 2ND STG REJAMAHALVILAS EXTN 2ND STG BANGALORE Phone- Pincode : Email : suchitra.industriesblr@gmail.com
JUNCTION BOX	K.S.INSTRUMENTS PVT.LTD.	S Raghavan No. 72, 3rd Main, 1st Stage Industrial Suburb, Yeshwanthpur Bangalore Phone- 9880385770 Pincode : 560022 Email : sales1@ksinstruments.net
JUNCTION BOX	Shrenik & Company,	Mr. Mitesh Shah/Mr. Pulin Shah 39 A/3 ,Panchratna Industrial Estate, Sarkhej-Bavla Road Ahmedabad Phone- 9825024921 Pincode : 382213 Email : sales@pustron.com, pulin@sumip.com
JUNCTION BOX	FLEXPRO ELECTRICALS PVT. LTD.	Mr. Dineshbhai Zaveri C-1/ 27&37, GIDC, Kabilpore, Navsari Phone- 02637-265140,265003 Pincode : 396424 Email : flexpro@flexproltd.com
JUNCTION BOX	AJMERA INDUSTRIAL & ENGINEERING WORKS	JIGNESH MAHENDRA AJMERA DENA BANK BLDG.,SHREE NAGESH INDL. ESTATE,STATION ROAD, MUMBAI Phone- 022 67973578 Pincode : 400 088 Email : ajmera@ajmera.net, jmajmera@yahoo.com
INSTRUMENTS TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
INSTRUMENTS TUBE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
INSTRUMENTS TUBE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
INSTRUMENTS TUBE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
LEVEL SWITCH-CAPACITANCE TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
LEVEL SWITCH-CAPACITANCE TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
LEVEL SWITCH-CAPACITANCE TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com

Package Name	Supplier Name	Supplier Communication Address
LEVEL SWITCH-CAPACITANCE TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com
LEVEL SWITCH-CAPACITANCE TYPE	Flow Star Engineering Pvt. Ltd.,	MR. KHALID AKHTAR/MR. TAPAN KUMAR JANA Plot No-7 F/2, Northern India Industrial 20/3, Mathura Road FARIDABAD Phone- 9818176380 Pincode : 121005 Email : khalid@flowstar.co.in
LEVEL SWITCH-CAPACITANCE TYPE	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
LEVEL SWITCH-CAPACITANCE TYPE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
LEVEL SWITCH-CONDUTIVITY TYPE	Sapcon Instrument Pvt Ltd.	131, PALSHIKAR COLONY Contact Person- Mr. Ashwin (9826080207) INDORE Phone- +91-731-4085751, Pincode : 452004 Email : sales@sapconinstruments.com
LEVEL SWITCH-CONDUTIVITY TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com
LEVEL SWITCH-CONDUTIVITY TYPE	BLISS ANAND PVT. LTD.	Mr. Vikas Anand/ Mr.RGRajan 92B & 93 B , IMT MANESAR Gurgaon Phone- 0124-4366000 TO 9 Pincode : 122001 Email : sales@blissanand.com
LEVEL SWITCH-CONDUTIVITY TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
LEVEL SWITCH-CONDUTIVITY TYPE	HI-TECH SYSTEMS & SERVICES LTD.	Mr. Vikash Agrawal/Mr. Tarun Debnath 119, PARK STREET , KOLKATA Phone- 033-22290045 Pincode : 700016 Email : sandeep@hitech.in
LEVEL SWITCH-CONDUTIVITY TYPE	RAMAN INSTRUMENTS PVT.LTD.	Mr. N R Shenoy/Mr G B Vijh 8, First Floor.Plot : 160A Bait-Ush-Sharaf, 29th Road,Bandra(W) MUMBAI Phone- 09892331381 Pincode : 400050 Email : ramanbpl@vsnl.com
LEVEL SWITCH-CONDUTIVITY TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
LEVEL SWITCH-CONDUTIVITY TYPE	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
LEVEL SWITCH-FLOAT TYPE	Pune Techtrol Pvt. Ltd.	N.P.Khatan/Sudhakar Badiger S-18, MIDC Bhosari, Pune Phone- 9850560042 Pincode : 411 026 Email : ho@punetechtrol.com
LEVEL SWITCH-FLOAT TYPE	D.K. INSTRUMENTS PVT.LTD.	N.SIKDAR/ SUMIT SIKDAR 76/2,SELIMPUR RD DHAKURIA Kolkata Phone- 033-2415-1310. Pincode : 700031 Email : dkinst@vsnl.net
LEVEL SWITCH-FLOAT TYPE	V. AUTOMAT & INTRUMENTS (P) LTD.	Mr. R. K. BASSI/Mr. PRAVEEN KUMAR F-61, OKHLA INDL.AREA, PH-1 NEW DELHI Phone- 9810005826 Pincode : 110 020 Email : sales@vautomat.com
LEVEL SWITCH-FLOAT TYPE	SCIENTIFIC DEVICES (BOMBAY) PVT LTD,	Office no. 53, Shree Manoshi Complex, Plot No. 5 & 6, Sec-3, Ghansoli (East), Navi Mumbai, Phone- 9892230623, Pincode : 400 701, Email : sdbpl@vsnl.com
LEVEL SWITCH-FLOAT TYPE	LEVCON INSTRUMENTS PVT. LTD.	Mr Shayak Gupta/Badal Jana Rajkamal', 7th floor, 13, Camac Street KOLKATA Phone- 0 33 2283 2766 Pincode : 700017 Email : b_jana@levcongroup.com
LEVEL SWITCH-FLOAT TYPE	GENERAL INSTRUMENTS CONSORTIUM	Mr. Amarendra Kulkarni 194/195, Gopi Tank Road, Off. Pandurang Naik Marg, Mahim Mumbai Phone- 9323195251 Pincode : 400016 Email : amarendra@general-gauges.com
LEVEL SWITCH-FLOAT TYPE	Baumer Technologies India Pvt. Ltd.	Mr. Shyam Warilani/Mr. V Suresh Babu 36, DAMJI SHAMJI INDUSTRIAL COMPLEX, OFF.-MAHAKALI CAVES ROAD, ANDHERI(E) MUMBAI Phone- +91 99589 25151 Pincode : 400093 Email : sales.in@baumer.com
LEVEL SWITCH-FLOAT TYPE	SBEM PVT. LTD.	MR.N.K. BEDARKAR/MR. VISHWANATH KARANDIK 39, ELECTRONIC CO.OP. ESTATE, PUNE SATARA ROAD PUNE, Phone- 912041030100 Pincode : 411009 Email : newdelhi@sbem.co.in
LEVEL SWITCH-FLOAT TYPE	SIGMA INSTRUMENTS CO.	Gopal Kannan/R Gopinath 201, ANANDRAJ INDUSTRIAL ESTATE, OFF.LBS MARG, SONAPUR LANE, BHANDUP (W) MUMBAI Phone- +919821038162 Pincode : 400078 Email : sales@sigmainstruments.co.in
LEVEL SWITCH-FLOAT TYPE	SOR INC.	LARRY DEGARMO/Avdhesh Chandra, 14685 W. 105TH STREET LENEXA Phone- 09810905139, Pincode : 66215 Email : Ldegarmo@sorinc.com, avdhesh@sherman-india.com,
INSTRUMENTS PIPE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com

Package Name	Supplier Name	Supplier Communication Address
INSTRUMENTS PIPE FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
INSTRUMENTS PIPE FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
INSTRUMENTS PIPE FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
INSTRUMENT FITTINGS	AURA INCORPORATED	NIRAJ SHARAN/SUJIT KUMAR W-167A, GREATER KAILASH-II NEW DELHI Phone- 9810182430 Pincode : 110048 Email : niraj@aurainc.com
INSTRUMENT FITTINGS	Comfit & Valve Pvt. Ltd.	Mr. Jeetu Jain/Mr. Vinay Sosa Survey No. 23/1, Part 2, Ahmedabad-Mehsana Highway Laxmipura, Nandasan Phone- 02764-267036/37 Pincode : 382705 Email : marketing@com-fit.com
INSTRUMENT FITTINGS	HP VALVES & FITTINGS INDIA PVT. LTD.	S. Harichandran/P.S. Pandi B-11, Mugappair Industrial Estate, CHENNAI Phone- 044 26252537 Pincode : 600037 Email : sales@hpvalvesindia.com
INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	K. SITARAM/ K. SRINIVAS 7,SIDHAPURA INDUSTRIAL ESTATE S.V. ROAD,GOREGAON(W) MUMBAI Phone- 022 42631700 Pincode : 400 062 Email : peiks@vsnl.com
INSTRUMENT FITTINGS	Perfect Instrumentation Control (India) Pvt. Ltd.	MD Hussain Shaikh/Shahanawaz Khan Gala No. 168, Loheki Chwal,216/ 218, Maulana Azad Rd. Nagpada Junction Mumbai Phone- 91-9324383121 Pincode : 400008 Email : shahanawaz.khan@perfectinstrumentation.com
INSTRUMENT FITTINGS	Arya Crafts & Engineering Pvt. Ltd.	Mr.Sanjay Brahman/Mr.Shyam Vazirani 102, Vora Industrial Estate No.4 Navghar, Vasai Road (E) Dist.Thane, Mumbai Phone- +91-250-2392246 Pincode : 401210 Email : arya@aryaengg.com
INSTRUMENT FITTINGS	FLUIDFIT ENGINEERS PVT. LTD.	Mr. Abbas Bhola Potia Building No. 2, Office No. 3,292, Bellasis Road,Mumbai Central (East) Mumbai Phone- 9920044113 Pincode : 400008 Email : ab@fluidfitengg.com
INSTRUMENT FITTINGS	VIKAS INDUSTRIAL PRODUCTS	S.R.SINGH/NAVEEN SINGH B - 2, SECTOR - 6, NOIDA Phone- +91-9810122070 Pincode : 201301 Email : naveensingh@vsnl.com
INSTRUMENT FITTINGS	Fluid Controls Pvt. Ltd.	Sophie Y. Moochhala/Mayur Rajput J.V.PATEL, I.T.I CMPD, B.MADHUKAR MARG, ELPHINSTONE ROADSTN.(WR), MUMBAI Phone- (022) 43338000 Pincode : 400013 Email : sales@fluidcontrols.com
INSTRUMENT FITTINGS	PANAM ENGINEERS	Mr. Santosh Shukla 203, Jaisingh Business,Parsiwada, Sahar road,Andheri(East), Mumbai, Phone- 9892179529, Pincode : 400099, Email : santosh@panamengineers.com,

Notes:

i) The above sub-vendor list is tentative & reference only. However Sub-Vendor List is subject to BHEL/ end user approval without any commercial/ delivery implication.

ii) New Sub-Vendor if proposed by Vendor during contract stage shall subject to BHEL/ end user approval without any commercial/ delivery implication.

SUB-SECTION – ID

DATASHEET-A

1.0	**GENERAL INFORMATION**		
	No. of Cooling Towers required	:	Two (02) Nos.
	Location		Out door
	Duty		Continuous
	Type		NDCT with PVC Splash fills
	Finished ground level		EL (-) 0.50 M (RL+ 3.3 M)
	Basin Kerb level (Basin Sill Top level)		EL(+) 0.0 M (RL+ 3.8 M)
2.0	**DESIGN PERFORMANCE FOR EACH COOLING TOWER**		
2.1	Design Cooling water flow	:	85500 M^3/hr.
2.2	Design ambient wet bulb temp.	:	28.0 ^oC
2.3	Design inlet air wet bulb temperature.	:	28.0 ^oC
2.4	Approach w.r.t. design inlet air wet bulb temperature (viz. 28.0^oC)	:	5.0 ^oC
2.5	Cold water temperature	:	33.0 ^oC
2.6	Hot water inlet temperature	:	43.0 ^oC
2.7	Cooling Range	:	10 ^oC
2.8	Design ambient Relative Humidity	:	60%
2.9	Liquid Handled	:	Sea Water (refer details of cooling water analysis at Annexure-3)
	a) Total CW Pumping head permissible viz. static head plus frictional losses as below: • Static head w.r.t. FGL • Frictional losses within bidders T.P. with 10% margin • Velocity head	:	Not to exceed 16.0 MWC from FGL
2.10	Maximum permissible drift loss	:	Max. 0.005 %

2.11	Design pressure for hot water distribution system	:	5.7 kg/cm^2(g)
2.12	Maximum foundation Diameter (outermost edge of foundation)	:	NA
2.13	Minimum Basin Diameter	:	140 M
2.14	Maximum Cooling tower flow capacity to be considered for design of hot water distribution and cold water channel	:	Min 120% of design CW flow.
3.0	**SPECIAL FEATURES**		
3.1	Basin type		Sectionalized (two compartment) by partition wall. Each basin chamber shall have overflow arrangement and sludge pit end with necessary dewatering arrangement.
3.2	Whether fills are removable	:	Yes
3.3	Fills supporting by nailing acceptable	:	No
4.0	**Cold Water Basin Details**		
4.1	Finished ground level	:	EL (-) 0.50 M (RL+ 3.3 M)
4.2	Maximum water level	:	EL (-) 0.30 M (RL+ 3.5 M)
4.3	Min. Water level	:	EL (-) 1.15 M (RL+ 2.65 M)
4.4	Storage capacity between Normal and minimum water levels.	:	7 minutes (Normal Water Level shall be 200 mm below Maximum Water Level)
4.5	Invert level of CT Basin	:	EL (-) 1.45 M (RL+ 2.35 M) ---at basin centre
4.6	Invert level of CW Channel near CT level	:	EL (-)4.65 M (RL(-) 0.85 M)
4.7	a) Depth of Sludge pit b) Submersible type sludge pumps	: :	Suitable for complete dewatering. To include sludge pump submergence & clearance depth below basin/ channel invert level 1 working + 1 standby (Pump capacity: 450 CuM/Hr)
4.8	Number of sludge pits	:	Sludge pit with isolating valves, and spool pipe shall be provided for individual basin chambers for connection to drainage pipe.
4.9	Number of cold water outlet channels	:	One for each compartment of CW basin. Cold water outlet shall be designed for flow velocity through them within 1.2 M/sec during the rated flow from cooling tower, with the minimum water level in the cold water basin. At T.P Bidder to match same as per T.P. Drawing.

4.10	Depth of CW channel		3.5M from Min WL
4.11	Number of screens and gates in common outlet channel	:	One for each compartment of CW basin
4.12	Maximum allowable effective velocity through Cold water channel at Min. Water Level	:	1.2 M/Sec.
4.13	Maximum allowable effective velocity through gates at Min. Water Level	:	1.2 M/Sec.
4.14	Max. allowable effective velocity through screens at Min. Water Level	:	1.2 M/Sec.
4.15	Length of outlet channel including expansion joint in bidder's scope	:	As per terminal point details in Section IA and details as shown in the enclosed Annexure-2.
5.0	**COOLING TOWER ACCESS DETAILS**		
5.1	Required number of stair cases from ground level up to hot water inlet for convenient access to top & interiors of Cooling tower	:	Two (2) Nos.
5.2	Number of cage ladders from ground floor to cooling tower top.	:	Minimum Four (4) Nos.: Diametrically opposite, for the full height of Tower.
5.3	Internal walkway of platform with hand rails	:	Walkways and platforms shall be provided inside the tower at distribution pipe level. These walkways and platforms shall provide safe and clear access to all sprayers and all distribution pipes. Clear width of walkways shall be 1.5M.
5.4	External walkway platform	:	1.2 M width around the circumference at top and at each aviation lamp levels
5.5	Platform for access of BFV	:	To be Provided by Bidder RC platform of 1.5M clear width
6.0	**HOT WATER SUPPLY HEADER TERMINALS**	:	CW piping in BHEL scope 3832mm X 16mm thick with 250 MM RCC encasement shall be terminated with centre line of pipe elevation as shown in GA Drawing. Further Piping from T.P. with isolating Motorized B.F. Valves in each riser shall be in bidder's scope.
7.0	**SCOPE OF SUPPLY :**		
7.1	Cooling tower basin outlet channels/ sump and sludge pits	:	Yes
7.2	Hot water piping to distribution Duct	:	Yes

7.3	Hot water header isolation valves(motorised) on risers	:	Yes
7.4	Flanges/counter flanges for all flanged connections with bolts, nuts & gaskets etc.	:	Yes
7.5	Screen & guide for each cold water outlet sump/ channel	:	Yes
7.6	Stop Log gate with guides and sealing device for each cold water outlet sump/ channel.	:	Yes
7.7	Isolation valves in sludge pit	:	Yes– Sluice gate / butterfly valve with complete head stock arrangement is required
7.8	Drain Piping from sludge pit to terminal point	:	Yes
7.9	Chain Pulley Block/Electric Hoist for lifting each screen and stop log gate in cold water outlet sump/ channel	:	Yes
7.10	All necessary supports, hangers	:	Yes
7.11	Base plates, foundation plates, anchor bolts, sleeves, inserts, bolts, nuts for all equipment supplied	:	Yes
7.12	Drift Eliminator	:	Yes
7.13	**Electrical**		
	As per electrical plant specification	:	Yes
7.14	All related Civil works included	:	Yes
8.0	**MATERIAL OF CONSTRUCTION**		
8.1	Cold water basin, outlet channel/ sump & sludge pit.	:	R.C.C.
8.2	Shell/Casing & Superstructure	:	R.C.C
8.3	Basin partition wall	:	R.C.C
8.4	Internal walk way	:	R.C.C.
	External walkway platform		R.C.C
8.5	Staircase/Ladders	:	R.C.C./ HDG Steel
	Hand rail		Hot dip galvanized steel
8.6	Supporting structures	:	R.C.C.
	Hot water distribution basin	:	R.C.C

8.7	Hot water distribution nozzles	:	Polyethylene or approved equal
8.8	Fills	:	PVC Splash
8.9	Fill support col, beams & trusses	:	R.C.C
8.10	Louvers	:	R.C.C.
8.11	Drift eliminators	:	PVC UV Stabilised
8.12	Fasteners/wetted parts	:	Duplex SS (For Wetted parts) SS 316L (For others)
8.13	Piping	:	**Above 300 Nb** : Carbon steel plates to IS 2062 internally lined with CorroCoat or Glass Flake Coating of 1500 Microns DFT, rolled and welded as per IS 3589 **Below and 300 Nb** : Duplex SS
8.14	Hot Water Distribution Pipes (Inside CT)	:	GRP
8.15	Hot water line valves		
	a) BF Valves	:	Body: CI IS 210 Gr 260 / IS 2062 with Rubber/Ebonite Lining Disc & Shaft: Duplex SS Seal : EPDM Internal Hardware : Duplex SS Test pressure & duration shall comply with AWWA C504
	b) Sludge pit isolation valves		
	Body	:	Duplex SS
	Spindle & Trim	:	Duplex SS
8.16	Sludge outlet pipe	:	Duplex SS
8.17	Submersible Pumps	:	Casing: Duplex SS Impeller: Duplex SS
8.18	Sluice gates with rubber seals in cold water outlet	:	SS 316L
8.19	Guide for stop log gates	:	SS 316L
8.20	Screen	:	SS 316L
8.21	Guide for Screen	:	SS 316L
8.22	Bolts, buts & other hardware	:	Duplex SS (For Wetted parts) SS 316L (For others)

Note:

(a) Carbon /Mild steel parts or structures used in Cooling Tower or its vicinity shall be Heavily Galvanised.

(b) Material of construction for items not specified shall be subject to purchaser's approval during detailed engineering stage, in the event of order.

9.0	Pipe work Painting / Protection of Pipes:

9.1	Internal surface		**Surface preparation :** Sand blast to SA 2.5 **Primer -** Application of two (2) coats (DFT of each shall be min 35 microns) of Epoxy primer. **Finish –** Two (2) coats (DFT of each shall be min 35 microns) of high build epoxy paint. Total DFT of min. 275 microns.
9.2	External surface – over ground piping	:	**Surface preparation :** Sand blast to SA 2.5 **Primer -** Application of two (2) coats (DFT of each shall be min 35 microns) of Epoxy primer. **Finish –** Two (2) coats (DFT of each shall be min 35 microns) of high build epoxy paint. Total DFT of min. 275 microns.
9.3	External surface – Buried piping	:	CW buried Piping shall be encased in 250 mm thick RCC. For other Non-encased Buried pipe: External Corrosion Protection Tape of Coal Tar based material confirming to AWWA C203.
	INSPECTION AND TESTING		
10.0	Quality Surveillance by	:	Manufacturer, purchaser and customer
10.1	Material testing and identification	:	Required
10.2	Stage inspection to be witnessed by Purchaser and customer	:	Yes
10.3	Hydrostatic test for piping & valves required	:	Yes
10.4	Hydrostatic test to be witnessed by Purchaser and customer	:	Yes
10.5	Field performance test of individual items and the cooling tower as a whole required	:	Yes
10.6	Field performance test to be done by	:	By Bidder
10.7	All tests on the Butterfly valves at manufacturer's works to be witnessed by Purchaser	:	Yes
10.8	All testing instruments by supplier	:	Yes
10.9	Commissioning at site by	:	Bidder
10.10	Mandatory spares	:	Refer Annexure-5

Attachments:

a) Thermal & Hydraulic Design Calculations of Natural Draught Cooling Tower (Annexure-1)

b) General Arrangement Drawing of Natural Draught Cooling Towers (Sheets 1 to 3) (Annexure-2)

c) Civil Design Basis Report for NDCTs (Annexure - 3)

d) Cooling Water Analysis (Annexure - 4)

e) Mandatory Spares (Annexure - 5)

ANNEXURE I

बी एच ई एल BHEL	PROJECT TITLE: 2x660 MW UDANGUDI THERMAL POWER PROJECT				Doc. No.	PE-DC-435-165-N001	
	PACKAGE: NATURAL DRAUGHT COOLING TOWERS				Rev. No.	1	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date	24.12.2018	
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.	1 of 5	
1	**General**						
1.1	**Design Duty Parameters**						
	Circulating Water Flow	85500	m^3/hr				
	HWT	43	^oC				
	CWT	33	^oC				
	Design WBT	28	^oC				
	Relative Humidity	60	%				
	Range	10	^oC				
	Approach	5	^oC				
	Basin Kerb above Max. WL	500	mm				
	Site Elevation above MSL for thermal design	0	m				
	Ambient Pressure	101325	N/m^2				
	Salinity	46150	ppm				
1.2	**Tower Sizing Data**						
	Type of Fill	**PVC SPLASH BAR**					
	Fill Height (total hanging height)	5.2	m				
	Fill Height above Air Inlet	4.8					
	Top of Air Inlet above basin kerb	8.7	m				
	Bottom of Fill above Sill level	8.7	m				
	Top of Fill above Sill	13.5	m				
	Bottom of distribution Pipe (BOP) above Fill	0.7	m				
	Static Head up to BOP w.r.t Sill	14.2	mWC				
	Center line Dia.of tower at basin Sill level	132.11	m				
	Internal Diameter of tower at basin sill level	131.11	m				
	Internal Diameter at top of Fill level	123.01	m				
	Gross Fill Area	11884.221	m^2 **==========>>**	**A**			
	Length of each HW Duct	110.1	m approx.				
	Outer Width of each HW Duct	3	m approx.				
	Area of HW Ducts	660.7791626	m^2 **==========>>**	**B**			
	Column Obstructions	146.75	m^2 **==========>>**	**C**			
	Net Fill Area Available	11076.692	m^2 **==========>>**	**(A-B-C)**			
	Effective Fill Area considered in design	10630.250	m^2				
	Water Loading Rate	8.043	$m^3/hr/m^2$				
	Liquid to Gas Ratio	1.944					

1.2.1	**Basin Sizing Calculations**						
	Max. Water Level	RL 3.50	m				
	Normal Water Level	RL 3.30	m				
	Min. Water Level	RL 2.65	m				
	Difference between Normal & Min. Water Levels	0.65	m ==========>>	**d**			
	Storage Capacity required between Max. & Min. Water Levels	7 minutes hold up					
	7 minutes' hold up water volume (= 85,500 m3/hr/60*7)	9975	m3 ==========>>	**V**			
	Basin Area required for 7 minutes' hold up capacity between NWL & Min.WL	15346.15	m2 ==========>>	**(V/d)**			
	Basin Diameter Required	**139.783**	**m**	**(SQRT((V/d)*4/PI)**			
		say 140	**m**				
2	**Thermal Calculations**						
	Inlet air properties						
	Design WBT	28	^{o}C				
	Relative Humidity	60	%				
	DBT	34.74	^{o}C				
	Abs. Humidity	0.021	kg/kg				
	Dry Air Density	1.1042	kg/m^{3}				
	Air-Vapour mixture Density	1.1322	kg/m^{3}				
	Enthalpy	21.258	kCal/kg				
2.1	**KaV/L Calculations**						
	KaV/L as per Tchebycheff Method	2.02	Calculations enclosed				
	KaV/L provided	2.02					
2.1.1	**Exit Air Properties**						
	WBT	41.09	^{o}C				
	Relative Humidity	100	%				
	DBT	41.09	^{o}C				
	Abs. Humidity	0.0515	kg/kg				
	Dry Air Density	1.0366	kg/m^{3}				
	Air-Vapour mixture Density	1.0895	kg/m^{3}				
	Enthalpy	41.708	kCal/kg				
	Enthalpy Gain	20.45	kCal/kg				
	Density Difference ($\Delta\rho$)	0.0427	kg/m^{3}				
	Average of Air-Vapour mixture Densities	1.11085	kg/m^{3}				
	Dry Air Flow through the tower	12315.69	kg/s				

2.2	**Draught Calculations**						
	Draught Losses						
	Air Inlet + Rain Zone + Others	2.5249	mmWC				
	Fill	2.5410	mmWC				
	Distribution + D/E	0.4400	mmWC				
	Throat+Other Phenomenon	0.4185	mmWC				
	Other Effects	0.6100	mmWC				
	Total of draught losses	6.5344	mmWC				
	Draught Height Required (∆pd/∆ ĵ)	153.030	m				
	Tower Height Required (Draught Height + 0.5*Fill Height + Air Inlet)	**164.13**	**m**				
	Tower Height Provided	**165.14**	**m**				
2.3	**Check for Heat Balance (as per BS:4485 for Effects due to Salinity)**						
	Dry Air Flow, G	44336484	kg/hr				
	Evaporation Loss	1352262.762	kg/hr				
	Specific Heat of Water	1	kCal/kg/^{o}C				
	Heat Lost by circulating Water	855000000	kCal/hr				
	Heat of Evaporated Water	44624671.15	kCal/hr				
	Total Heat Lost by Water	**899624671**	kCal/hr				
	Heat Gain by Air	20.450	kCal/kg				
	Total Heat Gain by Air	**906681098**	kCal/hr				
3	**Draught Loss Calculations**						
3.1	**Loss through Inlet + Rain Zone + Other Phenomena below Fill**						
	G	kg/s	12315.69				
	Abs. Humidity at Inlet	kg/kg	0.021				
	Air-Vapour mixture Density at Inlet	kg/m^3	1.1322				
	Inside Base Diameter	m	131.11				
	Air Inlet Height	m	8.7				
	Shell Angle (average)	deg.	16.7				
	Air Inlet Area	m^2	3512.140				
	Air Flow Rate through inlet	m^3/s	11106.0939				
	Air Velocity through inlet	m/s	3.1622				
	Effective rain area	m^2	11076.6918				
	Air Velocity through Rain Zone	m/s	1.0027				
	Draught Loss through Inlet + Rain Zone + Other Phenomena below Fill	**mmWC**	**2.5249**				

3.2	**Loss through Fill**						
	Gross Fill Height	m	5.2				
	Average Abs. Humidity	kg/kg	0.03625				
	Average Air-Vapour mixture Density through Fill	kg/m^3	1.11085				
	G	kg/s	12315.69				
	Air Flow Rate through Fill	m^3/s	11488.620				
	Effective Fill Area	m^2	10630.250				
	Average Air Velocity through Fill	m/s	1.081				
	Draught Loss through Fill	**mmWC**	**2.5410**				
3.3	**Loss through Distribution System + Drift Eliminator Packing (DDE)**						
	G	kg/s	12315.69				
	Abs. Humidity at Exit	kg/kg	0.0515				
	Air-Vapour mixture density at exit	kg/m^3	1.0895				
	Diameter at Distribution	m	122.590				
	Gross Area at Distribution	m^2	11803.202				
	Net Area at Distribution	m^2	7959.07				
	Effective Area considered in design	m^2	7959.07				
	Air flow rate through DDE	m^3/s	11886.13863				
	Air Velocity through DDE	m/s	1.4934				
	Draught Loss through DDE	mmWC	**0.4400**				
3.4	**Loss through Throat/Neck + Expansion Loss**						
	G	kg/s	12315.69				
	Abs. Humidity at Exit	kg/kg	0.0515				
	Air mixture/vapour density	kg/m^3	1.0895				
	Throat Diameter	m	77.07				
	Throat Area	m^2	4665.096				
	Air flow through throat	m^3/s	11886.13863				
	Air velocity through Throat/Neck	m/s	2.548				
	Draught Loss across Throat + Expansion	**mmWC**	**0.4185**				

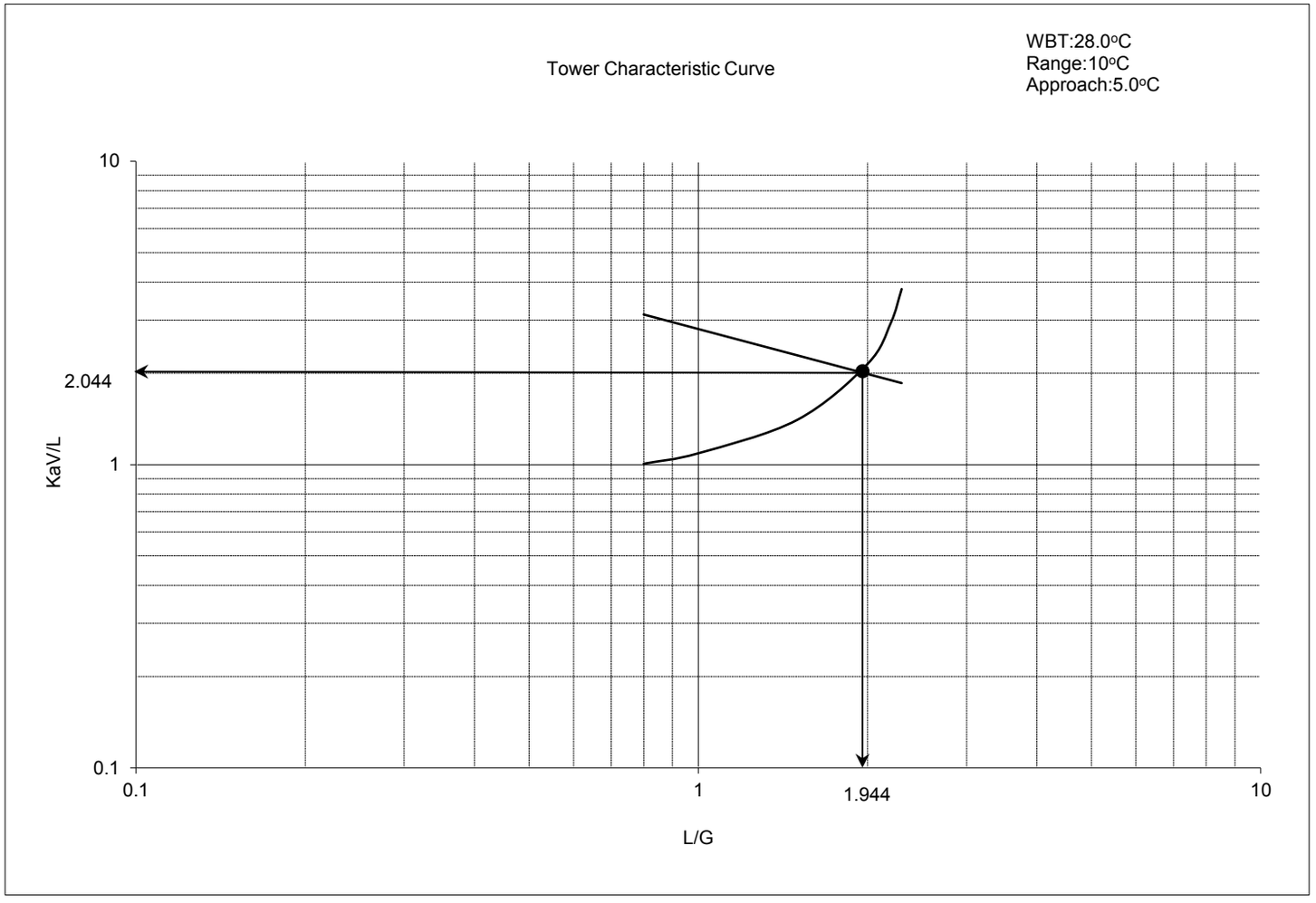
	PROJECT TITLE: 2x660 MW UDANGUDI THERMAL POWER PROJECT				Doc. No.	PE-DC-435-165-N001	
	PACKAGE: NATURAL DRAUGHT COOLING TOWERS				Rev. No.	1	
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date	24.12.2018	
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.	5 of 5	
4	**KaV/L Calculations (Chebyshev / Tchebycheff Method)**						
	L/G	1.944					
	Range	10	^{o}C				
	WBT	28	^{o}C				
	h1	21.339	kCal/kg				
	h2 = h1+L/G*Range*Cp	40.779	kCal/kg				
T ^{o}C		T ^{o}K	hw, kCal/kg	ha, kCal/kg		hw-ha	1/(hw-ha)
33	T2	306.15		h1	21.339		
34	T2+0.1*Range	307.15	29.15309595	h1+0.1*L/G*Range*Cp	23.282613	5.87048288	0.1703437
37	T2+0.4*Range	310.15	33.94671623	h1+0.4*L/G*Range*Cp	29.114613	4.83210316	0.2069492
39	T1-0.4*Range	312.15	37.5412646	h2-0.4*L/G*Range*Cp	33.002613	4.53865153	0.2203298
42	T-0.1*Range	315.15	43.62609316	h2-0.1*L/G*Range*Cp	38.834613	4.79148009	0.2087038
43	T1	316.15		h2	40.779		
	KaV/L = Range/4*Σ1/(hw-ha)*Cp					Σ1/(Ew-Ea)	0.8063265
	KaV/L Required =	2.02					
	KaV/L Provided =	2.02					
5	**Duty Coefficient (D_t)**						
	D_t=	A√H/(C√C)					
	where	A =	13500.86256	m^2 (area at sill)			
			145247.6798	ft^2			
		H =	165.14	m (tower height above sill)			
			541.6592	ft			
		C =	3.4912845	Performance co-efficient from S.No.6 below			
	Therefore, Dt=	518196					
6	**Performance Coefficient (C)**						
	C=	(1/(KaV/L) + L/(2G))*G/L*$N^{1/3}$					
	We have	KaV/L =	2.02				
		L/G =	1.944				
		N =	Pd * 2g/(ρ*V^2)	No. of velocity heads			
	where	Pd =	6.5344	mmWC (tower pressure drop)			
		ρ =	1.11085	air-vapour density in fill section			
		v =	1.081	afflux air velocity in fill section			
	Therefore, N=	98.81					
	Hence, C=	3.49					
7	**Draught Factor (F)**						
	F=	Δρ/(1.64*10^-8*Δh)					
	We have	Δρ =	0.0427	kg/m^3 (difference in air-vapour mixture density at inlet and			
			0.00266875	lb/ft^3			
		Δh =	20.45	kcal/kg (difference in enthalpy at inlet and outlet)			
			36.81	BTU/lb			
	Therefore, F=	4421					

	PROJECT TITLE: 2x660 MW UDANGUDI THERMAL POWER PROJECT				Doc. No.		PE-DC-435-165-N001
	PACKAGE: NATURAL DRAUGHT COOLING TOWERS				Rev. No.		1
	DOCUMENT TITLE: THERMAL & HYDRAULIC CALCULATIONS				Date		24.12.2018
	DOCUMENT TYPE: DESIGN DOCUMENT				Page No.		1 of 3
1	**Pumping Head Calculations**						
			Header Pipe	**Riser Pipe**			
	Inlet Pipe Diameter	m	3.8	2.8			
	Flow per inlet pipe	m^3/hr	85500	42750			
		m^2	11.341	6.158			
	Velocity of Flow	m/s	2.094	1.929			
1.1	**Friction Loss Through Pipes [as per Hazen-Willam Method]**						
	D[m]	V[m/s]	C (for new pipe)	*S*	*L[m]*		P_d[m]
	3.8	2.094	120	0.000795822	5		0.0039791
	2.8	1.929	120	0.000975637	70		0.0682946
	Total Friction Loss Through Staright Pipes						**0.0722737**
1.2	**Head Loss Through Fittings**						
1.2.1	**Welded Elbows [theeta=90, K=20f or 10f for 45deg]**						
	Flow [m3/s]	Dia. [m]	Vel [m/s]	Vh [mmWC]	f	K	Pd
	85500	3.8	2.094	0.22351881	0.0094	0.09430523	0.021079
	42750	2.8	1.929	0.18956421	0.0099	0.19871597	0.0376694
	42750	2.8	1.929	0.18956421	0.0099	0.19871597	0.0376694
							0.0964179
1.2.2	**TEE [K=60f]**						
	42750	2.8	1.929	0.18956421	0.0099	0.59614792	**0.1130083**
1.3	**Butterfly Vlaves [20f)**						
	42750	2.8	1.929	0.18956421	0.0099	0.19871597	**0.0376694**
		Exit Dia.	Vel [m/s]	Vh [mmWC}			
1.4	**Expansion Loss**	3.8	1.047	0.047041586			**0.0470416**

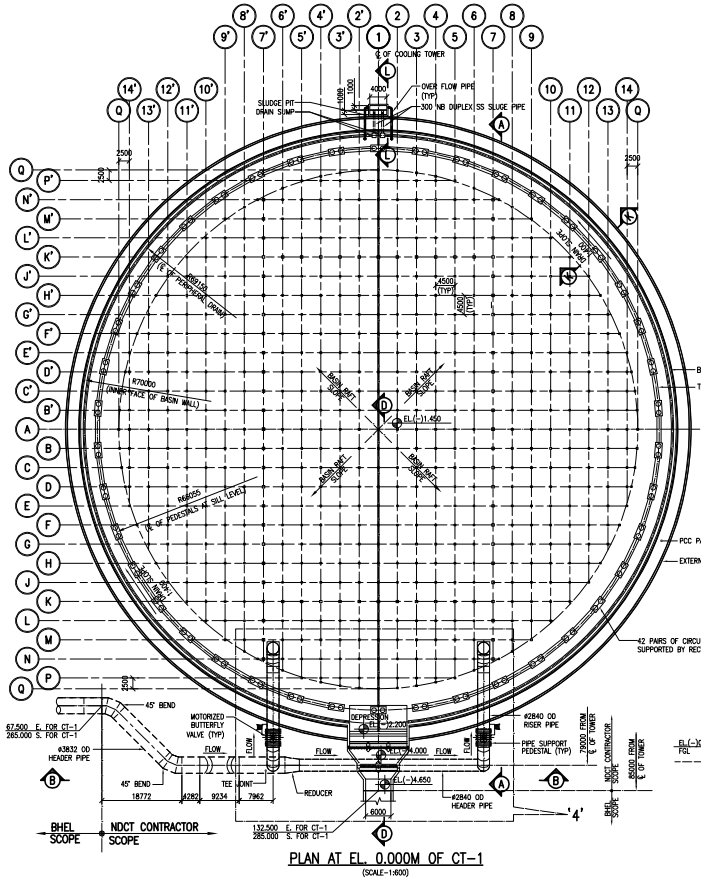
1.5	**Discharge Loss**						
	Discharge Velocity	m/s	1.047				
	Discharge Loss	mWC	**0.0559**				
1.6	**Friction Loss through RCC Duct**						
	Water Flow per duct (F)	m^3/hr	42750				
	Duct Depth	m	3.4				
	Duct Width	m	2.4				
	Duct Wetted Area (WA)	m^2	8.16				
	Duct Perimeter (P)	m	11.6				
	Hydraulic Radius (R = WA/P)		0.703				
	Flow Velocity through Duct (V = F/WA)	m/s	1.455				
	Slope S = (n * V / $R^{2/3}$)^2, n = 0.015	per m	0.000761658				
	Duct Length	m	111.1				
	Friction Loss through RCC Duct	mWC	**0.084643**				
1.7	**Head Loss due to sudden turns and contraction**						
	Turning into Sec. RCC Channel from Main. RCC Channel	mWC	**0.0324**				
	Sudden Contraction (Duct to Pipe)	mWC	**0.0389**				
1.8	**Friction loss through PVC distribution piping (longest pipe considered)**	mWC	**0.0695**				

1.9	**Sum of Friction + Head Losses from S.No. 1.1 to 1.8**	mWC	**0.6476**	**==========> SFH**			
		mWC					
2	**Spray Nozzle Head**	mWC	**0.6**	**==========> SNH**			
3	**Sum of SFH + SNH**	mWC	**1.2476**				
4	**Static Head**						
	Sill Level above FGL	0.5	m				
	Air Inlet Height above Sill	8.7	m				
	Fill Height above Air Inlet	4.8	m				
	Top of Fill to bottom of distribution Pipe	0.7	m				
	Total Static Head above FGL	**14.7**	m				
5	**Total Head Utilized**						
	Friction/Head Losses + Static Head	**15.948**	mWC				
	Total Head Utilized is	≈	Total Head Available				

बी एच ई एल BHEL	**PROJECT TITLE: 2x660 MW UDANGUDI THERMAL POWER PROJECT**	Doc. No.	PE-DC-435-165-N001
	PACKAGE: NATURAL DRAUGHT COOLING TOWERS	Rev. No.	1
	TOWER CHARACTERISTIC CURVE	Date	24.12.2018
	DOCUMENT TYPE: DESIGN DOCUMENT	Page No.	1 of 1



ANNEXURE 2



PLAN AT EL. 0.000M OF CT-1
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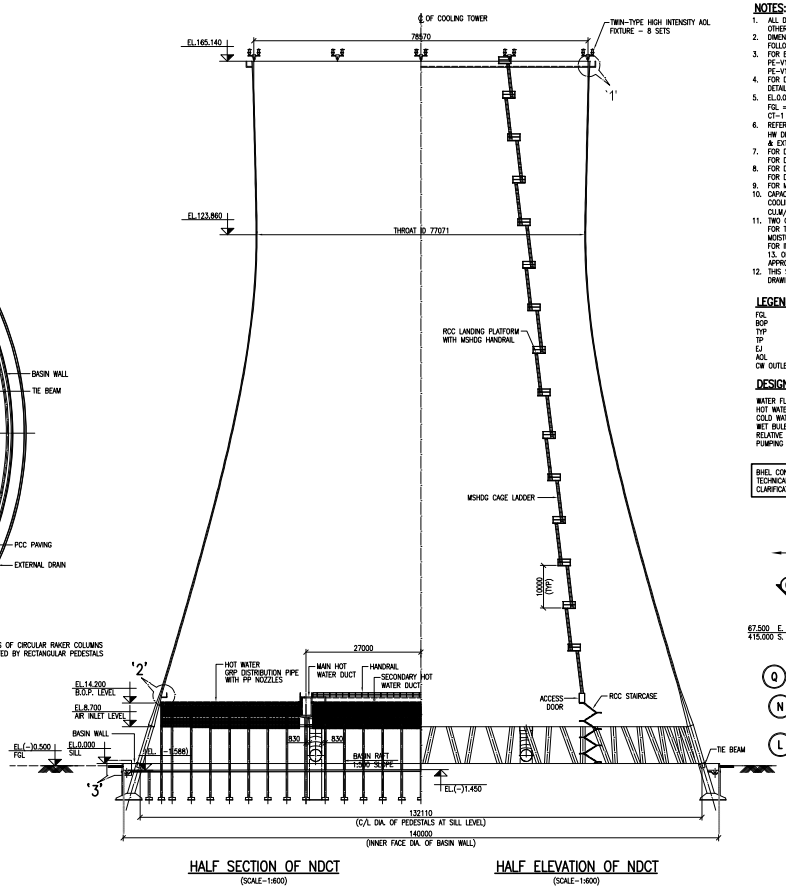


HALF SECTION OF NDCT
(SCALE-1:600)

HALF ELEVATION OF NDCT
(SCALE-1:600)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS ARE NOT TO BE SCALED. ONLY WRITTEN DIMENSIONS ARE TO BE FOLLOWED.
3. FOR EARTHING & LIGHTNING PROTECTION DETAILS REFER DRAWING NO. PE-V1-435-165-N055 AND FOR AOLs SYSTEM DETAILS REFER DRAWING NO. PE-V1-435-165-N065
4. FOR DETAILS OF STAIRCASE REFER DRAWING NO. PE-V1-435-165-N023 & FOR DETAILS OF CAGE LADDER REFER DRAWING NO. PE-V1-435-165-N045A
5. EL.0.00 CORRESPONDS TO RL.3.800 (FINISHED FLOOR LEVEL OF TG BUILDING) FGL = EL(-)0.500 CORRESPONDS TO RL.3.300 IN THE COOLING TOWER AREA FOR CT-1 & CT-2
6. REFER DRAWING NO. PE-V1-435-165-N059 (GENERAL ARRANGEMENT OF EXTERNAL HW DISTRIBUTION SYSTEM) FOR DETAILS OF PAINTING FOR PROTECTION OF INTERNAL & EXTERNAL SURFACES OF PIPING.
7. FOR DETAILS OF NDCT FOUNDATION REFER DRAWING NO. PE-V1-435-165-N034 & FOR DETAILS OF INNER COLUMNS REFER DRAWING NO. PE-V1-435-165-N036
8. FOR DETAILS OF BASIN SLAB REFER DRAWING NO. PE-V1-435-165-N044 & FOR DETAILS OF CW OUTLET REFER DRAWING NO. PE-V1-435-165-N016
9. FOR MASTER DRAWING LIST REFER DOCUMENT NO. PE-V1-435-165-N002
10. CAPACITY OF SLUDGE PUMP WOULD BE SUITABLE TO DEWATER ONE HALF OF COOLING TOWER BASIN FROM MINIMUM WATER LEVEL IN 12 HOURS i.e. 450 CUM/HR CAPACITY EACH.
11. TWO COATS OF ALIPHATIC ACRYLIC PROTECTIVE COATING SYSTEM SHALL BE PROVIDED FOR THE EXTERNAL SURFACE OF COOLING TOWER SHELL. HIGH PERFORMANCE MOISTURE COMPATIBLE CORROSION RESISTANT COATING SYSTEM SHALL BE USED FOR INNER SURFACE OF SHELL AND ALL OTHER ELEMENTS MENTIONED IN SECTION 13. OF DOCUMENT PE-V1-435-165-N002. THE COATING SYSTEM SHALL BE APPROVED BY CERI, KARAIKUDI.
12. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH SHEETS 2 & 3 OF THIS DRAWING.

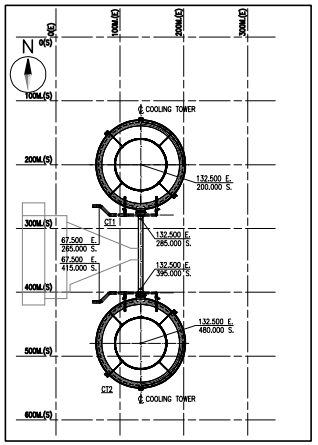
LEGENDS

FGL	–	FINISH GROUND LEVEL
BOP	–	BOTTOM OF PIPE
TYP	–	TYPICAL
TP	–	TERMINAL POINT
EJ	–	EXPANSION JOINT
AOL	–	AVIATION OBSTRUCTION LIGHT
CW OUTLET	–	COLD WATER OUTLET

DESIGN DUTY PARAMETERS

WATER FLOW	: 85500 M^3/HR
HOT WATER TEMPERATURE	: 43°C
COLD WATER TEMPERATURE	: 33°C
WET BULB TEMP	: 28°C
RELATIVE HUMIDITY	: 60%
PUMPING HEAD	: 15.5 MWC w.r.t BASIN SILL

BHEL CONFIRMED TO COMPLY WITH THE REQUIREMENTS OF TECHNICAL SPECIFICATION, POST-BID AND PRE-BID CLARIFICATIONS AS PER THEIR KNOWLEDGE AND UNDERSTANDING.



KEY PLAN
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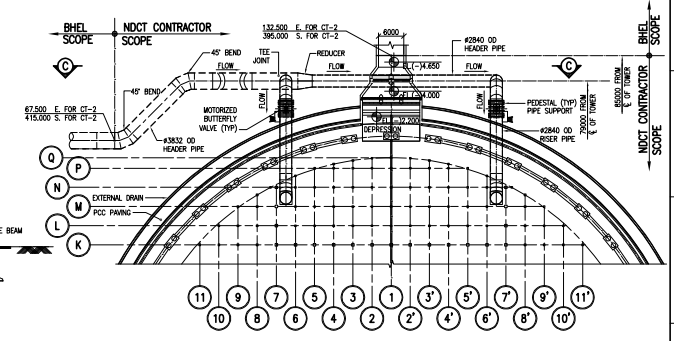

PLAN AT EL. 0.000M OF CT-2
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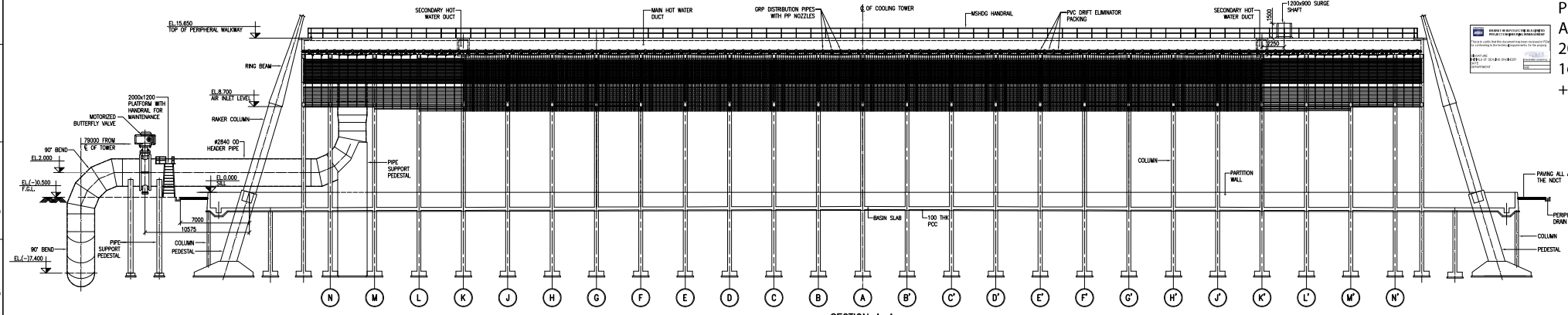

SECTION A-A
(SCALE-1:200)

Prashant Agarwal 2019.07.09 16:06:40 +05'30'

REV. NO.	DATE	DESCRIPTION	DRAWN
4	09/07/19	BASED ON CUSTOMER COMMENTS TRANSMITTAL NO: TCE.1-1403A-ME-V-DT-069	SVG
3	29/05/19	BASED ON CUSTOMER COMMENTS TRANSMITTAL NO: TCE.1-1403A-ME-V-DT-068	MMD
2	——	——	——
1	——	——	——
0	20/11/18	FOR APPROVAL	ARK

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED BENGALURU INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd

PROJECT: 2x660 MW UDANGUDI SUPERCRITICAL THERMAL POWER STATION, STAGE-I

DRAWN BY :	SVG
CHECKED BY	UNB
APPROVED BY	UKR
DATE	09/07/2019
SCALE	AS SHOWN

TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER

STCPL DRG.NO.: 787-E-DD-101 REV.NO.

BHEL DRG.NO.: PE-V1-435-165-N001 (SHEET 1 OF 3) 4

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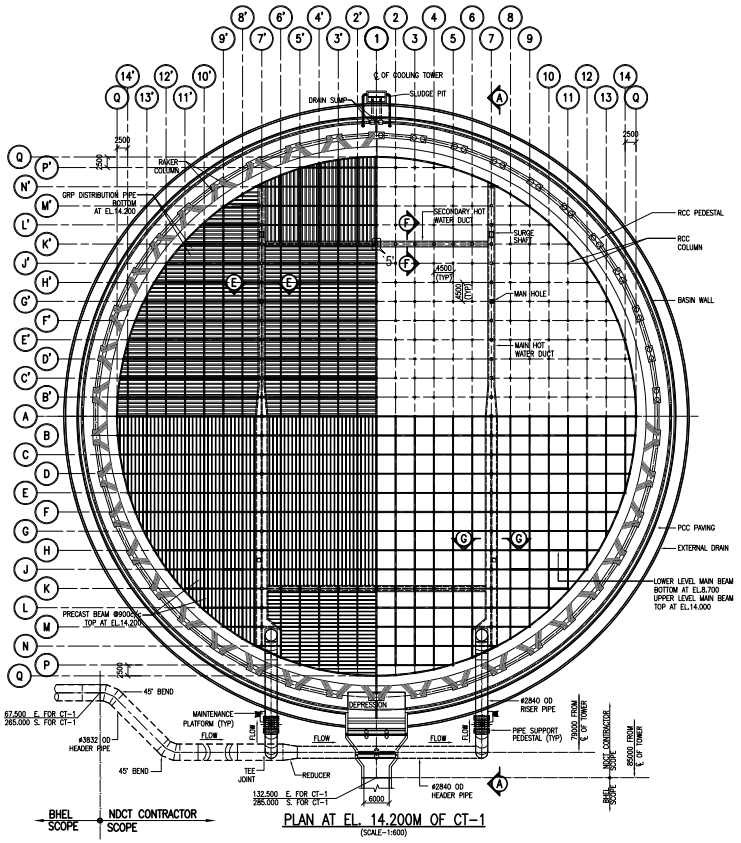
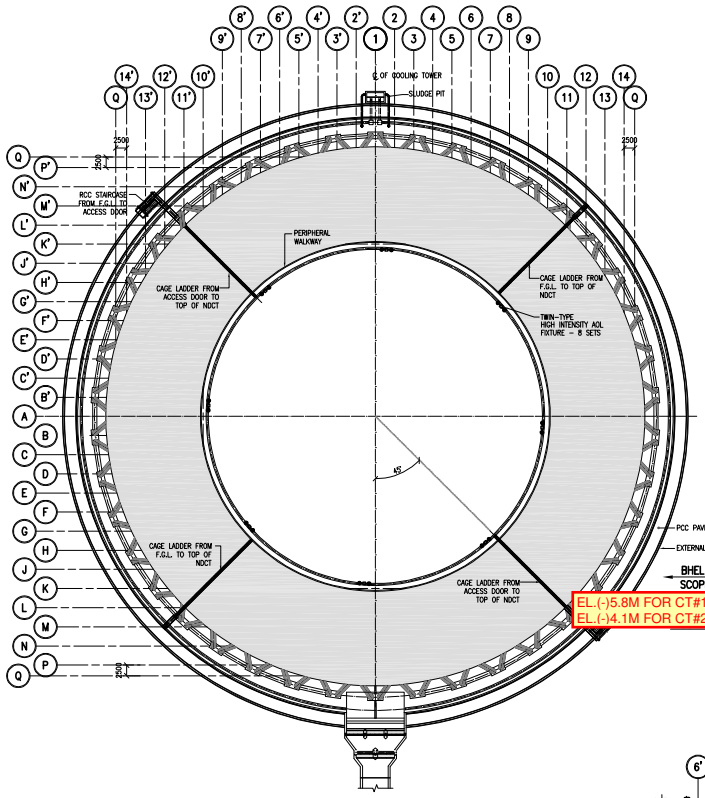
SHEET SIZE : A1



PLAN AT EL. 14.200M OF CT-1

(SCALE-1:600)

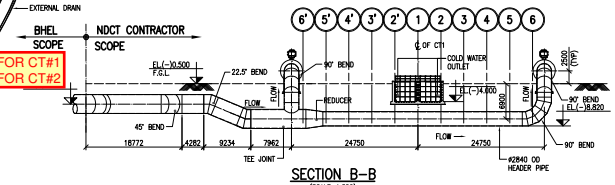


PLAN AT EL. 165.140M OF CT-1

(PLAN SHALL BE MIRRORED ABOUT PLANT EAST-WEST FOR CT-2)

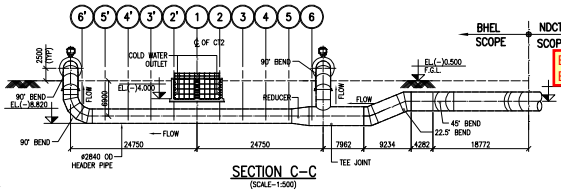
(SCALE-1:600)

EL.(-)5.8M FOR CT#1
EL.(-)4.1M FOR CT#2



SECTION B–B

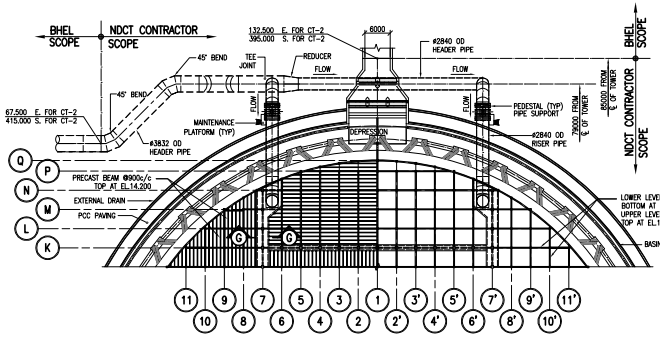
(SCALE-1:500)



SECTION C–C

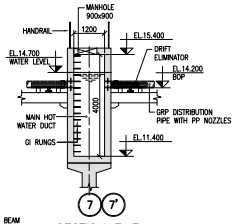
(SCALE-1:500)

EL.(-)5.8M FOR CT#1
EL.(-)4.1M FOR CT#2



PLAN AT EL. 14.200M OF CT-2

(SCALE-1:600)



SECTION E–E

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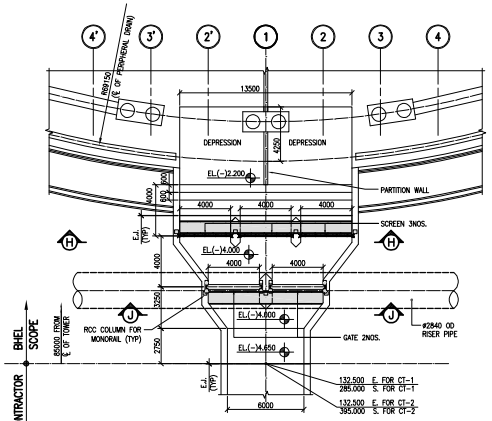
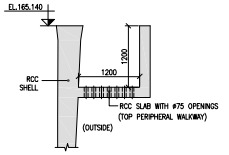


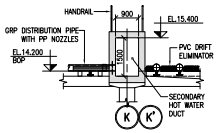
DETAIL '4'

(SCALE-1:200)



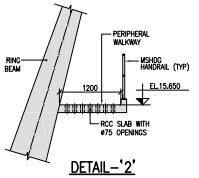
DETAIL-'1'

(SCALE-1:50)



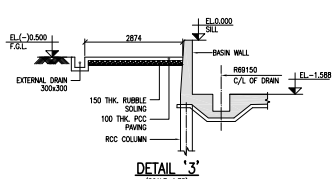
SECTION F–F

(SCALE-1:100)



DETAIL-'2'

(SCALE-1:50)



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CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED BENGALURU INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd

PROJECT: 2x660 MW UDANGUDI SUPERCRITICAL THERMAL POWER STATION, STAGE-I

DRAWN BY :	SVG
CHECKED BY	UNB
APPROVED BY	UKR
DATE	09/07/2019
SCALE	AS SHOWN

TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER

STCPL DRG.NO.: 787-E-DD-101 REV.NO.

BHEL DRG.NO.: PE-V1-435-165-N001 (SHEET 2 OF 3) 4

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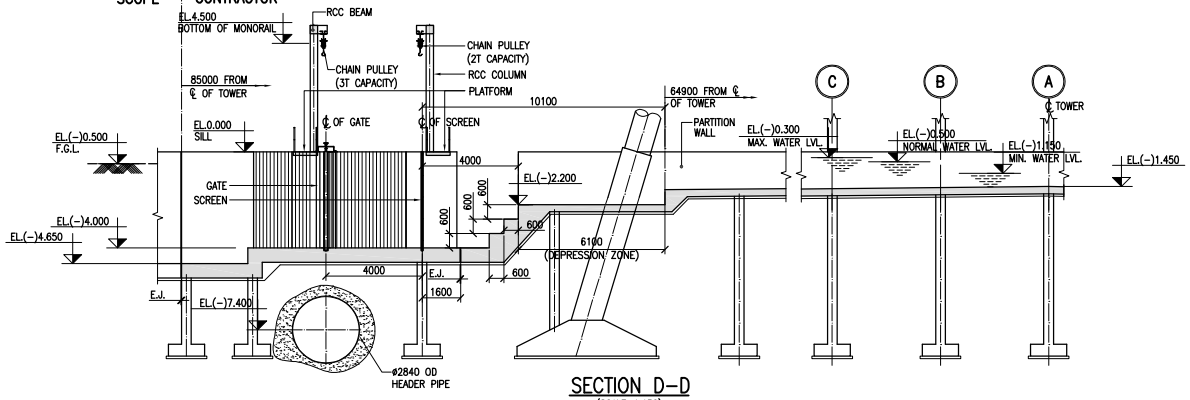

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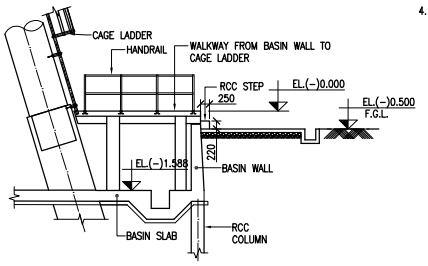

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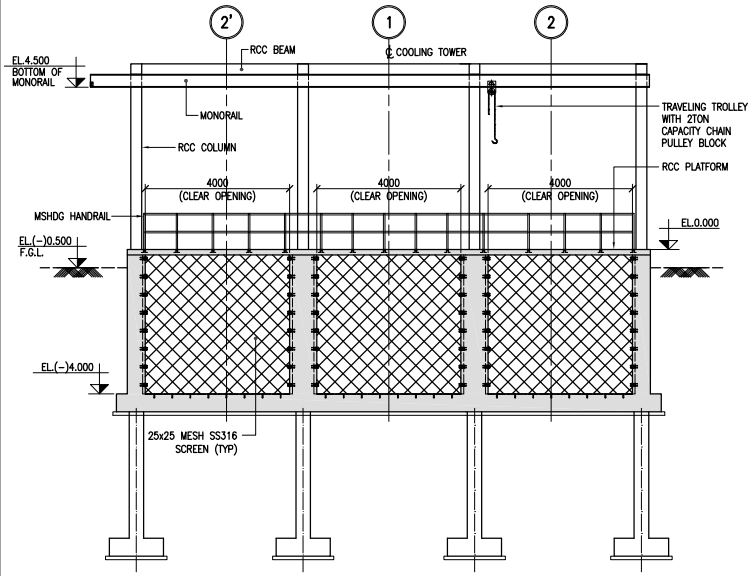

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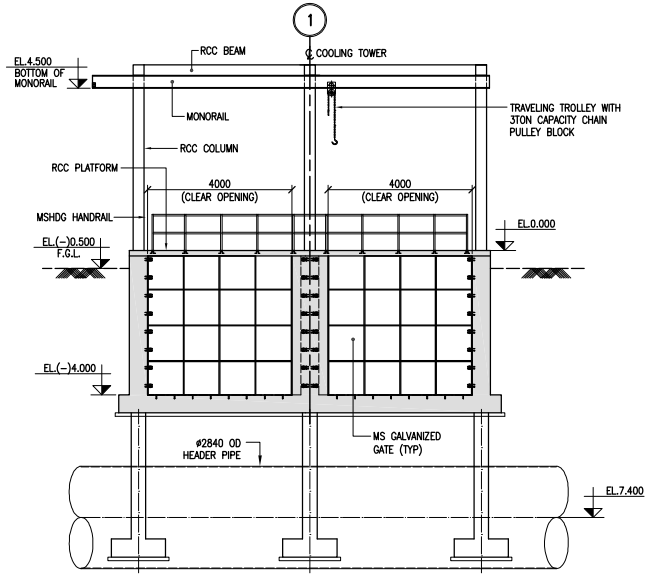

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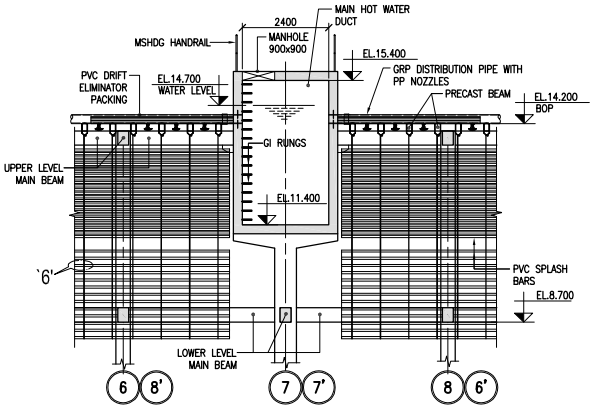

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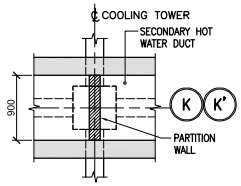

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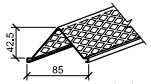

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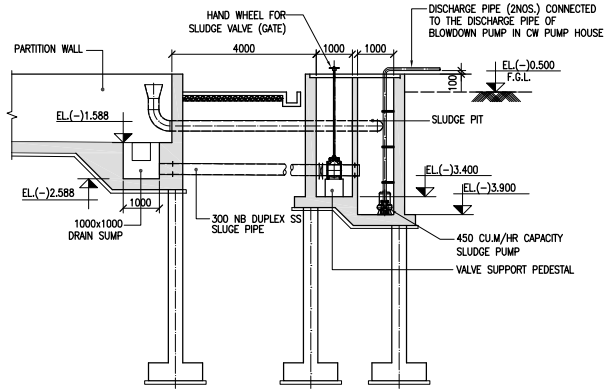

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CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED

CONSULTANT: TATA CONSULTING ENGINEERS LIMITED BENGALURU INDIA

EPC CONTRACTOR: BHARAT HEAVY ELECTRICALS LIMITED

NDCT CONSULTANT: SPECTRUM Techno Consultants Pvt Ltd
B-201,BSEL Tech Park, Sector 30A, Opp. Vashi Railway Station, Vashi Navi Mumbai-400 703, India. Email : info@spectrumworld.net

PROJECT: 2x660 MW UDANGUDI SUPERCRITICAL THERMAL POWER STATION, STAGE-I

DRAWN BY :	SVG
CHECKED BY	UNB
APPROVED BY	UKR
DATE	09/07/2019
SCALE	AS SHOWN

TITLE: GENERAL ARRANGEMENT OF NATURAL DRAUGHT COOLING TOWER

STCPL DRG.NO. 787-E-DD-101 | REV.NO. 4

BHEL DRG.NO. PE-V1-435-165-N001 (SHEET 3 OF 3)

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EPC Contractor: **BHARAT HEAVY ELECTRICALS LIMITED**			Owner: **TANGEDCO**		
NDCT Consultant: **Spectrum Techno Consultants Pvt. Ltd.**					
Project	Doc. Title	Doc. No	Prepared By	Rev No.	Date
2 x 660 MW Udangudi STPS, Tamil Nadu	Design Basis Report for Natural Draught Cooling Towers	PE-V1-435-165-N002	JHB	3	4-Jul -19

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1. INTRODUCTION

This document provides the design basis for NDCT for 2 x 660 MW Udangudi Supercritical Thermal Power Station of Tamil Nadu Generation and Distribution Corporation Ltd. (TANGEDCO).

2. Detailed Scope of Civil Works

- Excavation and backfilling for columns, foundation and substructure below cold water basin level.
- RCC foundation raft & Cold water Basin, RCC Shell, and RCC support framework for fill and other thermos-hydraulic components.
- Hot water distribution duct.
- Painting of concrete surfaces with approved type of paint.
- Providing and installation of access doors in the shell of cooling tower including the necessary fitting and appliances on Tower Shell. The access doors will be of pultruded or ribbed FRP material.
- Main access RCC staircase outside the tower up to Hot water Duct level, internal RCC walkways and platform, all with necessary hot dip galvanized MS pipe handrails.
- Cold water channel outlet up to terminal points.
- De-sludging arrangement for each compartment of cold water basin.
- Provision of permanent galvanized mild steel cage ladder up to top of tower with adequate landing platforms.
- Provision of peripheral drainage around cooling tower.
- Water fill test of cold water basin, cold water outlet channel.
- Hydro test of Hot water Duct.
- Supply and erection of all bolts, nuts, fasteners, embedded parts and any other likewise material required for completion of work.

3. DESCRIPTION OF STRUCTURE

Ref: Drg. No. PE-V1-435-165-N001 General Arrangement of Natural Draught Cooling Towers

i.	Tower Pedestal c/c diameter at sill level	:132.11 m
ii.	Inside diameter at throat level	: 77.07 m
iii.	Inside diameter at top	: 78.57 m
iv.	Inside diameter for pond wall	:140.00 m
v.	Sill level	: 0.00 m
vi.	Throat level	:123.86 m
vii.	Top level of tower	:165.14 m
viii.	Air inlet level	: 8.70 m
ix.	Basin depth (at center)	: 1.45 m
x.	Free board	: 0.300 m
xi.	Grade level (FGL)	: (-) 0.500 m
xii.	Type of fill	: PVC Splash Fill
xiii.	Height of Fill Packing	: 4.80 m above air inlet
xiv.	Distribution pipes	: GRP
xv.	Spray Nozzles	: PP
xvi.	Drift Eliminators	: PVC

4. MATERIAL

4.1 Concrete:

Minimum Grade of concrete (f_{ck})

Tower Foundation	: M30
Pedestal	: M30
Pond wall	: M30
Raker Columns	: M40
Shell	: M35
Pond basin floor	: M30

Grillage columns, bracings & Beams	: M30
Precast beams	: M30
Hot water duct	: M30
Platforms	: M30
Cold water channel	: M30
Drainage Sump	: M30
Staircase	:M30
PCC	:M15
Density of Concrete:	25kN/m^3
Elastic Modulus of Concrete:	$5000\sqrt{f_{ck}}$ MPa.
Poisson's Ratio:	0.2
Coefficient of linear thermal expansion of concrete & Steel	11 x 10 $^{-6}$ ^{o}C

4.2 Steel:

Shell	: Corrosion Resistant Steel/HCRM, Grade Fe415 / 500 to IS: 1786
Foundation & other structures	: Corrosion Resistant Steel/HCRM, Grade Fe415 / 500 to IS: 1786

5. LOADING

The following loads will be considered for the design of cooling towers

a) Dead loads

b) Imposed loads (including construction loads)

c) Wind loads

d) Earthquake forces

e) Temperature (Including solar radiation)

Note: Since the strata below founding level is comprised of rock as per soil investigation report, differential settlements are not expected. Hence, settlement load will not be considered in analysis.

5.1 Dead Load

For calculating the self-weight of the structure, the specific weight of the material will be taken as below. All other dead loads will be assessed in accordance with relevant codal provision. Dead load will include the self-weight of structure, weight of fill material, weight of water in hot water channel and distribution system including the self-weight of channel and distribution system, etc.

Concrete : 25 KN/m^3

Water : 9.81 KN/m^3

Steel : 78.5 KN/m^3

5.2 Imposed Loads (Including Constructional Loadings)

Imposed loads on various structures shall be as follows:

I. Basin, sump duct & underground pipe : Besides earth pressure under dry & wet condition, an additional surcharge of 2.0 T/m^2 shall be taken

II. Covers for HW distribution basin : 0.3 T/m^2

III. Walkways inside CT distribution basin : 0.5 T/m^2

IV. Landing platform & staircase : 0.3 T/m^2

V. Surcharge load : 2.0 T/m^2

Construction loadings that may occur during execution of work will be considered in the design of the cooling tower structure.

5.3 Wind Pressure

The wind pressure on the towers will be assessed on theoretical basis as well as with the help of model test in a wind tunnel of turbulent boundary layer.

The complete cooling tower will be designed for all possible wind directions and on the basis of worst load conditions as obtained from theoretical methods.

Under the theoretical method, the circumferential net wind pressure distribution and wind pressure coefficient (p1) for the tower shell will be obtained from the “Criteria for structural design of Reinforced concrete Nature Draft Cooling Towers IS: 11504-1985. The Fourier series coefficients up to seven harmonics used to obtain the net pressures are as follows: (will be verified post wind tunnel test)

-0.00071; 0.24611; 0.62296; 0.48833; 0.10756; -0.09579; -0.01142; 0.04551

This design net pressure coefficient (p) and the distribution along the circumference of tower will be used at all heights of the tower. The above design net pressure coefficient (p) includes the effect of internal suction.

In order to compute the quasi static design wind pressure at a given height along the circumference of the tower, the design pressure coefficient (p) will be multiplied by the wind pressure acting at that height [P(z)].

The wind pressure at a given height [P(z)] will be computed as per the stipulations of IS:875 (Part 3)-2015. For computing the design wind pressure at a given height the basic wind speed (Vb) will be taken as **Vb= 39 m/sec** at 10.0 meters height above mean ground level. For computing design wind speed (Vz) at a height z, the risk co-efficient **K1= 1.06** will be considered. For coefficient **K2, Terrain category 2 and class 'C'** as per table 2 of IS: 875 (Part-3) – 2015 will be considered. The wind direction for design purposes will be the one which induces worst load conditions. Topography coefficient **K3= 1** for the tower under consideration. A **Cyclone Factor K4 = 1.15** will be additionally considered for calculation of design wind speed as the project site is located within 60km strip of the east coast. The wind pressure at a given height will be computed theoretically in accordance to the IS codal provision given as under:

$Pz = 0.6\ Vz^2\ N/mm^2$; where Vz = Vb x K1 x K2 x K3 x K4

Computation of wind pressure (pz) along the wind direction by Gust Factor (GF) Method for estimating the wind load on the tower and other elements, will be based on IS: 875 (Part-3)-2015. While calculating the gust factor, the term 'b' will be taken as the diameter of the throat in Fig. 10 of IS: 875 (Part-3)-2015.

Design of the tower will satisfy Peak Wind method & Gust Effective Factor method.

A load enhancement factor of 1.43 will be applied to the wind loading calculated, to account for:

i) Natural turbulence in the incident wind resulting from the bluff obstruction and wake

ii) Increase in wind speed as well as turbulence induced in the incident wind by adjacent cooling tower and the structures of significant dimensions.

A 10% increase over the enhancement factor will be considered for imperfection in construction as per IS: 11504.

5.4 Earthquake Forces

The seismic analysis will be carried out in accordance with IS: 1893 (Part 4):2015 by modal analysis of the hyperbolic cooling towers. The earthquake analysis of the shell and its support columns including the foundations will be carried out by response spectrum method. Earthquake analysis for the fill supporting structures (RCC frames) will also be carried out by response spectrum method. For all analyses, acceleration will be considered in all 3 directions

in 1:0.3:0.3 ratio. The modulus of elasticity for concrete will be as per IS: 456-2000 Clause 6.2.3.1 with an Age Factor of 1.0. All the analysis will be carried out as per the theory of elasticity.

The project lies in Zone-II

Seismic zone factor : 0.10

Response reduction factor : 3 (as per Table 4 of IS: 1893 Part 4 – 2015)

Damping : 5% of critical

Importance factor : 1.50 (Cat. 2 as per Table 3 of IS: 1893 Part 4 – 2015)

5.5 Temperature Loads

a) For temperature loading, the total temperature variation shall be considered from 18 deg. C to 43 deg. C.

b) Temperature effects due to solar radiation will be considered in addition to above. Shell will be designed for one sided solar radiation effect. Nevertheless an effective temperature difference of at least 25 deg. C across the shell thickness constant over the height and following a sine function along half the circumference will be considered.

c) For calculating effects of temperature loads, modulus of elasticity of concrete E_c will be reduced by 50% as per cl. 6.4.2.5.(vi) of IRC: 112 – 2011. Since this is equivalent to reduction of temperature loads by 50% and keeping E_c as it is, the later method will be adopted by multiplying working temperature loads by a factor of 0.5.

6. LOAD COMBINATIONS

Following minimum load combinations shall be considered for the design of cooling towers:

6.1 Load Combination for Stability Checks for NDCT Tower:

△3

Case	Load Combinations	Global Stability Condition	Reference
Uplift Check	0.9 DL + WL	Factor of safety of 1.2	IS 875 (Part - 5): 1987
	0.9 DL + 1.5 WL	Lift-off shall be within 15^0 sector	Section 5.10.2.9 of Vol. II, Section – 5 Civil Specs
Sliding Check	0.9 DL + WL 0.9 DL + EQL	Factor of safety of 1.4	clause 20.2 of IS 456: 2000
Overturning Check	0.9 DL + WL 0.9 DL + EQL	Factor of safety of 1.4	clause 20.1 of IS 456: 2000

(*refer Section-9 for stability check of basin slab)

6.2 Load Combination for Cooling Tower and Foundation System Design

Sr.No.	Load Combinations
Working Stress Design	
1	DL+ WL
2	DL +TL
3	DL +EQL
4	DL + WL + TL
5	DL + EQL + TL

Limit State Design	
4	0.9DL+1.5WL
5	1.5DL+1.5WL
6	0.9DL +1.5EQ
7	1.5DL+1.5EQ
8	1.2 DL+1.2WL + 1.2 TL
9	1.2 DL+1.5EQ + 1.2 TL
10	0.9 DL+1.2WL + 1.2 TL
11	0.9 DL+1.5EQ + 1.2 TL

3

- All these load combinations shall be checked for both basin full and empty conditions. Temperature loads, wind loads and earthquake loads of different types (and/or directions) shall be considered separately forming all possible combinations.

DL = Self Weight

WL = Wind Load

TL = Temperature Load

EQ = Earth quake load

6.3 Load Combination for Internal Fill Structure

Sr. No.	Load Combinations	Elements		
		Basin Slab	HW Duct	RCC Grillage frame
Working Stress Design				
1	DL+SI + LL	√	√	
2	DL+SI + LL ±EQ	√	√	
Limit State Design				
3	1.5DL+1.5SI + 1.5LL			√
4	1.2DL+1.2SI + 0.6LL ±1.2EQ			√
5	0.9DL +0.9SI±1.5 EQ			√

DL - Self Weight

EQ - Earth quake load (acceleration will be considered in all 3 directions in 1:0.3:0.3 ratio)

SI - Superimposed dead load

7. Permissible stresses & Crack width limitation

For load combinations 1 to 5 in section 6.2, the stress in concrete and reinforcement shall be restricted as per working stress method of IS: 456. Any increase in allowable stresses in extreme load cases will not be considered.

In limit state method of design, the stress in the reinforcement steel shall not exceed 87% of the specific characteristic strength of reinforcement steel and the compressive stress in the concrete shall not exceed 45% of the specified 28 days cube strength of the concrete as per IS:456.

Permissible stress for steel structures shall be as per IS: 800 (Latest) based on working stresses.

Crack width for Tower shell will be restricted to 0.1mm. For liquid retaining structures, all water/soil facing sections will be designed as un-cracked sections. Calculation of crack widths will be done as per IS 3370 (Part 2): 2009.

8. TOWER DESIGN CONSIDERATION

8.1 General

The complete cooling tower, including the shell, columns, ring beam and foundation, will be structurally analyzed using finite element modeling technique using the FEM software SOFISTIK, concrete will be assumed to be homogenous and isotropic. The design geometric profile, thickness variation and support conditions of shell will be considered in the structural analysis.

Analysis based on the recognized bending theory of the elastic shells will be adopted for the design of the tower and supporting structures. The shell analysis shall include the following information at 10^{o} plan angle and not more than 0.05 of shell height:

A. Meridional and circumferential direct stress resultants and tangential shear stress resultants,

B. Meridional and circumferential bending moments, and

C. Displacement normal to shell mid surface.

A detailed dynamic analysis will be carried out for the complete tower for seismic forces by response spectrum method.

A single finite element model of cooling towers representing critical conditions shall be prepared for analysis in SOFiSTiK.

8.2 Buckling of Tower Shells

a) Critical dynamic wind pressure at buckling will be calculated as per BS 4485 – Part 4: 1996.

A factor of safety 5 will be considered for critical buckling pressure.

b) Local buckling will be checked for dead and wind loads with a factor of safety of 5.

8.3 Opening in Shell

Opening through the shell will be provided for hot water pipes and access door.

Openings will be provided with additional reinforcement at each edge equal to 75% of the reinforcement intercepted by the openings in the direction parallel to the edges. In addition diagonal reinforcement will be provided at each corner as close as possible. The total cross-sectional area in cm^2 of this reinforcement will be 0.5d, at each corner where'd' is the shell thickness in cm.

No horizontal thrust due to the inlet piping shall be transmitted to the shell.

8.4 Minimum Thickness of Shell

A minimum thickness of 200mm shall be provided for the shell.

8.5 Minimum Reinforcement in Shell Spacing and Placement

The reinforcement used will be corrosion resistant/ HCRM of grade Fe 500 conforming to IS: 1786.

For top 1/3rd height of the shell, the circumferential reinforcement on each face shall not be less than 0.2% of the concrete cross sectional area and meridional reinforcement shall not be less than 0.15% of the concrete cross sectional area.

Shell reinforcement for remaining 2/3rd portion will be 0.15% of concrete cross sectional area in both meridional & circumferential direction on each face.

Spacing of reinforcing bars shall not exceed 200 mm in both directions.

Minimum Bar Diameter : Circumferential : 8 mm

Meridional : 10 mm.

8.6 Raker Columns

Inclination of the circular raker columns will closely match the meridional slope at the shell so that the load transfer to foundation takes place through predominantly axial force in columns.

Raker columns will be designed for the most critical forces transferred to an individual raker column from superstructure considering various load combinations as under Clause 6 above.

Design of raker columns shall be carried out in both limit state and working stress methods for worst load combinations acting on critical elements.

For calculating effective length of raker columns, boundary conditions will be considered as follows: Fixed at the bottom; restrained against rotation but not held in position at the top. Effective length will be considered as 0.9 times the unsupported length.

8.7 Foundations

The foundation shall be continuous annular raft type.

Founding level of the towers is considered to be 7.5m below FGL. Net Safe Bearing Capacity (SBC) for the towers will be considered as 40 T/m^2, as per recommendations provided in soil investigation report.

Modulus of subgrade reaction will be applied as springs below the raft with spring constant calculated as follows:

$K_s = \frac{Gross\ safe\ bearing\ capacity\ at\ founding\ level}{s}$, s = settlement of 25mm.

The design of the cooling tower foundation structures will follow working stress method for worst load combination as per IS: 456 – 200. Limit state method shall also be adopted for design in cases involving wind loads (DL + 1.5 WL).

The foundation shall be of minimum M-30 grade concrete resting on 100mm thick PCC of grade M15. Clear cover shall not be less than 50mm.

Foundation will be checked for safety against uplift, over-turning and sliding. Ground water table will be considered to be at FGL for uplift check. Weight of soil weight contained in the inverted frustum of cone on the base of the footing with sides making an angle of 20^0 with vertical will be considered to be part of the restoring force against uplift, as per clause 5.1.3.3 of IS : 4091-1979.

8.8 Serviceability Design

Serviceability design shall be in accordance with IS: 456-2000

8.9 Durability Requirements

Clear cover for reinforcement shall be 50mm for shell.

8.10 Tolerances:

The construction will be carried out with in the tolerances stipulated below as per cl. 7.3 of IS 11504

a) Shell wall center line in horizontal plane measured radially at : $\pm$15mm

midpoint on a 3.0m wide chord

b) Shell wall center line in meridional plane over a height of 1.0m. : ± 10mm

c) Thickness of shell. : + 10mm or -5 mm

d) Horizontal radius of shell at any section other than shell base : ± 50 mm

e) Horizontal radius at shell base : ± 40mm

9. LIQUID RETAINING STRUCTURES

a) The cold water basin including sludge pits, cold water channels, will be designed as per IS 3370. Water/soil facing sections will be designed as un-cracked sections.

b) The structures will be designed for the following conditions:

I. Water filled inside up to full height and no earth outside.

II. Earth pressure at top surface level with surcharge load of 2.0 t/m^2 and with ground water table outside and no water inside.

c) The basin and associated structures will be checked against uplift for basin empty condition. Stability will be checked during construction stage as well.

d) The rafts Cold Water basin, CW outlet and sludge pit shall be supported by columns resting on isolated footings with founding level at 7.5m below FGL, since the allowable SBC is less than 7 T/m^2 as per soil investigation report.

e) Minimum thickness of the basin slab shall be 300mm, with minimum reinforcement of 0.25%.

f) A minimum clear cover of 50mm will be maintained for liquid retaining structures.

g) No pressure relief valves should be provided in the basin slab.

For the uplift check following condition will be ensured based on cl. 7.2(b) of IS 3370 (Part 1): 2009.

Stage	**Water Table level for stability check**	**Dead Load Factor**	**Factor of safety against uplift**
Construction stage	at top of basin slab	1.0	1.2
Service stage	at FGL	0.9	1.2

h) Weight of soil weight contained in the inverted frustum of cone on the base of the footing with sides making an angle of 20^0 with vertical will be considered to be part of the restoring force against uplift, as per clause 5.1.3.3 of IS : 4091-1979.

10. WATER DISTRIBUTION SYSTEM

The structural design of the water distribution system will consider the worst combination of the following loads.

I. Self-weight, other imposed loads and live load.

II. Hydraulic pressures during normal operations including pressure surges.

III. Hydraulic pressures due to mal-operation of tower or supply pumps.

Hot Water ducts be designed as uncracked section per IS 3370 Part 2 (2009) with a clear cover of 50mm to reinforcement on soil face.

The water distribution system will be provided with adequate pressure surge relief facilities to prevent pressure loading in excess of values used in the design.

11. PLATFORMS, WALKWAYS, STAIRWAYS, STAIRCCASES, INTERNAL GRILLAGE ETC.

11.1 Internal Grillage

Internal grillage system comprises of cast-in-situ RCC beams and columns. They will be designed for self-weight and permanent loads by limit state method as per IS: 456-2000.

The structure shall be designed for a temporary point load of 1.5 kN at any point.

11.2 Platform

Peripheral platform of 1.2m clear width will be provided all around the tower circumference at top of the tower

A platform of width 1.2m shall be provided inside the tower at distribution pipe level

A minimum live load of $5.0kN/m^2$ will be considered for the design of all platforms, walkways and staircases, in addition to their own weight.

11.3 Staircase

Two external dog-legged staircases shall be provided from the ground level to the water distribution level. The staircase shall have a minimum width of 1000mm and a landing width of

1000mm, with the landings not exceeding 2.5m in height. The stair riser shall not exceed 125mm and the treads shall be a minimum of 250mm.

11.4 Paving Outside Basin

PCC paving of M15 grade, 100mm thick will be provided for a distance up to 7m from center of raker columns, sloping away from basin. Dry rubble soling of 150mm thickness will be provided below the PCC.

11.5 Ladders

The tower shall be provided with 4 nos. safety ladders out of which 2 nos. will be laid from top landing of staircases up to top of NDCT and the balance 2 nos. will be laid from FGL up to top of NDCT.

MS hot dip galvanized rung ladders will be 600 mm wide, fabricated out of 60 mm x 10 mm flats with 20 mm dia. Rungs at 300 mm c/c. Stays will be provided at every 2.25 m intervals connecting the ladder with the concrete shell.

Safe cage will be provided for all ladders and will be fabricated out of 5nos. verticals of 50mm x 6mm flats with 50 mm x 6mm flats straps at 800 mm c/c.

Reinforced concrete landing platforms of size not less than 750mm x 1500mm shall be provided at every 8 to 10m height of the ladder.

12. STEEL STRUCTURES

These structures will be designed, fabricated and erected as per IS: 800 and other relevant Indian Standard codes for structural steel work. All exposed steel work will be protected by hot dip galvanizing. The minimum coating will be 900 gm/sq.m and comply with IS: 2629, IS: 2633 and IS: 4759.

12.1 Stop logs Gates and Screens in CW channel

Stop Log Gates will be designed as per IS: 5620. The guides for stop log gates will be of stainless steel material of Grade AISI 316 L.

Screens will be of min 8 gauge wire, 25 mm clear openings in SS 316 L material. The guides for screens will also be of stainless steel material of Grade AISI 316 L.

All the hardware (bolts & nuts) used for gates and screens will be of Duplex SS material.

12.2 Hand Railing

The MS pipe hand rails will be of 1.3m height with two intermediate rails at 450mm and 900mm height. The posts will be at 1500 mm spacing. The posts and runners will be minimum 32 nominal dia. And all welded construction with round corners. The tube will be as per IS: 1161 (for structural purpose) or equivalent. Handrails will be hot dipped galvanized after fabrication and provided with etch primer and bituminous painting.

12.3 Miscellaneous

All access doors shall be of size 1200mm wide and 2100mm height (clear). Access door shall be of FRP.

13. PAINTING

Extended two component coating system approved by CERI, Karaikudi will be provided to the following.

a) Basin floor

b) Internal and external surfaces of basin wall & basin partition wall

c) Internal and external surfaces of Cold water channel up to TP

d) Internal and external surfaces of drain chambers

e) Complete internal surface of Shell and up to 2m at the top and bottom of the Shell on the outside

f) Fill supporting columns and beams for the full height and length respectively

g) All concrete surfaces in contact with earth and seawater.

h) Raker columns and pedestal over complete height

Two coats of Aliphatic acrylic protective coating system will be provided for the external surface of cooling tower shell. High Performance Moisture Compatible Corrosion Resistant Coating System will be used for inner surface of shell and all other elements mentioned above.

14. Master Drawing List

CIVIL DRAWINGS			
Sl.no.	**Spectrum Drawing No.**	**BHEL Drawing No.**	**Title**
1	787-E-DD-001	PE-V1-435-165-N033	Excavation Layout of NDCT
2	787-E-DD-002	PE-V1-435-165-N038	Shell Profile And thickness
3	787-E-DD-003	PE-V1-435-165-N026	General Arrangement of Fill Supporting Structure
4	787-E-DD-004	PE-V1-435-165-N034	Concrete Dimensions of NDCT Foundation, Pedestal & Tie Beams
5	787-E-DD-005	PE-V1-435-165-N035	Reinforcement Details of NDCT Foundation, Pedestal & Tie Beams
6	787-E-DD-006	PE-V1-435-165-N036	Concrete Dimension of Raker Column
7	787-E-DD-007	PE-V1-435-165-N037	Reinforcement Details of Raker Column
8	787-E-DD-008	PE-V1-435-165-N044	Concrete Dimensions Details of Basin Floor
9	787-E-DD-009	PE-V1-435-165-N045	Reinforcement Details of Basin Floor
10	787-E-DD-0010A	PE-V1-435-165-N046A	Concrete Dimensions & Reinforcement Details of Grillage Columns Above Basin
11	787-E-DD-0010B	PE-V1-435-165-N046B	Concrete Dimensions & Reinforcement Details of Grillage Columns Below Basin
11	787-E-DD-0011	PE-V1-435-165-N047	Concrete Dimensions & Reinforcement Details of Lower Tier Beams
12	787-E-DD-0012	PE-V1-435-165-N048	Concrete Dimensions & Reinforcement Details of Upper Tier Beams
13	787-E-DD-0013	PE-V1-435-165-N028	Concrete Dimensions & Reinforcement Details of Main Hot Water Duct
14	787-E-DD-0014	PE-V1-435-165-N028A	Concrete Dimensions & Reinforcement Details of Secondary Hot Water Duct
15	787-E-DD-0015	PE-V1-435-165-N049	Concrete Dimensions & Reinforcement Details of Precast Fill Supporting Beams
16	787-E-DD-0016	PE-V1-435-165-N016	Concrete Dimension of CW Outlet
17	787-E-DD-0017	PE-V1-435-165-N016A	Reinforcement Details of CW Outlet

18	787-E-DD-0018	PE-V1-435-165-N052	Details of Pavement around NDCT
19	787-E-DD-0019	PE-V1-435-165-N050	Concrete Dimension & Reinforcement Details of Sludge Pit
20	787-E-DD-0020	PE-V1-435-165-N053	Details of Screens in CW Outlet
21	787-E-DD-0021	PE-V1-435-165-N023	Concrete Dimension of Staircase
22	787-E-DD-0022	PE-V1-435-165-N023A	Reinforcement Details of Staircase
23	787-E-DD-0023	PE-V1-435-165-N039	Summary of Shell Reinforcement for Each Lift
24	787-E-DD-0024	PE-V1-435-165-N041	Reinforcement Details of Circumferential reinforcement for each lift of NDCT Shell
25	787-E-DD-0025	PE-V1-435-165-N042	Reinforcement Details of Meridional reinforcement for each lift of NDCT Shell
26	787-E-DD-0026	PE-V1-435-165-N051	Concrete Dimensions & Reinforcement Details of Peripheral Platform at R.L+xx.xx m
27	787-E-DD-0027	PE-V1-435-165-N057	Details of Access Door
28	787-E-DD-0028	PE-V1-435-165-N045A	General Arrangement & Details of External MS Cage Ladder
29	787-E-DD-0029	PE-V1-435-165-N044A	Reinforcement Details around opening for Access Door for NDCT Shell
30	787-E-DD-0030	PE-V1-435-165-N032	Concrete Dimension and Reinforcement Details of Hot Water Pipe Support

CIVIL DESIGN NOTES

Sl.no.	Spectrum Document No.	BHEL Document No.	Title
1	787-E-DN-001	PE-V1-435-165-N002	Design Basis Report
2	787-E-DN-003	PE-V1-435-165-N004	Analysis of NDCT Shell
3	787-E-DN-004	PE-V1-435-165-N006	Design of Foundation, Pedestal & Raker Columns of NDCT
4	787-E-DN-005	PE-V1-435-165-N008	Analysis And Design Fill Supporting Structures
5	787-E-DN-006	PE-V1-435-165-N010	Analysis And Design of Hot Water Ducts .
6	787-E-DN-007	PE-V1-435-165-N012	Design of CW Outlet & Monorail Frame
7	787-E-DN-008	PE-V1-435-165-N013	Design of Sludge Pit
8	787-E-DN-009	PE-V1-435-165-N011	Design of Staircase for NDCT
9	787-E-DN-010	PE-V1-435-165-N007	Design of NDCT Shell

10	787-E-DN-011	PE-V1-435-165-N015	Design of Miscellaneous Items (platform etc.)

15. REFERENCE CODES

1) IS: 456 – 2000Code of Practice for plain and reinforced concrete.
2) IS: 3370 – 1967 Code of practice for concrete structure for storage of liquids Parts 1 to 4.
3) IS: 800 – 1984Code of practice for general construction in steel.
4) IS: 875 – 1987 Code of practice for design loads for building and structures Parts 1, 2, 4 & 5.
5) IS: 875 – 2015 Code of practice for design loads for building and structures Parts 3.
6) IS: 1893-2015 Code of practice for criteria for earthquake resistant design of structure.
7) IS: 11504-1992 Criteria for structural design of reinforced concrete natural draught cooling towers.
8) IS: 2210 – Criteria for Design of RCCC shell structure and folded plates.
9) IS: 2204-1962 Code of practice for construction of reinforcement concrete shell roof.
10) IS: 3043 Code of Practice for Earthing
11) IS: 2309 Code of Practice for the Protection of Buildings and Allied Structures against Lightning
12) IS: 5062 Recommendation for Structural Design Criteria for Low Head Slide Gates
13) IS: 2405, Part-1 Specification for Industrial Sieves (Wire Cloth Sieves)
14) CTI Code STD-136 Thermoplastic Materials Used for Film Fill, Splash Fill, Louvers and Drift Eliminators
15) IS: 4985 Unplasticized PVC Pipes for Potable Water Supplies
16) CTI Code ATC-105 Acceptance Test Code for Water Cooling towers
17) BS:4485-4-1996 Water cooling towers

Annexure-4

TYPICAL SEAWATER ANALYSIS

SAMPLE IDENTIFIED AS : SEA WATER

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,001,E-78+04,088/09.09.06
MARK	TOP LAYER
COLLECTED ON	09/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	7.98
2	Conductivity	ASTM D1125-99	53700µS/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	12.5 NTU
5	Salinity	ASTM method	35.5
6	Total Suspended Solids	ASTM D1888	6 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	400 mg/l
9	Magnesium as Mg	ASTM D511-98	1274 mg/l
10	Sodium as Na	ASTM D1428	12600 mg/l
11	Potassium as K	ASTM D1428	380 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.57 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.30 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.16 mg/l
21	Chloride as Cl	ASTM D512-99	21088 mg/l
22	Sulfate as SO4	ASTM D516-02	3189 mg/l
23	Nitrate as NO3	ASTM 3867-99	0.87 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.008 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	140 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL

27	Fluoride as F	ASTM D1179-99	1.4 mg/l
28	Boron as B	ASTM D3082-03	1.29 mg/l
29	Phosphate as PO4	ASTM D515-97	0.08 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.31 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.18 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	10 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	62 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	BDL (DL : 0.003 mg/l)
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,001,E-78+04,088/09.09.06
MARK	BOTTOM LAYER
COLLECTED ON	09/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	7.98
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	14.8 NTU
5	Salinity	ASTM method	35.4
6	Total Suspended Solids	ASTM D1888	8 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	400 mg/l
9	Magnesium as Mg	ASTM D511-98	1270 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	376 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.76 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.33 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.17 mg/l
21	Chloride as Cl	ASTM D512-99	20987 mg/l
22	Sulfate as SO4	ASTM D516-02	3000 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.21 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.008 mg/l

25	Bicarbonate as HCO3	ASTM D1067-02	137 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.2 mg/l
28	Boron as B	ASTM D3082-03	1.36 mg/l
29	Phosphate as PO4	ASTM D515-97	0.08 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.40 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.4 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	9 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	53 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit
DL : Detection Limit.

COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23.641,E-78+03,898/10.09.06
MARK	TOP LAYER
COLLECTED ON	10/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.1
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.9 NTU
5	Salinity	ASTM method	35.5
6	Total Suspended Solids	ASTM D1888	11 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	400 mg/l
9	Magnesium as Mg	ASTM D511-98	1270 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	375 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.87 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.35 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.21 mg/l
21	Chloride as Cl	ASTM D512-99	20886 mg/l
22	Sulfate as SO4	ASTM D516-02	3113 mg/l
23	Nitrate as NO3	ASTM 3867-99	0.83 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.01 mg/l

25	Bicarbonate as HCO3	ASTM D1067-02	137 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.4 mg/l
28	Boron as B	ASTM D3082-03	1.29 mg/l
29	Phosphate as PO4	ASTM D515-97	0.15 mg/l
20	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.36 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.23 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	11 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	57 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit
DL : Detection Limit.

*****

COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23.641,E-78+03,898/10.09.06
MARK	BOTTOM LAYER
COLLECTED ON	10/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.1
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	12.8 NTU
5	Salinity	ASTM method	35.5
6	Total Suspended Solids	ASTM D1888	11 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	393 mg/l
9	Magnesium as Mg	ASTM D511-98	1260 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	378 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	1.90 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.49 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.25 mg/l
21	Chloride as Cl	ASTM D512-99	20987mg/l
22	Sulfate as SO4	ASTM D516-02	3019 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.35 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.01 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	135 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL

27	Fluoride as F	ASTM D1179-99	1.0 mg/l
28	Boron as B	ASTM D3082-03	1.19 mg/l
29	Phosphate as PO4	ASTM D515-97	0.15 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.37 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.21 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.6 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	7 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	45 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,396,E-78+04,025/11.09.06
MARK	TOP LAYER
COLLECTED ON	11/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53700µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.4 NTU
5	Salinity	ASTM method	35.4
6	Total Suspended Solids	ASTM D1888	11 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	393 mg/l
9	Magnesium as Mg	ASTM D511-98	1260 mg/l
10	Sodium as Na	ASTM D1428	12500 mg/l
11	Potassium as K	ASTM D1428	378 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.11 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.38 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.17 mg/l
21	Chloride as Cl	ASTM D512-99	20886 mg/l
22	Sulfate as SO4	ASTM D516-02	3396 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.33 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.01 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	135 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	0.8 mg/l
28	Boron as B	ASTM D3082-03	1.38 mg/l
29	Phosphate as PO4	ASTM D515-97	0.10 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.39 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.25 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.2 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	8 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	41 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,396,E-78+04,025/11.09.06
MARK	BOTTOM LAYER
COLLECTED ON	11/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53300 µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	13.6 NTU
5	Salinity	ASTM method	35.2
6	Total Suspended Solids	ASTM D1888	4 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	385 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	376 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.25 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.29 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.14 mg/l
21	Chloride as Cl	ASTM D512-99	20683 mg/l
22	Sulfate as SO4	ASTM D516-02	2747 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.43 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.04 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	128 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.4 mg/l

28	Boron as B	ASTM D3082-03	1.22 mg/l
29	Phosphate as PO4	ASTM D515-97	0.12 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.34 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	11 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	57 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,503,E-78+04,543/12.09.06
MARK	TOP LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53600 µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.6 NTU
5	Salinity	ASTM method	35.4
6	Total Suspended Solids	ASTM D1888	6 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	401 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12400 mg/l
11	Potassium as K	ASTM D1428	378 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.13 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.28 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.15 mg/l
21	Chloride as Cl	ASTM D512-99	20784 mg/l
22	Sulfate as SO4	ASTM D516-02	2855 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.62 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.03 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	130 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.2 mg/l
28	Boron as B	ASTM D3082-03	1.24 mg/l
29	Phosphate as PO4	ASTM D515-97	0.11 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.33 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.6 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	8 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	41 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+24,503,E-78+04,543/12.09.06
MARK	BOTTOM LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	7.98
2	Conductivity	ASTM D1125-99	53200 µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	13.4 NTU
5	Salinity	ASTM method	35.1
6	Total Suspended Solids	ASTM D1888	5 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	377 mg/l
9	Magnesium as Mg	ASTM D511-98	1274 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	375 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.37 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.27 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.14 mg/l
21	Chloride as Cl	ASTM D512-99	20480 mg/l
22	Sulfate as SO4	ASTM D516-02	2729 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.49 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.03 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	128 mg/l
26	Carbonates as CO3	ASTM D1067-02	NIL

27	Fluoride as F	ASTM D1179-99	1.0 mg/l
28	Boron as B	ASTM D3082-03	1.24 mg/l
29	Phosphate as PO4	ASTM D515-97	0.16 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.34 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.19 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.2 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	8 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	41 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23,977,E-78+04,380/12.09.06
MARK	TOP LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.08
2	Conductivity	ASTM D1125-99	53300 µmhos/cm
3	Temperature	ASTM method	32°C
4	Turbidity	ASTM D1889-00	12.5 NTU
5	Salinity	ASTM method	35.2
6	Total Suspended Solids	ASTM D1888	6 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	385 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	376 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.17 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.26 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.13 mg/l
21	Chloride as Cl	ASTM D512-99	20582 mg/l
22	Sulfate as SO4	ASTM D516-02	2747 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.39 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.04 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	128 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.4 mg/l
28	Boron as B	ASTM D3082-03	1.36 mg/l
29	Phosphate as PO4	ASTM D515-97	0.16 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.32 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.19 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	10 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	62 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

SAMPLING METHOD	N.A.
SAMPLE DESCRIPTION	SEA WATER
SAMPLE QTY.	20L
SAMPLE CODE	N.08+23,977,E-78+04,380/12.09.06
MARK	BOTTOM LAYER
COLLECTED ON	12/09/2006
TEST START DATE	13/09/2006
TEST END DATE	27/09/2006

S.NO	Parameter	Protocol	Result
1	pH	ASTM D1292-99	8.05
2	Conductivity	ASTM D1125-99	53100 µmhos/cm
3	Temperature	ASTM method	34°C
4	Turbidity	ASTM D1889-00	13.2 NTU
5	Salinity	ASTM method	35
6	Total Suspended Solids	ASTM D1888	5 mg/l
7	Total Organic Carbon	ASTM D4129-98	Less than 5 mg/l
8	Calcium as Ca	ASTM D511-98	409 mg/l
9	Magnesium as Mg	ASTM D511-98	1265 mg/l
10	Sodium as Na	ASTM D1428	12000 mg/l
11	Potassium as K	ASTM D1428	375 mg/l
12	Ammonia as NH3	ASTM D1426-98	BDL (DL : 0.01 mg/l)
13	Strontium as Sr	ASTM D5673-02	2.11 mg/l
14	Barium as Ba	ASTM D5673-02	BDL (DL : 0.41 mg/l)
15	Total Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
16	Dissolved Aluminium as Al	ASTM D5673-02	BDL (DL : 0.03 mg/l)
17	Total Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
18	Dissolved Manganese as Mn	ASTM D5673-02	BDL (DL : 0.02 mg/l)
19	Total iron as Fe	ASTM D1068-03	0.27 mg/l
20	Dissolved iron as Fe	ASTM D1068-03	0.15 mg/l
21	Chloride as Cl	ASTM D512-99	20480 mg/l
22	Sulfate as SO4	ASTM D516-02	2729 mg/l
23	Nitrate as NO3	ASTM 3867-99	1.56 mg/l
24	Nitrite as NO2	ASTM D3867-99	0.03 mg/l
25	Bicarbonate as HCO3	ASTM D1067-02	140 mg/l

26	Carbonates as CO3	ASTM D1067-02	NIL
27	Fluoride as F	ASTM D1179-99	1.2 mg/l
28	Boron as B	ASTM D3082-03	1.21 mg/l
29	Phosphate as PO4	ASTM D515-97	0.12 mg/l
30	Sulfide as H2S	ASTM D4658-03	BDL (DL : 0.01 mg/l)
31	Total Silica as SiO2	ASTM D859-00	0.32 mg/l
32	Dissolved Silica as SiO2	ASTM D859-00	0.20 mg/l
33	Dissolved Oxygen	ASTM D888-96	5.5 mg/l
34	BOD @ 27°C for 3 days.	ASTM method	9 mg/l
35	Phenols	ASTM D1783-01	BDL (DL : 0.001 mg/l)
36	COD	ASTM D1252-00	53 mg/l
37	Oil & Grease	ASTM D4281-01	Less than 1 mg/l
38	Zinc as Zn	ASTM D5673-02	0.10 mg/l
39	Copper as Cu	ASTM D5673-02	BDL (DL : 0.006 mg/l)
40	Nickel as Ni	ASTM D5673-02	BDL (DL : 0.008 mg/l)
41	Cadmium as Cd	ASTM D5673-02	BDL (DL : 0.003 mg/l)
42	Lead as Pb	ASTM D5673-02	BDL (DL : 0.01 mg/l)
43	Mercury as Hg	ASTM D5673-02	BDL (DL : 0.001 mg/l)

NOTE: BDL: Below Detection Limit.
DL : Detection Limit

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COC of 1.5 to be considered for MOC selection

Annexure-5

2x660 MW UDANGUDI TPS STAGE-I

MANDATORY SPARES FOR ELECTRICAL

(* One set corresponds to actual quantity of components and devices as installed for the equipment at Site)

Sl.No	Description	Unit	Quantity
1	**Illumination system**		
a)	Each type and rating of HRC fuse	Nos.	10
b)	Each type and rating of MCBs	Nos.	10
c)	Each type and rating of lamp	Nos.	10 % of total population or 1-No which is higher
d)	Each type and rating of ballast	Nos.	10 % of total population or 1-No which is higher
e)	Each type and rating of starter	Nos.	10 % of total population or 1-No which is higher
f)	Each type and rating of igniter	Nos.	10 % of total population or 1-No which is higher
g)	Each type and rating of capacitor	Nos.	10 % of total population or 1-No which is higher
h)	Each type and rating of receptacles	Nos.	10 % of total population or 1-No which is higher
i)	Lighting Switches	Nos.	10 % of total population or 1-No which is higher
j)	Junction Boxes(each type)	Nos.	10
k)	Photo voltaic sensor	Nos.	10 % of total population or 1-No which is higher
l)	Electronic circuit for the above	Nos.	10 % of total population or 1-No which is higher
2	**LT Motors of each type and rating**		
a)	Driving end bearing	Set*	1
b)	Non driving end bearing	Set*	1
c)	Terminal block for motors up to 30 Kw each rating	Nos.	10
d)	Terminal block for motors above 30 Kw each rating	Nos.	5
e)	Motors of each type & rating	Nos.	10% of installed quantity or 1 –no whichev is higher
3	**DC Motors of each type and rating**		
a)	Driving end bearing	Set*	1
b)	Non driving end bearing	Set*	1
c)	Carbon brushes of each type	Set*	10
d)	Brush assemblies of each type	Set*	2
e)	Terminal blocks of each type	Set*	2
f)	Motor of each type & rating	Nos.	10% of installed qty or 1-no Which ever is higher

2x660 MW UDANGUDI TPS STAGE-I - EPC		
MANDATORY SPARES FOR CONTROL & INSTRUMENTATION		
SI. NO.	**PARTICULARS**	**QUANTITY**
1	RTD's of each type and length(with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length, whichever is more
2	Thermocouples of each type like K-type, R-type, metal etc. (with head assembly, terminal block & nipple)	10% or 2 nos. of each type and length which ever is more
3	Local Indicators like temperature gauges, pressure gauges, differential pressure gauges, flow gauges, flow meters etc.,	10% or 2 no. of each make, model and type whichever is more and for each plant (to be divided to various ranges in proportion to main of all make, model, type population)
4	Process Actuated Switch Devices Includes all types of Pressure, differential pressure, flow, temperature, differential temperature, level switch Devices	5% or 1 no. of each type and model whichever is more
5	**POWER SUPPLY SYSTEM – 24 VDC (To be provided for each system)**	
	Silicon controlled thyristors, diodes, power transistors	100%(1 Lot)
	Capacitors	1 set
	Filter regulators	20% of each model or 2 nos. whichever is more.
6	**INSTRUMENTATION CABLE, INTERNAL WIRING & ELECTRICAL FIELD**	
	Pre fabricated cable of each type.	10% of installed quantity
	Pre fabricated cable connector of each type	10% or 1 no. of each type and model, whichever is more.
	Other cables	5% of each type, pair and size of actual installed quantity
7	**Electrical actuator, complete assembly, of each rating**	**2 Nos.**
Note: Mandatory Spares mentioned here are inline with spares list received from PG vide email dated 23.03.2018. Quantity mentioned is considered for 2 Units		

	TITLE	SPECIFICATION NO.: PE-TS-435-165-N011
BHEL	**DATA SHEET-A** **NATURAL DRAFT COOLING TOWER**	VOLUME : SECTION : REV. NO. 0 DATE 12.11.2018 SHEET 1 OF 9

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
1.0	**Type Model No.**		NATURAL DRAUGHT COOLING TOWER
2.0	**Quantity**	Nos//Unit	TWO
3.0	**Rated Capacity**	M^3/Hr	85,500
4.0	**Design Wet Bulb Temperature**	°C	28
5.0	**Cold Water Temperature**	°C	33
6.0	**Cooling Tower Approach**	°C	5
7.0	**Cooling Tower Range**	°C	10
8.0	**Cooling Tower Loss**		
	a. Evaporation Loss		1,352.262762 m3/hr
	b. Drift Loss		4.275 m3/hr
	c. Blow Down Loss (Concentration Factor to be indicated)		4,503 m3/hr @ COC = 1.3
9.0	**Total Differential Pressure Drop** (Considering recovery)		
	a. Drop through ~~Louvers~~ (up to bottom of fill)	mm of H_2O	2.5249
	b. Drop through Fills	mm of H_2O	2.5410
	c. Drop through Eliminators + Distribution	mm of H_2O	0.4400
	d. ~~Velocity Pressure~~ Other Phenomena	~~mm of H_2O~~	0.6100
	e. ~~Drop through plenum~~ Throat	mm of H_2O	0.4185

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
10.0	**Basin Storage Capacity**	M^3	7 minutes of storage between Min. & NWL
11.0	**Plan Dimensions (Diameter)**	M	140 (inside clear)
12.0	**Overall Size of Cooling Tower (Plan Dimensions X Height)**	MXM	132.11 dia. CL x 165.14 m ht.
13.0	**Required Pumping Head including all losses measured from Terminal Point**	M	16 w.r. FGL
14.0	**Cooling Tower Levels**		
	a. Graded Level	M	EL (-) 0.50
	b. Maximum Water Level	M	EL (-) 0.30
	c. Basin Curb Level	M	EL 0.00
	d. Minimum Water Level	M	EL (-) 1.15
	e. Basin Bottom Level	M	EL (-) 1.45 @ Center
15.0	**Overall Tower Height from Basin Floor**	M	Please refer GA Drawing
16.0	**Basin Dimensions**		
	a. Diameter	M	140 inside dia at Sill Level
	b. Depth (from Basin Curb)	M	1.45 at Center
17.0	**Free Board (Above Max. Water Level)**	mm	300
18.0	**Heat Transfer Data**	~~mm~~	
	a. Heat Transfer Coefficient (K)		CONFIDENTIAL
	b. Tower Coefficient © Ka V/L	M	2.02
	c. Average Fill Height	M	4.8
	d. Total Fill Volume	M^3	53,168

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	e. Total Tower Wetted Surface	M^2	271,157
19.0	**Hot Water Distribution Piping**		
	a. Size (OD X Thk)	Mm X mm	3800NB (Header) 2800NB (Riser)
	b. Elevation of Center Line of Hot Water distribution Header	M	Please refer GAD
	c. Design pressure for Hot Water Distribution System	Kg/cm^2 (g)	5.7
20.0	**Isolation Valves in Hot Water Risers**		
	a. Size	mm	2800
	b. Quantity		2 PER NDCT
	c. Type/Code & Standard		BUTTERFLY /AWWA C504
	d. Make		AS PER APPROVED MAKES
	e. Pressure drop across the valve in fully open position		0.047 MWC
	f. Materials of Construction i) Body ii) Disc iii) Drive Shaft/Stub Shaft iv) Bearings		AS PER SPECIFICATIONS
21.0	**Flow Control Valves (If Applicable)**		
	a. Size	mm	NOT APPLICABLE
	b. Quantity		
	c. Type		
	d. Make		

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	f. Materials of Construction i) Body ii) Spindle iii) Trim		----------
22.0	**Isolating Valve in Sludge Pit**		
	a. Size	mm	300
	b. Quantity		2 PER NDCT
	c. Type		GATE
	d. Make		FOURESS/KIRLOSKAR/KEYSTONE/SIRCAR/DURGA
	e. Conform to which code in respect of design/testing		IS: 778
	f. Materials of Construction i) Body ii) Stem iii) Trim		AS PER SPECIFICATIONS
23.0	**Stationary Screen**		
	a. Quantity		3 PER NDCT
	b. Size & Material of Bar		25 mm Clear Opening, 6 mm Wire of SS 316 L
	c. Clear Space between the bar		25 mm
	d. Lifting Arrangement		MONORAIL-CHAIN PULLEY
24.0	**Fill & Fill Supports**		
	a. Type of fill		PVC SPLASH
	b. Material		PVC
	c. Expected Life	Years	5 TO 10 APPROX.

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	d. Arrangement of Fill		STAGGERED
	e. Method to prevent dislocation of Fills	Years	CLIPPING
	f. Type/Material/Size of fixing arrangement to supporting grid		HUNG FROM RCC BEAMS
	g. Fill Support Grids		
	i) Type		WELD MESH
	ii) Material (give full specification)		DUPLEX SS
	iii) Size		--
	h. Grid Supporting Frames		
	i) Type		RCC
	ii) Material (give full specification)		
	iii) Size		
	i. Fasteners		
	i) Type		SLEEVES WITH BOLTS
	ii) Fill/Splash Bars		
	iii) Fill Support Grids		
	iv) Frames for Supporting the Grids		
25.0	**Drift Eliminators**		
	a. Number of Passes		THREE
	b. Gross Face Area per pass	M^2	7,959 approx
	c. Type		BLADE/WAVE
	d. Eliminator Blades	mm	
	i) Material		PVC
	ii) Maximum Length of blade		2500
	iii) Size and shape of blades		WAVE
	iv) Type and material of drain boards		SELF DRAINING

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	e. Blade Support Spacers		
	i) Type		MOULD
	ii) Material		POLYPROPYLENE
	f. Support for Spacers		
	i) Type		RCC BEAM
	ii) Material		
	g. Fasteners		
	i) Type		NOT APPLICABLE
	ii) Material		
26.0	**Gate in Cold Water Outlet Channel**		
	a. Number per cold water outlet channel		TWO
	b. Gate Type		STOP LOG
	c. Name of Manufacturer		FABRICATED
	d. Gate Size		4 M X 4 M
	e. Weight of each gate		DURING ENGG.
	f. Are elements of gate dismantling type?		NO
	g. Weight of each Element		Separate drwg will be submitted during engineering
	h. Frame Type		SS 316 L
	i. Fixing arrangement of frame with RCC channel		WITH EMBEDDED PLATES
	j. Lifting Arrangement of Gate		MONORAIL-CHAIN PULLEY

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	k. Expected Life	Years	15 APPROX.
27.0	**Sludge Pump & Motor**		
	a. Pump Type		SUBMERSIBLE
	b. Make & Model No.		KISHORE/DARLING/KIRLOSKARAQUA MACHINERY
	c. Capacity	M^3/Hr	450
	d. TDH	MWC	25
	e. Pump Speed	RPM	1500 (SYN)
	f. Pump Efficiency at Rated Flow		65% to 70%
	g. Power Consumption at Rated Flow	KW	Vendor Data Sheet will be submitted
	h. Material of Construction i) Impeller ii) Casing iii) Pump & Line Shaft iv) Bearings v) Impeller/Casing Wearing Rings		AS PER SPECIFCATIONS
28.0	**Cooling Tower Materials of Construction**		
	a. Casing		RCC
	b. Louvers		N/A
	c. Partition Walls		N/A
	d. Basin Partition Walls		RCC
	e. Stack		N/A
	f. Stair Case		RCC
	g. Hot Water piping		MS outside and GRP inside

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER
	h. Hot Water distribution basin		RCC
	i. Internal Walkways		RCC
	j. Supporting Structure		RCC
	k. Hand Rails		MS HDG
	l. Structure Connector		N/A
	m Bolts, nuts, washers and other hardware		As per Technical Specification
	n. Nails		N/A
	o. Anchor Bolts		N/A
	p. Hot Water Distribution Nozzle		POLYPROPYLENE
	q. Hot Water distribution Plates		N/A
	r. Spacers		N/A
	s. Mechanical Equipment Support		N/A
29.0	**Weight of Equipments**		
	a. Weight of Heaviest part to be handled	Kgs.	2000 APPROX.
	b. Size of largest part to be handled	Kgs	4 m x 4 m APPROX.
30.0	**Inspection & Testing**		
	a. Hydro Test Pressure for Hot water piping		
	i) Test Pressure	Kg/cm^2 (g)	1.5 x Design Pressure
	ii) Duration	Minutes	AS PER CODE

SL. NO.	DESCRIPTION	UNIT	DATA/PARAMETER

31.0 Painting Details

a. Externally painted Surfaces

		External Surface	Surface Preparation	Primer	Final Paint
i.	Piping (Under Ground)		Encased with 250 thk RCC		
ii.	Piping (Over Ground)		Sand Blasting	2 Coats of Coal Epoxy Primer + (total DFT 100 - 125 microns)	2 finish coats of high build epoxy paint (total DFT 100 - 125 microns)
iii.	Stationary Screens	N/A			
iv.	Hoist Derric	N/A			
v.	Other Items	N/A			

a. Internally painted Surfaces

		Internal Surface	Surface Preparation	Primer	Final Paint
i.	Piping ~~and Valves~~		Sand Blasting	Corrocoat or Flake Coating of 1500 Microns DFT	Glass
ii.	Other Items	N/A			

32.0	**Maximum Water Handling capacity**	M^3/Hr	85,500 (design)
33.0	**Cooling Water Flow Rate (L)**	$Kg/m^2/Hr$	8043.084593
34.0	**Dry Air Flow Rate (G)**	$Kg/m^2/Hr$	4136.919075
35.0	**Ratio of Water to Air (L/G)**		1.944
36.0	**Dry Air Flow**	Kg/Hr	43,976,484
37.0	**Temperature of air leaving the Stack**	°C	41.09
38.0	**Inlet air Enthalpy**	KCal/Kg	21.258
39.0	**Exit air Enthalpy**	KCal/Kg	41.708
40.0	**Total Heat Exchange/Kg of Inlet Dry air**	KCal/Kg	20.450
41.0	**Losses in hot water piping in MWC**	MWC	0.4223
42.0	**Type of air inlet**	MWC	All Around

SUB-SECTION - IIA

STANDARD TECHNICAL SPECIFICATION (MECHANICAL)

STANDARD TECHNICAL SPECIFICATION FOR COLING TOWER

STANDARD QUALITY PLANS

1.0 GENERAL:

1.1 This standard specification covers the design, manufacture and assembly, inspection and testing at the Vendor's and/or his sub-vendor's works, suitable painting and packing requirements for transportation, erection, commissioning and testing at site of all materials and equipments inclusive of complete electrical and civil works for the Natural Draft Cooling Tower complete with all accessories as specified hereinafter.

2.0 CODES AND STANDARD:

2.1 The design, manufacture, inspection and testing and performance of the Cooling Tower as specified hereinafter shall comply with the requirements of all applicable latest Indian/British/American Standards and Codes of practice. The latest editions of the following standards and publications shall be followed in particular.

a) Cooling Tower Institution of USA, Bulletin ATP-105: Acceptance Test Code for Industrial Water Cooling tower.

b) PTC-23: ASME Performance Test Code for Atmospheric Water Cooling equipment.

c) For Electrical, Civil Codes/ Standards refer respective Specification.

d) BS-4485 – Specification for Water Cooling Tower.

2.2 In case of any conflict between the above codes/ standards and this specification, the later shall prevail and in case any further conflict in the matter, the interpretation of the specification by the Engineer shall be final and binding.

3.0 DESIGN REQUIREMENTS:

3.1 The Cooling Tower shall be designed for continuous operation to cool not less than the design flow of water from specified inlet temperature to outlet temperature at a design ambient wet bulb temperature as indicated under Data Sheet-A enclosed to this specification.

3.2 All the components shall be capable of safe, proper and continuous operation at all cooling water flows up to and including those specified under Data Sheet-A and shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

3.3 The cooling tower shall be Natural Draft cross flow/ counter flow type as per enclosed Data Sheet-A.

3.4 The vendor under this specification shall assume full responsibility in proper design and operation of each and every component of the cooling tower as well as the cooling tower as a whole unit.

3.5 The Cooling tower shall be suitable for handling the fluid as per Data Sheet-A and also for achieving the specified parameters in Data Sheet-A.

3.6 The Cooling tower shall be designed such that the drift losses and the evaporation losses are limited to the values as specified in Data Sheet-A.

3.7 The Cooling Tower structure shall be of adequate strength to withstand the wind load and the effect of earthquake on the structure. Design wind pressure and horizontal/vertical seismic coefficient shall be taken as mentioned in the specification for civil works enclosed to this specification.

4.0 CONSTRUCTIONAL FEATURES:

4.1 Casing and Louver (If required):

4.1.1 The Louvers shall be designed for air entry to the tower with low velocity for minimum pressure drop and less chance of recirculation of moist air. To eliminate splash out, louvers shall slope to shed water inwards.

4.1.2 The louvers and casing shall be made of material as specified in the Data Sheet-A.

4.2 Partitions:

4.2.1 Partitions shall be provided so that one section can be taken out of service without affecting the operation of capacity of other section.

4.3 Fill:

4.3.1 Cooling tower fills type and material shall be as specified in Data Sheet-A.

4.3.2 Design and arrangement of the fills shall be so as to expose high air/ water surface with minimum air pressure drop.

4.4 Fill Supports:

4.4.1 Fills shall be supported at frequent intervals, which shall minimise sag. Possibility of dislodgement and damage to fill materials as a consequence of induced vibration in the fill.

4.5 Drift Eliminations:

4.5.1 Multipass drift eliminators with minimum two-pass zig zag path type shall be provided so as to limit the drift loss to that specified in Data Sheet-A.

4.5.2 The eliminator frame shall be of rugged construction and shall be firmly secured to the structural

frame to arrest vibration. Suitable access to the eliminator frame work from the basin should be provided for any maintenance or physical replacement of eliminator blades etc., when the particular cell is taken out for maintenance.

4.6 **Hot Water Distribution System:**

4.6.1 Motorised/Manual valves (as indicated in Data sheet A) shall be provided in the hot water distribution piping such that each section can be isolated without affecting the operation of other section.

4.6.2 The pipes and valves in hot water distribution system shall be designed to take care of the possible thermal stresses due to temperature variation. This could be achieved by providing sliding supports for supporting all the pipes fabricated from carbon steel.

4.6.3 The hot water distribution piping and valves shall be designed for the design pressure as indicated in the Data Sheet-A.

4.7 **Cold Water Basin:**

4.7.1 The cooling tower basin shall be constructed in RCC (unless otherwise specified in Data Sheet-A). The capacity of the cooling tower basin shall be as indicated in Data Sheet-A.

4.7.2 The cold water basin shall be partitioned into two chambers or as specified in Data Sheet-A. The two sections of the Cooling Tower basin should be separate water tight compartments, which can be isolated one at a time for cleaning/maintenance purposes.

4.7.3 Sludge pits with isolating valves and spool pipe having flanged ends shall be provided for individual basin chamber for connection to drainage pipe.

4.7.4 For each basin chamber, there shall be a cold-water outlet channel. In the connection between basin chamber and cold water outlet channel there shall be a stationary coarse bar screen and gate in the absence of any specific preference under Data Sheet-A.

4.7.5 Each basin chamber shall have an overflow arrangement and scouring arrangement.

4.8 **Submersible sludge Pumps:**

4.8.1 The submersible type sludge pumps complete with electric motors, discharge side valves, piping, supports, hangers and clamps etc. shall be supplied at the option of the purchaser for each cooling tower for basin draining/ desludging. The quantity, design parameters and the materials of construction of the vertical sludge pumps shall be as per Data Sheet-A. Each pump shall be non-clog type, self water lubricated. The vertical sludge pumps shall be treated as an optional item and are to be offered if asked for in the Data Sheet-A enclosed to this specification.

4.9.0 **Screens & Gates in Cold Water outlet Chamber:**

4.9.1 The screens shall be vertical stationary type; the opening size and the mesh aperture shall be as per Data Sheet-A. The guides for the screens to be embedded in the concrete shall be of material as per Data Sheet-A.

Lifting lugs or eye bolts shall be provided on top of the screen frame for ease of handling.

4.9.2 For handling screens, one set of monorail with supporting structure and chain pulley hoist complete with lifting chain and trolley for mounting the hoist shall be furnished. The chain pulley hoist shall be manually operated and shall conform to IS-3832 class-II.

4.9.3 The gates fixed in vertical sections in cold water outlet chamber shall be as per standard practice and quality, material and type shall be as given in Data Sheet-A.

4.9.4 The isolating valves on the scour lines within the sludge pits shall conform to class I of IS-780 and shall be of reputed make.

4.10 **Hardware:**

4.10.1 All nails and fastening bolts, nuts and washers etc used in the cooling tower which are coming in direct contact with water or humid air shall be made of stainless steel 304, all others nuts & bolts etc. shall be made of HDG steel.

4.11.0 **Access:**

4.11.1 Two R.C.C. staircases for approach to the hot water distribution level

4.11.2 Doors for entrance into Cooling Tower Distribution level shall be provided as specified in Data Sheet -A.

4.11.3 Two external ladders for approach to top of cooling tower from water distribution level.

4.11.4 Access/platforms for inspection and maintenance of hot water distribution system along with spray nozzles.

4.11.5 Suitable arrangement for supporting walkways inside the cooling tower shall be made and loading of such arrangement shall be independent of the fill material.

4.11.6 Whether specifically mentioned in the data sheet or not, steel components and fittings used in walkways, handrails and access doors shall be hot dip galvanised after fabrication.

5.0 **INSPECTION AND TESTING:**

5.1 The inspection/ testing of cooling tower and its various components shall be as per the approved Quality Plans.

5.2 Hydrostatic test for the hot water distribution piping shall be conducted at site after complete erection. The test pressure and duration shall be as per Data Sheet-A.

6.0 TEST AT SITE:

6.1 The Cooling Tower as a whole shall be tested at site to check and ascertain that the performance meets the requirements of the specification. It is the responsibility of the vendor to conduct the performance test of the cooling tower and prove the specified parameters to the satisfaction of the purchaser. The test shall be witnessed by the purchaser/ customer's representative or both, for which 15 days clear notice will be given to purchaser by the vendor.

6.2 The performance test of the cooling tower shall be carried out in accordance with cooling tower Institute Bulletin No. ATP 105 Acceptance test for Industrial Cooling Tower.

The details of the proposed test procedure shall be submitted by the vendor sufficiently in advance of the commencement of test for the review and approval of the purchaser.

6.3 Necessary correction curves required for correcting the test results for any difference in test and guaranteed design condition shall be furnished by the supplier for approval along with the proposed test procedure.

6.4 All testing and calibrating instruments required for the site performance test shall be arranged by the cooling tower supplier without any extra cost. All instruments used by the supplier shall be duly calibrated from a recognised Institution and the same is to be arranged by the supplier.

7.0 PERFORMACNE GUARANGTEE, TOLERANCE & PENALTIES:

7.1 Each equipment shall be guaranteed to meet the performance requirement as specified.

7.2 The tests shall be conducted at the manufacturer's works/ site in accordance with this specification and rectification of all defects shall be satisfactory done without charging any extra amount to purchaser.

7.3 The performance test shall be carried out at site as specified and all defects shall be satisfactorily rectified within a time period decided by purchaser. No extra amount shall be charged to purchaser for such rectification. After rectification, retesting will be done by purchaser/ customer's representative without any extra cost to purchaser till satisfactory performance is achieved.

7.4 The vendor shall submit performance curves for the cooling tower showing variation in performance from the design duty point with change in approach to wet bulb temperature,

cooling range, water loading of the tower.

7.5 The vendor shall guarantee the performance of the whole cooling tower plant to meet the specifications when tested in accordance with cooling tower institute acceptance test code ATP-105, performance curves as per ATP-105 shall be furnished by the vendor.

7.6 If any defects are observed, the bidder shall rectify the same without extra cost to the purchaser. Even after rectification if the guaranteed performance is not achieved, then for every increase of 0.5 degree C or part thereof in the cold water temperature over design conditions, a sum as specified in data Sheet-A shall be paid by vendor to the purchaser for shortfall of guarantee, for the cooling tower.

7.6.1 In case the cold water temperature exceeds the acceptable limits of purchaser, the whole plant will be rejected and the vendor shall refund the entire money paid to him together with any penalty levied otherwise.

8.0 SPECIAL CLEANING PROTECTION & PAINTING:

8.1 All equipment shall be neatly finished. All exposed metal/ concrete/ wooden surface shall be smooth and free from burrs/ projections.

The metal surfaces to be painted should be accessible, suitable for priming and affording maximum protection throughout the life of the plant. The surface preparation shall be done either mechanically or chemically by one or more of the methods as given in IS-1477 (Part-I) and shall include the following:

a) Removal of oil, grease, dirt and swarf etc., as per Section 6.1 of IS-1477 (Part-I).

b) Removal of rust and scale etc., as per Section 6.2 of IS-1477 (Part-I).

c) Sand blasting/ shot blasting as per Section 6.2.4 of IS-1477 (Part-I) or wire brushing and picking as specified in Data Sheet-A.

8.2 INSIDE SURFACE OF PIPING & VALVES IN HOT WATER RISERS:

8.2.1 The inside surfaces of the piping and the valves which are in contact with water and which are not made of stainless steel or other corrosion resistant materials shall be painted with coal tar based epoxy paint of approved make and quality over a coat of Zinc Chromate Primer. The thickness of cured coating shall be as specified in Data Sheet-A.

8.3 Outside Surface of Piping (Buried):

8.3.1 Surface treatment as specified in Data Sheet-A.

8.3.2 Coating/ wrapping/ concrete lining as specified in Data Sheet-A.

8.4 **Outside Surface or Piping (Exposed):**

8.4.1 Surface treatment as specified in Data Sheet-A.

8.4.2 One coat of red oxide primer.

8.4.3 Synthetic enamel paint of approved shade, make and quality. The thickness of cured coating shall be as specified in Data Sheet-A.

8.5 All steel parts used for cooling tower construction shall be hot dip galvanised as per IS-4736 after shop fabrication. The external surfaces of the flow regulating valves access platform, access door and also the hoisting derrick subjected to hot water fumes shall also be thoroughly cleaned and treated and shall be coated with rust preventing paints.

8.6 All parts shall be properly boxed, crated or otherwise protected for transportation. Exposed metal finished surfaces shall be thoroughly greased before transportation.

8.7 The external and internal surfaces of the tower shall also be painted.

9.0 **DRAWING AND DATA AFTER AWARD OF CONTRACT:**

The vendor shall furnish drawings and other technical documents as given in Data Sheet-C, enclosed with the specification.

10.0 **SPECIAL TOOLS & TACKLES**:

Special tools & tackles, if any, shall be included in scope of supply by the vendor. A list giving description of such tools & tackles shall be furnished by vendor.

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED (03)	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS (07)	ACCEPTANCE MORMS (08)	FORMAT OF RECORD (09)	AGENCY (10)			REMARKS (11)
									P	N	V	
1	MATERIAL AND BOUGHT OUT CONTROL											
1.1	FAN BLADE (NON- METALLIC)											
	RESIN	CHEM. PROPS.	MA	CHEM. ANALYSIS	1/BATCH	MFR. SPECH	MFR. SPECH.	MFRS. TC	3		2,1	CORRELATION REQD.
1.2	FAN BLADE (METALLIC)	PHYS.,CHEM. PROPS.	MA	PHYS., CHEM ANALYSIS	1/HEAT	APPD. DATA SHEET	APPD. DATA SHEET	TC	3		2,1	DO
1.3	FAN HUB (CENTRE PORTION, SPOKES,BRACES ETC.)	DO	CR	DO	DO	DO	DO	IR	3/2		2,1	DO
1.4	DRIVE SHAFT & COUPLING	DO	CR	DO	DO	DO	DO	IR	3/2		2,1	DO
1.5	REDUCTION GEAR UNIT- TURN SHAFT,WHEEL, PINION, BEVEL GEARS, CASING	DO	CR	DO	1/CASE	DO	DO	IR	3/2		2,1	DO
	1. SHAFT & GEAR BLADES	SUB- SURFACE DEFECTS	CB	UT	100%	ASTM A388, BACKWALL ECHO 100%	DEFECT ECHO NOT MORE THAN 20% OF BACK WALL ECHO FALL IN BACK WALL ECHOE NOT MORE THAN 20%	IR	3/2	2,1		FOR DIA 50MM AND ABOVE

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
PAGE NO.	1 OF 6	PARTY	CUSTOMER/CONSULTANT		BHEL		VENDOR		

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
1.6	HARDWARES	1. PHYS., CHEM. PROPS.	MA	PHYS. ,CHEM.ANALYSIS	IS:2614 TABLE 2	APPD. DATA SHEET	APPD. DATA SHEET	LAB. REPORT	3/2		2,1	
		2. DIMENSIONS, VISUAL DEFECTS	MI	MEAS. ,VISUAL EXAM.	p	MFG. DRG.	MFG. DRG.	LOG BOOK	3/2		2,1	
		3. UNIFORMITY, WT.,ADHESION,SURFACE DEFECTS OF ZINC COATING.	CR	DIP.TEST, STRIP TEST ADHESION TEST, VISUAL EXAM.	IS:5358	IS:5358, APPD DATA SHEET	IS:5358, APPD DATA SHEET	TC	3/2	2,1		
1.7	TIMBER(FOR ALL TIMBER COMPONENTS)											
	1. MATERIAL	1. DEFECTS	MA	VISUAL EXAM.	100%	TECH. SPECN. IS:2372	TECH. SPECN. IS:2372	IR	3/2	2,1		
		2.DIMENSIONS	MA	MEAS.	RANDOM	DO	DO	IR				
	2. PRESERVATIVE TREATMENT	1. PRESERVATIVE RETENTION& PENETRATION	CR	ANALYSIS	1/BATCH	IS:2372,IS:401	IS:2372	IR	3/2	2,1		
1.8	WIRES, WIRE MESH											
	1. WIRES	1. PHYS., CHEM. PROPS	MA	PHYS. ,CHEM. ANALYSIS MEAS.	RANDOM	APPD. DATA SHEET	APPD. DATA SHEET	TC	3/2		2,1	
		2. UNIFORMITY, WT. , ADHESION SURFACE DEFECTS OF ZINC COATING	CR	DIP, STRIP, ADIESION TESTS VISUAL EIAM.	IS:4826	APPD. DATA SHEET IS:4826	APPD. DATA SHEET IS:4826	TC	3/2		2,1	

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
PAGE NO.	2 OF 6	PARTY	CUSTOMER/CONSULTANT		BHEL		VENDOR		

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE

STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
	2. WIRES - PVC COATING (IF APPLICABLE)	SURFACE DEFECTS, PIN HOLES	CR	VISUAL EXAM. , SPARK TEST	100%	IS:4682 PT.IV	IS:4682 PT.IV	IR	3/2	2,1		
	3. WIRE MESH	MESH, SIZE, SURFACE DEFECTS	MI	MEAS. , VISUAL EXAM.	RANDOM	MFG. DRG.	MFG. DRG.	IR	3/2		2,1	
1.9	NOZZLES,FILLS,FILLS SUPPORT,SPLASH BARS AND OTHER ACCESSORIES	DIMENSIONS, WORKMAMSHIP AND FINISH	MI	DO	RANDOM	MFG. DRG./APPD. DATA SHEET	MFG. DRG./APPD. DATA SHEET	IR	3/2		2,1	
1.10	VIRRATION SWITCH	1. CONTACT RESISTANCE 2. CONTACT RATING 3. INSULATION RES. 4. DI-ELECTRIC STRENTH 5. OPTION	MA	ELEC. TESTS	100%	APPD. DATA SHEET /DRG.	APPD. DATA SHEET /DRG.	IR	3/2	2,1		
		6. DEGREE OF PROTECTION & VIBRATION TEST	MA	ELEC. TESTS	1/TYPE/SIZE	DO-	DO	LAB. REPORT	3/2		2,1	
1.11	PIPES ,FITTINGS & PIPE WORK	REFER STANDARD QUALITY PLAN FOR PIPES, FITTINGS & PIPE WORKS										
1.12	VALVES (ALL TYPES)	REFER RESPECTIVE STANDARD QUALITY PLANS										
1.13	PUMPS	REFER STANDARD QUALITY PLAN FOR CENTRIFUGAL PUMPS.										
1.14	LIGHTING PLAN	REFER STANDARD QUALITY PLAN FOR CONTROL PANELS										

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE	DATE	DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME				
PAGE NO.	3 OF 6	PARTY	CUSTOMER/CONSULTANT	BHEL		VENDOR

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
1.15	CABLES	1. TYPE TESTS INCLUDING FRLS TESTS	MA	VERF. OF TYPE TEST CERT.	IS:1554	TECH. SPECH. , APPD. DATA SHEET IS:1554, IS:5931	TECH. SPECH. , APPD. DATA SHEET IS:1554, IS:5931	TYPE TC	3		2,1	
		2. ROUTINE TESTS	MA	ELECT. TESTS	DO	DO-IS: 1554	DO-IS: 1554	ROUTINE TC	3		2,1	
		3. ACCEPTANCE TESTS	MA	DO	DO	DO	DO	ACCEPT. TC	3		2,1	
1.16	IN PROCESS CONTROL											
1.17	FAN BLADE(CURED & FORMED)/MACHINED	1. HARDNESS	MA	PHYS. TEST	SAMPLE	APPD. DATA SHEET/MEG.STD. IS:10661	APPD. DATA SHEET/MEG.STD. IS:10661	LOG BOOK/IR	3/2		2,1	11 TO 31 FOR GRP/FRP ONLY.
		2. PROFILE	CR	TEMPLATE/ MEAS.	SAMPLE	MFG. STD./DRG.	MFG. STD./DRG.	IR	3/2		2,1	
		3. DIMENSIONS	MA	MEASUREMENT	SAMPLE	DO	DO	IR	3/2		2,1	
		4.DEFLECTION/PROOF LOAD CAPACITY	CR	DEFLECTION TEST/PROOF LOAD TEST	100%	DO	NO PEMT. DEFCTN./NO CRACK	IR	3/2	2,1		
		5. WORKMANSHIP AND FINISH	MA	VISUAL EXAM.	100%	DO	DO	IR	3/2	2,1		ON METALLIC BLADES ONLY
		6. SURFACE DEFECTS OF HUB ENDS	MA	PT	100%	ASTME 165	NO SURFACE DEFECT	IR	3/2	2,1		
2.2	HUB DRIVE SHAFT & COUPLING (BEFORE GALVANISING)	1. DIMENSIONS	MA	MEASUREMENT	100%	MFG. DRG./STD.	MFG. DRG./STD.	IR	3/2	2,1		
		2. WORKMANSHIP AND FINISH	MA	VISUAL EXAS.	100%	DO	DO	IR	3/2	2,1		
		3. SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECT	IR	3/2	2,1		
		4. STATIC DYNAMIC RESIDUAL UNBALANCE	CR	STATIC DYNANIC BALANCING	100%	ISO 1940	ISO 1940 G 6.3	IR	3/2	2,1		
2.2.1	HUB DRIVE SHAFT & COUPLING (AFTER GALVANISING)	1. UNIFORMITY, WT. ,ADHESION	CR	DIP, STRIP, ADHESION TESTS	1/ BATCH, IS:2633	APPD. DATA SHEET IS:2633	APPD. DATA SHEET IS:2633	IR	3/2	2,1		
		SURFACE DEFECTS OF ZINC COATING		VISUAL EXAM.	100%							

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
PAGE NO.	4 OF 6	PARTY	CUSTOMER/CONSULTANT		BHEL		VENDOR		

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
2.3	REDUCTION GEAR UNIT- ALL COMPONENTS	1. WORKMANSHIP AND FINISH,DIMENSIONS	MA	VISUAL EXAM.MEAS.	100%	MFG. DRG.	MFG. DRG.	LOG BOOK /IR	3/2		2,1	
2.3.1	GEARS WORMS	1. HEAT TREATEMENT CYCLE, HARDNESS, CASE DEPTH	MA	VERF OF HT CHART MEAS.	100% RANDOM	MFR. SPECN/APPD. DATA SHEET	MFR. SPECN./APPD. DATA SHEET	HT CHART LOG BOOK	3/2		2,1	
2.3.2	GEARS	1. UNIFORMITY OF CONTACT	MA	BLUE- MATCHING	100%	MFR. SPECN.	MFR. SPECN.	LOG BOOK	3/2		2,1	
2.3.3	SHAFT AND GEARS	1. SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECT	IR	3/2	2,1		
3	ASSEMBLY CONTROL, FINAL TEST											
3.1	FAN ASSEMBLY BLADES WITH HUB	1. STATIC RESIDUAL UNBALANCE	CR	STATIC BALANCING	100%	TECH. SPECN.	NO REDIDUAL UNBALANCE	IR	2	1		
3.2	COMPLETE GEAR BOX	1. GEAR RATIO, ORIENTATION, NOISE,TEMP. RISE, LEAKAGES	MA	VISUAL EXAM. NO LOAD RUNNING FOR ONE HR.	100%	MFG.STD., APPD. DATA SHEET	MFG. STD. APPD. DATA SHEET NO LEAKAGES	IR	3/2	2,1		
3.3	COMPLETE FAN ASSEMBLY	1. AIR DELIVERY 2. POWER CONSUMED 3. FAN EFFICIENCY 4. NIOSE, VIBRATION	CR	PERFORMANCE TEST	1/ TYPE/SIZE	BS 848 PT 1,2 TYPE-C/DULLETIN ATP 105-COOLING TOWER INSTT. OF USA	APPD. DATA SHEET BS 840 PT.1,2 TYPE-C/BULLETIN ATP 105-COOLING TOWER INSTT. OF USA	TYPE TEST REPORT	2		1	IN THE ABSENCE OF TYPE TEST REPORT,TO BE WITNESSED BY BHEL

Q.P.NO.	CQS/SQP/42	SIGNATURE			DATE		DATE					DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME										
PAGE NO.	5 OF 6	PARTY	CUSTOMER/CONSULTANT			BHEL		VENDOR				

PROJECT

VENDOR

BHARAT HEAVY ELECTRICAL LIMITED
CORPORATE QUALITY ASSURANCE
STANDARD QUALITY PLAN

ITEM : COOLING TOWER

S NO. (01)	COMPONENT /OPERATION (02)	CHARACTERISTICS CHECKED	CATEGOGY (4)	TYPE/METHOD OF CHECK (05)	EXTENT OF CHECK (06)	REFERENCE DOCUMENTS	ACCEPTANCE MORMS (08)	FORMAT OF RECORD	AGENCY (10)			REMARKS (11)
									P	N	V	
4.0	COMPLETE COOLING TOWER											
4.1	COMPLETE COOLING TOWER	PERFORMANCE TESTS , DIMENSIONS, WORKMANSHIP & FINISH	CR	PERFORMANCE TEST MEAS.VISUAL EXAM.	100%	TECH. SPECN./APPD. DATA SHEET/DRG.	TECH. SPECN./APPD. DATA SHEET/DRG.	IR	2	1		AT SITE

Q.P.NO.	CQS/SQP/42	SIGNATURE		DATE		DATE			DATE
REV.NO./ DATE	0/1-11-85 ,01 JULY,88	NAME							
PAGE NO.	6 OF 6	PARTY	CUSTOMER/CONSULTANT		BHEL		VENDOR		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 1… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS		FORMAT OF RECORD	AGENCY			REMARKS
					M	C	N			D		M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.	9.	10.	11.			12.
1	**RAW MATERIAL INSPECTION**														
1.1	Casting For Fan Hub Centre	Chemical Properties	Major	Chemical	1 sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	T.C.	P	V	V	As Cast Heat Mark Required
		Heat Treatment	Do	Heat Treatment	100%	-		Do	Do		HT Chart	P	V	V	
		Mechanical Properties	Do	Mech. test	1 sample per Heat/ HT batch			Do	Do	✓	T.C.	P	V	V	
		Dimensions	Do	Measurement	100%	-		Mfg /Drg.	Mfg. Drg.		IR	P	V	V	
		Surface Defect	Do	Visual	100%	-		Approved drg./ mfg. drg.	Free from Surface Defects		IR	P	V	V	
1.2	Pipes For Spokes & Braces	Review of Mnf. TC for Chemical / Mechanical / Flattening	Major	Review of TC	1 sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	T.C.	P	V	V	
		Dimensions	Do	Measurement	100%	-		Mfg. drg.	Mfg. Drg.		I.R.	P	V	V	
		Surface defect	Do	Visual	100%	-		-	No harmful Defects		Do	P	V	V	
1.3	BLADE CLAMP	Chemical & Mechanical Test	Major	Mech./ Chem.	1 Sample per Heat			Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	TC	P	V		
		Appearance	Major	Visual	100 %			Mfg. Drg.	Mfg. Drg.		TC	P	V		
		Dimension	Major	Measurement	Random			Mfg. Drg	Mfg. Drg		TC	P	V		
1.4	HARDWARE	Appearance & Dimension	Major	Visual	Random			Approved Drg./ Mfg. Drg.	Approved Drg./ Mfg. Drg.		IR	P	V		Compliance Report
1.5	GLASS ROVING FIBER GLASS	Weight	Major	Measurement	100 %			Manufacturer ES	Manufacturer's ES		TC	P	V		Manufacturer T.C Shall be submitted for Review.

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

M: MANUFACTURER/SUB-CONTRACTOR
C: MAIN SUPPLIER OF PACKAGE/SYSTEM,
N: BHEL/CUSTOMER/CONSULTANT

P: PERFORM
W: WITNESS
V: VERIFICATION.

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
				APPROVED BY	APPROVED BY
	Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 2… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMRKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.		9.	10			11
		Finish & Ribonization	Major	Visual	100 %			--- DO ---	--- DO ---		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
1.6	POLYSTER RESIN	Physical & Chemical	Major	Review of TC & Visual	Sample			Supplier Test Cerrtificate	Supplier Test Cerrtificate		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
1.7	FOAM	Free – rise Density	Major	Measurement	Sample			Supplier Test Cerrtificate	Supplier Test Cerrtificate		TC	P	V	-	Manufacturer T.C Shall be submitted for Review.
2	**IN PROCESS INSPECTION**														
2.1	Welding (Hub)	WPS/PQR/WQR	Major	Qualification Verification	100%	-		ASME-IX	ASME-IX		WPS PQR	P	-	-	Refer Note - 1
		NDT on Finished Weld	Critical	DPT	100%	-		ASTM E 165	NO INDICATIONS	✓	IR	P	V	V	
			Critical	RT	10%	-		ASME SEC VIII	ASME SEC VIII	✓	IR	P	V	V	On Butt Weld between Hub & Spokes
		Dimensions	Major	Measurement	100%	-		MFG. DRG.	MFG. DRG.		I.R.	P	V	V	
2.2	FAN BLADE	Appearance	Major	Visual	100 %	10%		Mfg. Drg & Manual K – 1109 P1	Mfg. Drg & Manual – 1109 P1		IR	P	V	V	
		Contour	Major	Measurement	100 %	10%		Mfg. Drg & Manual K – 1109 P1	Mfg. Drg & Manual – 1109 P1		IR	P	V	V	
		Proof Strength/Deflection	Major	Physical Test	100 %	10%		------- DO ----------	------- DO ----------	✓	IR	P	V	V	

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

M: MANUFACTURER/SUB-CONTRACTOR
C: MAIN SUPPLIER OF PACKAGE/SYSTEM,
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P: PERFORM
W: WITNESS
V: VERIFICATION.

	PREPARED BY	REVIEWED BY	APPROVED BY	BHEL	STANDARD
				APPROVED BY	APPROVED BY
	Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

MANUFACTURING QUALITY PLAN

NAME OF CONTRACT: STANDARD

NAME OF CONTRACTOR:STANDARD

ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062

SUB-SYSTEM:COOLING TOWER

DATE : **PAGE 3… OF….4**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK			REFERENCE DOCUMENT	ACCEPTANCE NORMS	D	FORMAT OF RECORD	AGENCY			REMRKS
					M	C	N					M	C	N	
1.	2.	3.	4.	5.	6.			7.	8.		9.	10			11.
3	**FINAL INSPECTION**														
3.1	Hot Dip Galvanizing of Fan Hub	Surface Defects	Major	Visual	100%	-		IS:2629	IS:2629	✓	I.R.	P	V	V	HDG Supplier TC' S Shall Be Submitted For Review
		Uniformity Of Coating	Major	Dip Test	Samples as per IS:2633			IS: 2633	IS: 2633	✓	I.R./TC	P	V	V	
		Thickness / Weight / Adhesion of Zn coating	Major	Mechanical	Samples as per IS:4759- 1996			IS:4759 - 1996	Approved drg./ mfg. drg.	✓	Do	P	V	V	
3.2	FAN ASSY. (Hub & Blades)	Overall Dimensions	Major	Visual	100%	20%		Approved drg./ mfg. drg.	Approved drg./ mfg. drg	✓	IR	P	W	W	
		Static Balancing	Do	Measure	100%	20%		Do	Do	✓	Do	P	W	W	CHP
		Blade Track Variations & Tip Clearence.	Do	Measure	100%	20%		Do	Do	✓	Do	P	W	V	
3.3	Identification & Packing	Serial Numbering	Major	Visual	100%			Mfg. Std.	Mfg. Std.	✓		P	V		
		Packing	Do	Visual	100%			Mfg. drg.	Mfg. Drg.	✓		P	V		
3.4	HUB COVER (FRP)	Appearence	Major	Visual	100%			MFG. DRG.	MFG. DRG.	✓	IR	P	V		
		Dimensions	Major	Measurement	100%			MFG. DRG.	MFG. DRG.	✓	Do	P	V		
	Note1:- Only Qualified Welders / WPS shall be used Note2:- Fan Hub will be done at manufacturer's works, Blades & Fan Assy. At manufacturer's works Note 3:-Before sending the documents for approval, supplier to ensure that 'Reference documents' and 'Acceptance norms" do contain data required for the characteristics to be checked as indicated in QP.														

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION					BHEL	STANDARD
M: MANUFACTURER/SUB-CONTRACTOR **C:** MAIN SUPPLIER OF PACKAGE/SYSTEM, **N**: BHEL/CUSTOMER/CONSULTANT	**P:** PERFORM **W**: WITNESS **V:** VERIFICATION.		PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED BY	APPROVED BY
			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

	MANUFACTURING QUALITY PLAN **NAME OF CONTRACT: STANDARD** **NAME OF CONTRACTOR:STANDARD**	**ITEM /EQUIPMENT : FAN ASSY. QP NO.: PE-QP-999-165-N062** **SUB-SYSTEM:COOLING TOWER** **DATE :** **PAGE 4… OF….4**

LEGEND: RECORDS IDENTIFIED WITH 'TICK ' SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION						BHEL	STANDARD
M: MANUFACTURER/SUB-CONTRACTOR **C:** MAIN SUPPLIER OF PACKAGE/SYSTEM, **N**: BHEL/CUSTOMER/CONSULTANT	**P:** PERFORM **W**: WITNESS **V:** VERIFICATION.		PREPARED BY	REVIEWED BY	APPROVED BY	APPROVED BY	APPROVED BY
			Divyanshu Arora	Maheep Singh	Vishal kumar Yadav		

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 1 OF 3	SYSTEM **POWER CYCLE/ LP VALVES**	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	**MATERIALS**											
1.1	BODY,BONNET, YOKE,WEDGE/DISC, SPINDLE, BODY SEAT, BACK SEAT, THRUST PLATE	1. PHYS,CHEM,PROPS	MA	PHYS,CHEM. TESTS	ONE/HEAT	APPD. DRG./ TECH.SPEC.	APPD. DRG./ TECH.SPEC.	TEST CERT.	3/2	2	1	CORRELATION REQD. FOR BODY BONNET, SPINDLE - FOR GREY C.I. ONLY PHYS. TEST.
		2. HEAT TREATMENT	MA	REVIEW OF H.T. CHART	100%	-DO-	-DO-	H.T. CHART	3/2	2	1	
		3. SURFACE DEFECTS	MA	VISUAL	100%	MSS-SP-55	MSS-SP-55	INSPN. REPORT	3/2	2	1	
1.2	BODY & BONNET FOR RATING 900 & ABOVE (ALSO FOR LOWER RATING IF REQUIRED IN SPEC.)	1. SURFACE DEFECTS	CR	PT/MT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	2,1	-	
		2. SUB-SURFACE DEFECTS	CR	RT/UT	100%	ANSI B16.34 AND TECH. SPEC.	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	FILM REVIEW BY BHEL
1.3	ACTUATORS 1. ELECTRIC ACTUATORS	1. TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH., ELEC. TESTS	100%	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET./ IS:9334	INSPN. REPORT	3	2,1	1 *	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. TRAVEL/STROKE	MA									
		3. TRAVEL TIME	MA									
		4. OPERATION OF LIMIT SWITCH	MA									
		5. MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6. OPERATION TEST WITH POWER SUPPLY VARIATION ENERGISES TO OPEN/CLOSE	MA									
		7. IR,HV,IR	MA									
		8.DEGREE OF PROTECTION	MA	WATER, DUST TEST	1/TYPE	TECH. SPEC./ APPD. DRG./ DATA SHEET/ IS:9334	APPD. DRG./ DATA SHEET/ IS:9334	3RD PARTY TEST CERT.	3	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 2 OF 3	SYSTEM **POWER CYCLE/ LP VALVES**	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
	2. PNEUMATIC ACTUATORS	1. LEAK TIGHTNESS	CR	PNEUMATIC TEST AT 1.2 X DESIGN	100%	APPD. DATA SHEET/MFG. STD.	NO LEAKAGE	INSPN. REPORT	3	2,1	1*	*BHEL TO WITNESS IF QTY. MORE THAN 10/ TYPE
		2. ACCURACY	CR	CALIBRATION	100%	-DO-	APPD. DATA SHEET/MFG. STD.	CALIBRATION REPORT	3	2,1	1*	
		3. SIMULATION (OPERATION, AIR TO OPEN/CLOSE)	CR	OPERATION AT RATED PRESSURE	100%	-DO-	-DO-	INSPN. REPORT	3	2,1	1*	
2.0	SS/STELLITE DEPOSIT ON DISC / BODY SEAT/BACK SEAT	1. SURFACE DEFECTS	CR	P.T	100%	ASTME:165 & TECH.SPEC.	ANSI B16.34 & TECH.SPEC.	-DO-	3/2	2,1	2,1	FOR 900 CLASS & ABOVE TO BE WITNESSED BY BHEL
3.O	IN-PROCESS INSPECTION											
3.1	MACHINING OF ALL COMPONENTS	1. DIMENSIONS, WORKMANSHIP AND FINISH	MA	MEAS.,VISUAL	100%	MFG.DRG.	MFG.DRG.	LOG BOOK	3/2	-	-	
3.2	WEDGE/DISC, BODY SEAT RING, BACK SEAT, SPINDLE, THRUST PLATE	1. HARDNESS	MA	TESTING	100%	APP.DRG.	APP. DRG./ ANSI B16.34	TEST CERT.	3/2	-	2,1	
3.3	SPINDLE, BODY SEAT RING, WEDGE/DISC, BACK SEAT	1. SURFACE DEFECTS	CR	P.T.	100%	ANSI B16.34 AND TECH. SPEC./	ANSI B16.34 AND TECH. SPEC.	-DO-	3/2	-	2,1	
3.4	WEDGE/DISC & SEAT RING, SPINDLE AND BACK SEAT	1. LAPPING	CR	BLUE MATCHING	100%	UNIFORM METAL TO METAL CONTACT		INSPN. REPORT	3/2	-	2,1	
4.0	ASSEMBLY	1. DIMENSIONS	MA	MEAS.	100%	APPD.DRG.	APPD.DRG.	-DO-	3/2	2,1	-	
		2. WEAR TRAVEL	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	FOR GATE VALVES ONLY
		3. VALVE LIFT	MA	MEAS.	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
5.0	TESTING											
5.1	BODY, SEAT, BACK SEAT	1. LEAK TIGHTNESS OF BODY	CR	HYDRAULIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2,1	-	
		2. LEAK TIGHTNESS OF BACK SEAT AND SEAT	CR	-DO-	100%	-DO	-DO-	-DO-	3/2	2.1	-	
		3. LEAK TIGHTNESS OF SEAT	CR	PNEUMATIC TEST	100%	-DO	-DO-	-DO-	3/2	2.1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN	CUSTOMER:	PROJECT:		SPEC. NO :
		BIDDER/VENDOR	QP NO.PE-QP-999-100-M004	REV. 00 DT.31.03.99	SPEC. TITLE
	SHEET 3 OF 3	SYSTEM **POWER CYCLE/ LP VALVES**	ITEM: GATE/ GLOBE VALVE		SECTION VOLUME

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE-GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
5.2	SEAT & BACK SEAT FOR MOTORISED/ PNEU. VALVES WITH ACTUATOR	1. LEAK TIGHTNESS OF SEAT	CR	HYDRUALIC TEST	100%	APPD. DRG./ TECH. SPEC.	NO LEAKAGE	I.R./ IBRTC (IF REQD)	3/2	2.1	-	
5.3	OPERATION AL TESTING											
	1. MANUALLY OPERATED VALVES	1. SMOOTH & FULL OPENING AND CLOSING	CR	MANUAL	100%	TECH. SPEC.	SMOOTH OPERATION OF VALVES & CLEAR BORE	INSPN. REPORT	3/2	2,1	-	
	2.MOTOR /PNEU OPERATED VALVES	1. ASCENDING& DESCENDING LIFT CHARACTERISTIC	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	APP. DRG./ TECH. SPEC./ IS:9334	INSPN. REPORT	3/2	2,1	-	
		2. LIMIT/TORQUE SWITCH SETTING FOR OPENING AND CLOSING TIME	CR	ELEC.	100%	APP. DRG./ TECH. SPEC./ IS:9334	TECH. SPEC./ APPD.DRG	INSP. REPORT	3/2	2,1	-	
6.0	COMPLETE VALVES	1. OVERALL DIMENSION	MA	MEAS	SAMPLE	APPD.DRG	APP.DRG.	-DO-	3/2	2,1	-	
7.0	END CONNECTION DETAILS	1. DIMENSIONS	MA	MEAS.	100%	APPD. DRG. / RELV.STD	APPD. DRG. / RELV.STD	-DO-	3/2	2,1	-	
		2. SURFACE DEFECTS FOR B.W. ENDS	CR	PT	100%	ASTME:165	NO DEFECTS	TEST CERT.	3/2	2	1	
8.0	FINAL INSPECTION	1. CLEANLINESS & COMPLETENESS	MA	VISUAL	100%	APPD. DRG./ TECH. SPEC.	APPD. DRG./ TECH. SPEC	INSPN. REPORT	3/2	-	2,1	
9.0	PAINTING	1. SURFACE PREPARATION	MI	VISUAL	100%	TECH. SPEC.	TECH. SPEC.	INSPN. REPORT	3/2	-	2,1	
		2. UNIFORMITY & THICKNESS	MI	MEASUREMENT	100%	-DO-	-DO-	-DO-	3/2	2	1	
10.0	PACKING	AS PER BHEL TECH. SPEC	MA	VISUAL	100%	AS PER BHEL TECH. SPEC.	AS PER BHEL TECH. SPEC	-DO-	3/2	-	2,1	

ABBREVIATIONS

CR = CRITICAL CHARACTERISTIC **P = PERFORMED BY** **W = WITNESSED BY** **V = VERIFIED BY**

MA =MAJOR CHARACTERISTIC **1 = PURCHASER (BHEL)** **2 = VENDOR** **3 = SUB VENDOR OF THE VENDOR**

MI = MINOR CHARACTERISTIC

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

QUALITY PLAN SHEET 1 OF 3	CUSTOMER :	PROJECT :		SPEC. NO
	BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99	VOLUME: II-B
	SYSTEM:	ITEM: PIPES & FITTINGS		SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0.0	MATERIAL CONTROL											
1.1.0	PIPES (MILL MADE)	1. PHY., CHEM. PROPS, DIMENSIONS, SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE), LEAK TIGHTNESS	MA	PHY, CHEM . TESTS MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART HYDRO TEST	TECH. SPEC., IS:4711	APPD. DATA SHEET/ TECH. SPEC.	APPD. DATA SHEET/ TECH. SPEC.	MFR.TC/ LAB REPORT	3	-	2,1	SAMPLE IDENTIFICATION BY BHEL
1.2.0	FITTINGS	1. PHY, CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/HEAT	-DO-	-DO-	-DO-	3/2	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM, VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3/2	-	2,1	
1.3.0	PLATE FOR FLANGES, FABRICATED PIPING AND FORGINGS FOR FLANGES	1. PHY. CHEM. PROP.,	MA	PHY., CHEM. TESTS	1/CAST	-DO-	-DO-	-DO-	3	-	2,1	-DO-
		2. DIMNS., SURFACE FINISH, HEAT TREATMENT (IF APPLICABLE)	MA	MEASUREMENTS, VISUAL EXAM VERI. OF HT CHART	100%	-DO-	-DO-	-DO-	3	-	2,1	
2.0.0	IN PROCESS CONTROL											
2.1.0	PIPES, FITTINGS, FLANGES - MACHINING, BENDING	1. DIMNS. INCLUDING THINNING, OVALITY, FINISH, WRINKLES ETC.	MA	MEASUREMENTS, VISUAL EXAM.	100%	MANUFAC-TURING DRG.	MANUFAC-TURING DRG.	I. R	3/2	-	2,1	
2.2.0	WELDING PROCEDURE SPECIFICATION	1. CORRECTNESS	MA	EXAM	100%	IS:7307/ ASME - IX	IS:7307/ ASME - IX	FORMAT OF IS:7307/ ASME - IX	3/2	-	2,1	
2.3.0	PROCEDURE QUALIFICATION AND WELDER'S QUALIFICATION	1. WELD SOUNDNESS	MA	PHY. TESTS	ASME IX IS:7310 IS:7307	IS:7310/ ASME - IX	IS:7310/ ASME - IX	FORMAT OF IS:7310/ ASME - IX	3/2	2,1	-	
2.4.0	WELD FIT-UPS	1. DIMNS.,	MA	MEASUREMENT,	100 %	W.P.S,	W.P.S,	I.R	3/2	2	1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

	QUALITY PLAN SHEET 2 OF 3	CUSTOMER :		PROJECT :			SPEC. NO					
		BIDDER/VENDOR		QP NO.PE-QP-999-100-MO41 REV.00 DT. 31.03.99			VOLUME: II-B					
		SYSTEM:		ITEM: PIPES & FITTINGS			SECTION D					

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
		ALIGNMENT, ORIENTATION		VISUAL		APPD. DRGS.	APPD. DRGS.					
2.5.0	**WELDS**											
	A) BUTT WELDS WITH JOINT EFFICIENCY OF 1.0 & 0.9											
	I) ROOT RUN	I) WELD DEFECTS	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME VIII DIV.I ASME B 31.1	INSPN. REPORT	3/2	2	1	
	ii) FINAL RUN	I) WELD DEFECTS	MA	-DO-	100%	-DO-	-DO-	-DO-	3/2	2/1	-	
				RADIOGRAPHY TEST	100% FOR JT. EFF. 1.0 & 10% FOR JT. EFF. 0.9	ASME B 31.1	ASME B 31.1	-DO-	3/2	-	2/1	FILMS TO BE SHOWN TO BHEL FOR APPROVAL
	B) OTHER BUTT WELDS WITH JOINT EFF. LESS THAN 0.9	1. WELD DEFECTS (FOR ROOT RUN & FINAL RUN)	MA	PENETRANT TEST	100%	IS:3658/ ASTM E 165	ASME B 31.1	INSPN. REPORT	3/2	2,1	-	
3.0.0	COMPLETE PIPE WORK & PIPES INCLUDING GALVANIZED/ RUBBER LINED PIPING (BEFORE GALVANIZING/ RUBBER LINING)	1. WORKMANSHIP AND FINISH, DIMNS., ORIENTATION, LEAK TIGHTNESS	CR	MEAS, VISUAL, HYDRO TEST AT 1.5 X DESIGN PRESS.	100%	APPD. DRGS.	APPD. DRGS., NO LEAKAGE	I.R.	3/2	2,1	-	
3.1.0	COMPLETE PIPE WORK (DULY GALVANIZED AS APPLICABLE)	1. FREEDOM FROM SURFACE DEFECTS	MA	VISUAL	100%	IS:4736/ IS 2629 & TECH. SPECN.	IS:4736/ IS 2629 & TECH. SPECN.	INSPN. REPORT	3/2	2,1	-	
		2. UNIFORMITY OF COATING	MA	DIP TEST	SAMPLING AS PER IS	IS 2633 & TECH. SPECN.	IS 2633 & TECH. SPECN.	-DO-	3/2	2,1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

QUALITY PLAN SHEET 3 OF 3	CUSTOMER :	PROJECT :		SPEC. NO
	BIDDER/VENDOR	QP NO.PE-QP-999-100-MO41	REV.00 DT. 31.03.99	VOLUME: II-B
	SYSTEM:	ITEM: PIPES & FITTINGS		SECTION D

S.NO.	COMPONENT/ OPERATION	CHARACTERISTICS CHECKED	CATE GORY	TYPE/METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
		3. MASS OF ZINC COATING	MA	STRIP TEST	-DO-	IS 4736/ IS 6745 & TECH. SPECN.	IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-	
		5. ADHESION	MA	ADHESION TEST	-DO-	IS-2629/ IS 4736 & TECH. SPECN.	IS-2629/ IS 4736 & TECH. SPECN.	-DO-	3/2	2,1	-	
3.2.0	COMPLETE PIPE WORK (RUBBER LINING AS APPLICABLE)	---------- AS PER QUALITY PLAN FOR RUBBER LINING----------										
4.0.0	PAINTING AND PACKING	1. SURFACE PREPARATION, DFT, NO. OF COATS, SOUNDNESS OF PACKING, MARKING ETC.	MA	VISUAL EXAM, MEASUREMENT	100%	APPD. PROCEDURE	APPD. PROCEDURE	I.R, MFRS CHECK LIST	3/2	-	2,1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/ VENDOR'S COMPANY SEAL

BHARAT HEAVY ELECTRICALS LIMITED

MANUFACTURERS NAME & ADD

MANUFACTURING QUALITY PLAN

ITEM : Sump pumps/Submersible Pump

QP NO: PE-QP-999-100-N005
REV-02
DATE: 14.06.16
PAGE 1 OF 2

PROJECT :
END CUSTOMER:
CONTRACT No.:
MAIN SUPPLIER: BHEL, Noida

SR. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	D*	AGENCY M	AGENCY B	AGENCY C	REMARKS
1	2	3	4	5	6	7	8	9	D*	10			
1.0	**Raw Material and Bought out Control**												
1.1a	Pump Casing	Physical Properties - Tensile Strength & Hardness / Chemical Composition	CR	Physical / Chemical Analysis	1 / Heat / Batch	Appd. C S Drg.	Approved drawing/Data sheet	Lab Report	√	P	V	V	
1.1b	Impeller	Physical Properties - Tensile Strength, Yield Strength & Elongation Chemical Composition	CR	Physical / Chemical Analysis	1 / Heat / Batch	Appd. C S Drg.	Approved drawing/Data sheet	Lab Report	√	P	V	V	
1.2	Heat treatment of Stainless Steel Castings	Heat Cycle	MA	Verification of HT chart	All Batches	Appd. C S Drg.	Approved drawing/Data sheet	Corelated HT charts	√	P	V	V	
1.3	Bars / forgings for pump and motor shafts	Physical/Chemical Properties	CR	Physical / Chemical Analysis	1 / Bar	Appd. C S Drg.	Approved drawing/Data sheet	Mill TC or lab report	√	P	V	V	
		Dimensions	MA	Measurment	100%	Manufacturers Drawing	Manufacturers Drawing	IR		P	V	V	
		Internal defects for 40 mm and above diameter	CR	UT	100%	ASTM A-388	Refer Note 1	IR	√	P	V	V	
1.4	Cable Type: PVC insulated, multicore, copper conductor	Routine TC and acceptance TC as per IS 694/Is1554, Length and size	MA	Measurement	100%	Approved Datasheet / IS 694/IS1554	Approved Datasheet / IS 694/IS1555	IR & TC	√	P	V	V	Compliance cert. To be submitted by Vendor
1.5	Bearings	Make, Bearing No., Surface finish	MA	Visual Examination	100%	Manufacturers Std	Manufacturers Std	IR		P	V		
2.0	**Inprocess Control**												
2.1	All Components	Visual Defects	MA	Visual	100%	Manufacturers Drawing	No harmful defects	Log book / IR		P	V	V	
		Dimensions	MA	Measurement	100%	Manufacturers Drawing	Manufacturers Drawing	Log book / IR		P	V	V	
2.2	Pump discharge casing	Leak tightness	CR	Hydro test (Duration 30 minutes min.)	100%	Refer Remark.	No leakage	IR	√	P	W	V	Test Pr.2 x duty pts. Pr. OR 1.5 x shut off whichever is higher
	Motor Housing	Leak tightness	CR	Air test (Duration 30 Minutes min)	100%	Air test at 0.5 kg/cm2 (guage pressure)	No leakage	IR	√	P	V	V	
2.3	Casing & Impeller (machined surfaces)	Surface Defects	CR	DPT	100%	ASTME:165	No Surface defect	IR	√	P	V	V	On machined surface only
2.4	Impeller	Static & Dynamic residual unbalance	CR	Static, Dynamic balancing	100%	ISO : 1940	ISO 1940 Gr. 6.3	IR	√	P	V	V	
2.5	Pump Motor Shaft	Internal Defects	CR	DPT	100%	ASTME:388	ASTME:388, Refer note 1	IR	√	P	V	V	On machined surface only
		Surface Defects	CR	DPT	100%	ASTME:165	No Surface defect	IR	√	P	V	V	On machined surface only
3.0	**Sub-Assembly, Assembly Control**												
3.1	Pump, Motor, Rotor	Eccentricity	MA	Measurement	100%	Manufacturers Drawing	Manufacturers Drawing	Log book / IR		P	V	V	
3.2	Pump and Motor assembly	Completeness, correctness	MA	Visual Examination	100%	Manufacturers Drawing	Manufacturers Drawing	IR		P	V	V	

LEGEND: RECORDS IDENTIFIED WITH "TICK" ( ) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION

** **M:** MANUFACTURER/SUB CONTRACTOR
B: BHEL, **C**:CUSTOMER (END USER)
P : PERFORM **W:** WITNESS **V :** VERIFICATION AS APPROPRIATE

BHEL DOC No.:PE : V8 - XXX - 100-N005

MANUFACTURER/ SUBCONTRACTOR	BHEL / CONTRACTOR	NAME AND SIGN OF APPROVING AUTHORITY AND SEAL
SIGNATURE		

ENGG DIV / QA & I

	BHARAT HEAVY ELECTRICALS LIMITED	MANUFACTURERS NAME & ADD		MANUFACTURING QUALITY PLAN									
				ITEM :	Sump Pump/Submersible Pump		QP NO: PE-QP-999-100-N005			PROJECT :			
							REV-02			END CUSTOMER:			
							DATE: 14.06.16			CONTRACT No.:			
							PAGE 2 OF 2			MAIN SUPPLIER:			BHEL, Noida

SR. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	D*	AGENCY M	AGENCY B	AGENCY C	REMARKS
1	2	3	4	5	6	7	8	9	D*	10			
4.0	**Final Inspection, Test, Packing, Despatch Control**												
4.1	Pump set (Pump+ Motor)	Q Vs Head, Q Vs Power Q Vs Efficiency	CR	Performance test	100%	Tech. Spec., Appd. Data Sheet, Appd. Curves, HIS, Test procedure	Tech. Spec., Appd. Data Sheet, Appd. Curves, HIS	Performance test record, Plotted Curves	Ö	P	W	V	
4.2	Routine Test on motor	HV, IR, Locked Rotor, No Load, Make type, Rating	CR	Electrical tests	100%	IS 325	Approved Data Sheet	IR	Ö	P	V	V	Widing resistance ** Degree of protection shall be IP 68, HV at 2.5 KV AC for 1 Minute.
4.3	Strip down after Performance test	Undue wer, tear and breakages	CR	Visual examination of Casing & Impeller after stripping	100%	Undue wer, tear and breakages	No undue wear, tear and breakages	IR	Ö	P	W	V	Witnessing one no. of each type
4.4	Complete Pump	Completeness, Correctness, Workmanship and finish, overall dimensions	MA	Visual examination	100%	Approved G.A. drawing	Approved G.A. drawing	IR	Ö	P	V	V	Compliance report for accessories will be submitted.
4.5	Completion of all stages	Completion	MA	Verification of IR's TC's	100%	Approved QP	Approved QP	IR	Ö	P	V	V	
4.6	Painting	Surface Preparation		Visual examination	100%	Approved data sheet/Manufacurer standard		IR		P	V	V	Compliance report by Manufacurer
		Adhesion, Uniformity and thickness		Visual Measurement	100%	As per painting schedule/Manufacurer standard		IR		P	W	V	Compliance report by Manufacurer
4.7	Wooden Packing	Soundness, Aesthetic		Visual	100%	As per packing procedure		IR		P			Compliance report by Manufacurer

Note :

1. For accessories and bought out items, Manufacurer will submit Compliance for review.

2. For UT test on shaft, defect echo < 20 % full screen height when back wall echo set @ 100 % screen height. Reduction in back wall echo to be <20%.
Defect height > 20 % of FSH is not acceptable, also loss in backwall echo>20 % not acceptable.

3. IP 68 protection certificate for test conducted on similar motor shall be submitted for review

4. Compliance for provision of thermic switch for over heating protection of winding, reverse rotation protection device shall be submitted by Manufacurer

5. For control panel separate QAP is applicable.

6. Before sending the documents for approval, supplier to ensure that "Reference documents" & "acceptance Norms" does contain data required for the Characteristic to be checked" as indicated in QP.

			LEGEND: RECORDS IDENTIFIED WITH "NCK" ( ) SHALL BE	BHEL DOC No.:PE : V8 - XXX - 100-N005
			ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION	
		BHEL	** **M:** MANUFACTURER/SUB CONTRACTOR	NAME AND SIGN OF APPROVING AUTHORITY AND SEAL
	MANUFACTURER/	CONTRACTOR	**B**: BHEL, **C:**CUSTOMER (END USER)	
	SUBCONTRACTOR		**P :** PERFORM **W:** WITNESS **V :** VERIFICATION AS APPROPRIATE	
	SIGNATURE			

ENGG DIV / QA & I

	MANUFACTURERS NAME & ADDRESS	STANDARD QUALITY PLAN		PROJECT
	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO REV 0 DATE 20.02.2001 PAGE 1 of 3	PACKAGE PROJECT No CONTRACTOR

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
1	**RAW MATERIAL & B/OUT ITEMS:**												
1.1	HOOKS	DIMENSIONS	MA	MEASUREMENT		IS 8610 GR M/P	IS 8610 GR M/P	T.C.		P	-	-	
		CHEMICAL COMPOSITION	MI	LAB ANALYSER									
		IDENTIFICATION & CORELATION WITH TC	MA	VERIFICATION		DRAWING	DRAWING & SPECIFCATION						
1.2	LOAD CHAIN	DIMENSIONS		MEASUREMENT	100%	IS 6216	IS 6216	MFR'S TC		P	-	-	
		BREAKING STRENGTH		TENSILE TEST									
1.3	RAW MATL FOR GEAR/RATCHET PAWL/RATCHET WHEEL	CHEMICAL COMPOSITION	MA	LAB ANALYSIS	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			
1.4	LOAD CHAIN WHEELS	TENSILE STRENGTH	MA	TENSILE TEST	ONE SAMPLE PER LOT	SPECS AS PER APPD. DRG.	RELEVANT STANDARD	TC		P			

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR
C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL)
N: CUSTOMER
INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	
SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY &SEAL

	MANUFACTURERS NAME & ADDRESS	**STANDARD QUALITY PLAN**		PROJECT
	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO	PACKAGE
			REV 0	PROJECT No
			DATE 20.02.2001	CONTRACTOR
			PAGE 2 of 3	

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
2	PROCESS												
2.1	HOOKS	PROOF LOAD	MA	LOAD TEST	100%	IS 8610	IS 8610	IR		P	W		
		DPT AFTER PROOF LOAD	MA		100%	ASTM 709	ASTM 709	IR		P	W		
2.2	RACHET PAWL/RACHET WHEEL	HARDNESS	MA	HARDNESS TESTER	100%	IS :1832	IS : 3832	IR		P	W		
		SURFACE CRACKES	MA	DPT	100%	ASTME				P	W		
2.3	LOAD CHAINS	PROOF - LOAD	MA	LOAD TEST	100%	IS : 6216	IS:6216	MFR'S		P			
3	FINAL INSPECTION												
3.1	COMPLETE ASSEMBLY	PROOF LOAD TEST	CR	LOAD TEST	100%	IS: 3832	IS: 3832	IR		P	W	W	
		OPERATIONAL EFFORT	MA	LOAD TEST	RANDOM	IS: 3832	IS: 3832	IR		P	W	W	
		HEIGHT OF LIFT	MA	MEASUREMENT	100%	IS: 3832	IS: 3832	IR		P	W	W	
		SWIVELLING OF HOOK	MA	VISUAL	100%	IS: 3832	IS: 3832	IR		P	W	W	

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR

C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL)

N: CUSTOMER

INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" CUSTOMER SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	
SIGNATURE			NAME & SIGN OF APPROVING AUTHORITY &SEAL

	MANUFACTURERS NAME & ADDRESS	STANDARD QUALITY PLAN		PROJECT
	(AS PER BHEL APPROVED VENDOR LIST)	ITEM: Chain Pulley Block With Trolley	QP NO	PACKAGE
			REV 0	PROJECT No
			DATE 20.02.2001	CONTRACTOR
			PAGE 3 of 3	

Sl. No	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	AGENCY M	AGENCY C	AGENCY N	REMARKS
1	2	3	4	5	6	7	8	9		** 10			11
3.2	PAINTING	CLEANED	MA	VISUAL	AT RANDOM	SPEC.	PE	IR		P	-	-	
		SHADE OF PAINT GOLDEN YELLOW	MA	VISUAL	AT RANDOM	SPEC.	PE	IR		P	W	W	
3.3	NAME PLATE	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	
3.4	PACKING	VERIFICATION	MI	VISUAL	100%	PR	PR	IR		P	W	-	

LEGNDS

* RECORDS INDENTIFIED WITH 'TICK'( ) SHALL BE ESSENTIALLY INCLUDED BY CONTRACTOR IN QA DOCUMENTATION

** M: MANUFACTURER/SUBCONTRACTOR

C: CONTRACTOR NOMINATED INSPECTION AGENCY(BHEL) N: INDICATE 'P' PERFORM"W" WITNESS AND "V" VERIFICATION AS APPROPRIATE " CHP" NTPC SHALL IDENTIFY IN COLUMN"N"

MANUFACTURER/ SUB CONTRACTOR	CONTRACTOR	REVIEWED BY	NAME & SIGN OF APPROVING AUTHORITY &SEAL
SIGNATURE			

STANDARD QUALITY PLAN

PROJECT :
VENDOR :

SYSTEM :
ITEM : BUTERFLY VALVES

S N	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT. EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL BOUGHT-OUT CONTROL											
1.1	BODY & SHAFT SEAT RING	1.CHEM COMPOSITION & PHYS. PROPS	MA	CHEM. & PHYS TESTS	ONE/HEAT BATCH	TECH SPEC APPD DRG	TECH SPEC / APPD DRG.	LAB REPORT / INSPN REPORT	3/2	-	2.1	CORRELATION NOT REQUIRED FOR GREY C.I. FOR OTHER POURING WITNESS BY BHEL
		2.INTERNAL DEFECTS OF SHAFT DIA ≥ 50MM	CR	UT	100%	ASTM A388 & XE 100%		INSPN. REPORT	3/2	2.1	-	MATERIAL IDENTIFICATION OF SHAFTS BY BHEL NOTE. COMPLIANCE TO CL - MS & GI CORRELATION & IDENTIFICATION FOR SS
		3.CASTING DEFECTS/ FORGING DEFECT	MA	1. VISUAL 2. MPI	100% 100%	MSSSP65 TECH. SPEC. APPD DATA SHEET	MSSSP55 TECH. SPEC / APPD DATA SHEET	-DO-	3/2	-	2.1	
1.2	DISC & SHAFT SEAL	1. VISUAL INSPECTION 2. DIMENSIONS 3. HARDNESS 4. O ZONE RESISTANCE 5. AGEING TEST	MA MA MA MA MA	VISUAL MEAS MEAS TESTING TESTING	100% 100% 100% 1/BATCH -DO-	TECH SPEC -DO- -DO- -DO-, ASTM D1149 IS 3400	TECH. SPEC -DO- -DO- -DO-, RELV. STD. -DO-	LOG BOOK -DO- TEST CERT. -DO- -DO-	3/2 3/2 3/2 3/2 3/2	- - - - -	- - - - -	COMPLIANCE TO
1.3	COUNTER FLANGES	1. CHEM., PHYS. PROPERTIES	MA	CHEM. PHYS. TEST	1/HEAT	APPD. DRG. /DATA SHEET	APPD. DRG. /DATA SHEET	LAB. REPORT, INSPN. REPORT	3/2	-	-	COMPLIANCE TC FOR MATERIAL IDENTIFICATION BY BHEL

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		SIGNATURE			SIGN.
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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

PROJECT :
VENDOR

SYSTEM :
ITEM BUTERFLY VALVES

S. NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CAT-EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
		2 DIMENSION	MA	MEASUREMENT	100%	-DO-	-DO-	INSPN. REPORT	3/2	2 1	-	
		3. INTERNAL DEFECTS FOR THICKNESS 50MM AND ABOVE	CR	UT	100%	ASTM A435	ASTM A435	INSPN. REPORT	3/2	2 1	-	
		4 HEAT TREATMENT		SR/M.T. CHART	100%	STANDARD PRACTICE	STANDARD PRACTICE	CORRELATED SR/M.T. CHART	3/2	-	-	
4	FASTENERS (APPD. MAKE	1 VERIFICATION OF MAKE GRADE	MI	VISUAL	100%	TECH. SPEC /DATA SHEET	TECH. SPEC DATA SHEET	INSPN. REPORT	3/2	2	1	
5	OPERATORS (GEAR BOX GE	COMPOSITION	MA	CHEM ANALYSIS	ONE/BATCH	AS PER MATERIAL SPEC	AS PER MATERIAL SPEC	TC'C'	3	3	2/1	
5 1	GEAR / PINION, SHAFT	HARDNESS	MA	MEAS	SAMPLING	AS PER APPD DRG /MATL SPEC	AS PER APPD DRG /MATL SPEC	TC'C'	3	3	2/1	
		DIMENSION	MA	-DO-	-DO-	-DO-	-DO-	REPORT	3	3	2/1	UT ON GEAR BLANKS
		NDT	MA	UT/MPI	100%	-DO-	-DO-	TC'C'	3	3/2	2/1	UT ON SHAFTS & SCREW DIA
5 2	HYDRAUL. TEST OF GEAR B( ) AT 2) RATED TORQUE	TORQUE TRANSMITTING	MA	TESTING	ONE/TYPE	AWWA C504 STD 87	AWWA C504 STD 87	TC'C CHP	3	3/2	2/1	MPI OR LPI ON GEAR & SHAFT AFTER MACHINING
												**NO DAMAGE TO TEETH FACE OF GEAR
5 3	ELECTRICAL ACTUATORS	1 TORQUE TESTING & SETTING OF TORQUE SWITCH	MA	MECH./ELEC. TESTS	100%	TECH. SPEC /APPD DRG /DATA SHEET/ IS 9334	APPD DRG /DATA SHEET/IS 9334	INSPN. REPORT	3	2 1	-	BHEL TO WITNESS 1 PER TYPE IF QTY IS MORE THAN 10/TYPE

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		SIGNATURE				SIGN.	
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BHARAT HEAVY ELECTRICALS LIMITED
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NO	OPERATION	CHARACTERISTICS CHECKED	CAT-EGO-RY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY	REMARKS
1	2	3	4	5	6	7	8	9		10		
		2 TRAVEL/STROKE	MA									
		3 TRAVEL TIME	MA									
		4 OPERATION OF LIMIT SWITCH										
		5 MANUAL OPERATION THROUGH HAND WHEEL	MA									
		6 OPERATION TEST WITH POWER SUPPLY VARIATION, ENERGISE TO OPEN/CLOSE, CURRENT DRAWN	MA									
		7 IR, HV, IR	MA									
		8 DEGREE OF PROTECTION	MA	WATER DUST TEST	1/TYPE	-DO-	-DO-	3rd PARTY TEST CERT	3	-	2.1	
6	HYD. TEST	1 CHEM & PHYS. PROPS	MA	CHEM. PHYS TESTS	1/HEAT/ BATCH	APPD. DRG. /DATA SHEET	APPD. DRG. /DATA SHEET	TEST CERT	3/2	-	2.1	
		2. HARDNESS	MA	MEAS	100%	-DO-	-DO-	-DO-	3/2	-	2.1	
		3 DIMENSIONS	MA	MEAS.	100%	MFG. DRG	MFG. DRG.	LOG BOOK	3/2	-	-	
		4. LEAK TIGHTNESS	MA	HYDRO TEST	100%	APPD. DATA SHEET	NO LEAKAGE	INSPN. REPORT	3/2	2.1	-	
	RAW MATL.	1. CHEM., PHYS. PROPS.	MA	CHEM., PHYS. TESTS	1/HEAT	APPD. DATA SHEET	APPD. DATA SHEET	TEST CERT.	3/2	2	1.1	
		2. DIMENSION	MA	MEASURE-MENT	100%	MFG. DRG.	MFG. DRG.	LOG SHEET	3/2	-	-	

			PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY VENDOR
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REV. NO DATE	00/8-10-97	NAME				NAME
		SIGNATURE				SIGN
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BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

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S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
	CLIP SHROUD	1 CHEM PHYS PROPS	MA	CHEM PHYS TESTS	1/BATCH	MATL SPEC /APPD ORG.	MATL SPEC /APPD ORG	LOG BOOK	3/2	2	1	
		2 DIMENSIONS	MA	MEAS.	100%	MFG ORG.	MFG ORG	-DO-	3/2	2	1	
		3 HARDNESS	MA	MEAS	100%	-DO-	-DO-	TEST CERT	3/2	2	1	
2.0	IN-PROCESS CONTROL											
2.1	BODY & DISC	1 SURFACE DEFECTS	MA	PT	100%	ASTME-165	NO DEFECTS	INSPN REPORT	3/2	2	1	
		2 DIMENSIONS	MA	MEAS	100%	MFG ORG	APPD ORG	LOG BOOK	3/2	-	-	
		3 LEAK TIGHTNESS OF BODY	MA	HYDRO TEST	100%	TECH. SPEC /APPD ORG /DATA SHEET	NO LEAKAGE	INSPN REPORT	3/2	-	2.1	
2.2	SHAFT	1 DIMENSIONS	MA	MEAS	100%	MFG ORG	APPD ORG	LOG BOOK	3/2	-	-	
		2 SURFACE DEFECTS AT DISC	MA	PT	100%	ASTME-165	NO SURFACE DEFECTS	INSPN REPORT	3/2	-	2.1	
2.3	SEAT RING	1 DIMENSIONS	MA	MEAS	100%	MFG ORG	APPD ORG	LOG BOOK	3/2	-	-	
		2 BOND STRENGTH IN CASE OF RUBBER SEAT	MA	PEEL STRENGTH	ONE/BATCH	ASTMD 429	ASTMD429	TEST CERT	3/2	-	2.1	
		3 HARDNESS	MA	MEAS	100%	MFG ORG	MFG ORG	-DO-	3/2	2	1	

			PREPARED BY	REVIEWED BY	APPROVED BY	ACCEPTED BY
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Q.P. NO.	PEM/MSE/SOP/03	NAME				NAME
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S NO	COMPONENT OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
		4 SURFACE DEFECTS	MA	PT	100%	ASTME 165	NO SURFACE DEFECTS	-DO-	3/2	2	1	
			MA	PHYS TESTS	100%	ASME IX	ASME IX	FORMATS OF ASME IX	3/2	2.1	1	
2.4	WELDED FLANGES/COUNTER FLANGES											
		1 FIT UP	MA	MEAS, TEMPLATE, VISUAL	100%	MFG DRG	MFG DRG	LOG BOOK	3/2		2.1	FOR FABRICATED FLANGES ONLY FILMS TO BE SHOWN TO BHEL
		2 INTERNAL DEFECTS OF WELDMENTS	CR	RT/UT	100%	ASME VIII DIV. I	ASME VIII DIV I	RADIO GRAPH REPORT FILMS	3		2.1	
2.4.1	WELDING PROCEDURE SPECIFICATION	CORRECTNESS	MA	EXAM	100%	ASME SEC IX	ASME SEC IX	QW 482 OF ASME SEC IX	3/2		2.1	
2.4.2	WELDING PROCEDURE QUALIFICATION	WELD SOUNDNESS	MA	VISUAL, PHYS. TESTS RT (AS APPLICABLE)	100%	ASME SEC IX	ASME SEC IX	QW 483 OF ASME IX	3/2	2.1		WELDING PROCEDURE APPROVEL BY BHEL AS WELL AS 3RD PARTY (LLOYDS, BVQI OR EQ.)
2.4.3	WELDER PERFORMANCE QUALIFICATION	WELL SOUNDNESS	MA	-DO	100%	ASME SEC. IX	ASME SEC. IX	QW 484 OF ASME	3/2	2.1		

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		SIGNATURE				SIGN
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PROJECT ENGINEERING MANAGEMENT

STANDARD QUALITY PLAN

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S NO	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9		10		11
2.4.4	WELD FIT-UPS	1 DIMENSION/ALIGNMENT	MA	MEAS, VISUAL EXAM	100%	WPS, MFG. DRAWING	WPS, MFG. DRAWING	IR/LOG BOOK	3/2	-	-	
2.4.5	ROOT RUNS	1 SURFACE DEFECTS	MA	PENETRANT TEST	100%	ASTME 165	NO SURFACE DEFFECT	-DO-	3/2	-	2	
2.4.6	WELDMENTS	1 SURFACE DEFECTS	MA	-DO-	100%	ASTME 165	ASME-VIII, DIV. I,	INSPN REPORT	3/2	2,1	-	
2.4.7	BUTT WELDS	INTERNAL DEFECT	MA	UT/RT	100%			IR	3/2	-	2,1	WITNESSING OF U T
2.4.8	SR WELDING	SR	-	SR	100%	ASME SEC. V	ASME SEC VIII, DIV I	IR	3,2	-	2,1	
3.0	FINAL ASSEMBLY											
3.1	VERIFICATION OF ALL PREVIOUS TEST AND DOCUMENTS	VERIFICATION OF RECORDS	MA	-DO-	100%	TECH. SPEC.	TECH. SPEC		2	-	1	
3.2	TESTS (HYDRAULIC)	1 BODY TEST 2 DISC STRENGTH 3 SEAT LEAKAGE 4 PERFORMANCE TEST	MA MA MA MA	HYDRO TEST HYDRO TEST -DO- PERFORMANCE	100% 1/TYPE 100% 3 TIMES UNDER NO LOAD/FLOW COND. BOTH MANUAL & THROUGH OPERATORS	TECH. SPEC /REL. STD -DO- -DO- -DO-	TECH /SPEC / REL. STD -DO- -DO- -DO-	TEST CERT. -DO- -DO- -DO-	3,2 3/2 3/2 3,2	2,1 2,1 2,1 2,1	- - - -	

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	COMPONENT / OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE OF CHECK / METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENTS	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
2		3	4	5	6	7	8	9				11
		5 TESTING OF ACCESSORIES	MA	TESTING	100%	TECH SPEC /REL STD	TECH SPEC /REL STD	TC	3.2	2		
		6 PROOF OF DESIGN TEST	MA	TESTING	1 TYPE	DO.	DO.	TC	3.2	2		NOTE: IF CYCLE LIFE TEST ALREADY CONDUCTED ON SIMILAR SIZE, RANGE & VALVE REPORT SHALL BE SUBMITTED
4	SHIPPING RELEASE											
5	FINAL INSPECTION	1 OVERALL DIMENSIONAL	MA	MEASUREMENT	100%	APPD DRG	APPD DRG		3.2	2		
		2. DOCUMENTATION REVIEW	MA	REVIEW	100%	TECH SPEC APPD DRG	TECH SPEC APPD DRG		3.1			
		3 CLEANLINESS	MA	VISUAL	100%	DO.	DO.		3.2	2		
		4 NAME PLATE DETAILS	MA	VISUAL	100%	DO	DO		3.1			
		5 STAMPING	MA	STAMPING	100%	DO.	DO.		3			
6	PAINTING	1 SURFACE PREP	MI	VISUAL, MEAS.	100%	TECH SPEC	TECH SPEC	INSPN REPORT	3.2		2.1	
		2. UNIFORMITY & THICKNESS	MI	DO.	100%	DO.	DO.	DO.	3.2		1	

			PREPARED BY	REVIEWED BY	APPROVED BY		ACCEPTED BY
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Q.P. NO.	PEM/MSE/SQP/03	NAME				NAME	
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SUB-SECTION - IIB

STANDARD TECHNICAL SPECIFICATION (ELECTRICAL)

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement ofr rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechnical vibration of rotatinf electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable fro three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be sutable fro mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechnical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise statedin Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 Unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or V W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

	TITLE	SPECIFICATION NO.
	LV MOTORS	VOLUME II B
		SECTION D
	DATA SHEET-A	REV NO. 00 DATE 09.05.2018
		SHEET 1 OF 1

1.0	Design ambient temperature	:	50 ºC
2.0	Maximum acceptable kW rating of LV motor	:	<200KW
3.0	Installation (Indoors/ Outdoors)	:	As required
4.0	Degree of Protection (Indoor/Outdoor)	:	IP55
5.0	Type of Cooling	:	TEFC/CACW
6.0	Details of supply system		
	a) Rated voltage (with variation)	:	415V ± 10%
	b) Rated frequency (with variation)	:	50 Hz (Variation: +3% TO –5%)
	c) Combined voltage & freq. variation	:	10%
	d) System fault level at rated voltage	:	50 kA for 1 sec
	e) Short time rating for terminal boxes		
	o 90kW & Above (Breaker controlled)	:	50 kA for 1 sec
	o Below 90kW (SFU/MCCB+: Contactor controlled)		50 kA for 0.20 sec.
	f) LV System grounding	:	Solidly
7.0	Class of insulation	:	Class ‘F’, with temp rise limited to class B.
8.0	Minimum voltage for starting (As percentage of rated voltage)	:	80% of rated voltage
9.0	Power cables data	:	Shall be given during detailed engg.
10.0	Earth Conductor Size & Material	:	Shall be given during detailed engg.
11.0	Space heater supply	:	240 V, 1Φ, 50 Hz
12.0	Rating up to which Single phase motor	:	Acceptable below 0.20 kW
13.0	Tests	:	As per motor spec. (enclosed)
14.0	Energy efficient/ Flame proof motor	:	Continuous duty LT motors up to 160 KW Output rating (At 50 deg.C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC: 60034-30.

- **For further detailing please refer specification**

	TITLE	SPECIFICATION NO.
	MOTOR	**VOLUME II B**
		SECTION D
	DATA SHEET - C	**REV NO. 00 DATE 09.05.2018**
		SHEET 1 **OF** 2

S. No.	Description	Data to be filled by successful bidder
A.	**General**	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	**Design and Performance Data**	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a Voltage	
6	b Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR				REV.	
NAME	SIGNATURE	DATE	SEAL		

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	**Constructional Features**	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	**Characteristic curves/ drawings** (To be enclosed for motors of rating ≥ 55KW)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
		SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	**W**	**V**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	IS-325/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN	CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :					
		BIDDER/ VENDOR :		QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :					
	SHEET 2 OF 2	SYSTEM		ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

NOTES:

1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON

2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

			CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
	QUALITY PLAN		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 1 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	-DO-	INSPEC. REPORT	3	-	2	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-	3	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IS/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%		FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK	3	-	2	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IS/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 2 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	MFG. DRG. SPEC.	RELEVANT IS	SUPPLIER'S TC	3	-	2	
		3. DIMENSIONS	MA	MEASUREMENT	100%	-DO-	MANUFR'S DRG.	LOG BOOK	3	-	2	
		4.INTERNAL FLAWS	CR	UT	-DO-	ASTM-A388	MANUFR'S SPEC. BHEL SPEC.	-DO-	3	2	1	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNEC-TORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	-DO-	MANUFR'S DRG. SPEC.	MANUFR'S DRG. SPEC.	-DO-	3	-	2	
		2. PHYSICAL COND.	MA	-DO-	-DO-	-	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	-DO-	3	-	2	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG./ SPEC.	MANUFR'S DRG. / SPEC.	-DO-	3	-	2	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-DO-	-DO-	INSP. REPORT	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 3 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	NO VISUAL DEFECTS	INSPT. REPORT	3	-	2	
		2. OTHER CHARACTERISTICS	MA	TEST	SAMPLE	MANUF'S SPEC.	MANUF'S SPEC.	LOG BOOK AND OR SUPPLIER'S TC	3	-	2	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK	3	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	MANUFR'S DRG. .	MANUFR'S DRG.	-DO-	3	-	2	FOR MV MOTOR INSULA-TION/VARNISH THICKNESS SHALL BE MORE THAN THE BURS HEIGHT
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	-DO-	MANUF'S SPEC./ RELEVANT IS	RELEVANT IS	SUPPLIER'S TC	3	-	2	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	LOG BOOK	3*	-	2*	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY BHEL/CUSTOMER.
		2.ELECT. PROP, & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	RELEVANT IS/ BS OR OTHER STANDARDS	RELEVANT IS/ BS OR OTHER STANDARDS	SUPPLIERS TC & VENDOR'S INSPN. REPORTS	3	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 4 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	-DO-	Log Book	3	-	2	
1.10	BEARINGS	1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2	
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./ BHEL SPEC.	MANUF'S SPEC./ BHEL SPEC.	-DO-	3	-	2	
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./ SPECS.	-DO-	3	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 5 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	2	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVENT SPEC./ ASTM-E165	MANUFR'S SPEC./ BHEL SPEC./	-DO-	2	-	1	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	MANFR'S SPEC/BHEL SPEC./ RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	Log Book	2	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE			
	SHEET 6 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	FOR MV MOTOR
2.6	IMPREGNATION	1.VISCOSCITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 7 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		4.DURATION	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.7	COMPLETE STATOR ASSEMBLY	1.COMPACTNESS & CLEANLINESS	MA	VISUAL	100%	-DO-	-DO-	Log Book	2	-	-	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.SOUNDNESS	CR	MALLET TEST & UT	-DO-	-DO-	-DO-	Log Book	2		1	
		3.HV	MA	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2		1	
2.9	COMPLETE ROTOR ASSEMBLY	1.RESIDUAL UNBALANCE	CR	DYN. BALANCE	-DO-	MFG SPEC./ ISO 1940	MFG. DWG.	Log Book	2		1	VERIFICATION FOR MV MOTOR ONLY
		2.SOUNDNESS OF DIE CASTING	CR	ELECT. (GROWLER TEST)	-DO-	MFG. SPEC.	MFG. SPEC.	Log Book	2		1	
2.10	ASSEMBLY	1.ALIGNMENT	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	-	
		2.WORKMANSHIP	MA	VISUAL	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.AXIAL PLAY	MA	MEAS.	-DO-	-DO-	-DO-	Log Book	2	-	1	
		4.DIMENSIONS	MA	-DO-	-DO-	MFG.DRG./ MFG SPEC.	MFG. DRG/ RELEVANT IS	Log Book	2	-	-	
		5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2	-	-	
		6. RTD, BTD & SPACE HEATER MOUNTING.	MA	VISUAL	100%	MFG SPEC. RELEVANT IS	MFG SPEC. RELEVANT IS	Log Book	2		1	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03	SPECIFICATION : TITLE
	SHEET 8 OF 9	SYSTEM	ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS AS PER BHEL SPEC.	MA	ELECT.TEST	1/TYPE/SIZE	IS-325/ BHEL SPEC./ DATA SHEET	IS-325/ BHEL SPEC./ DATA SHEET	TEST REPORT	2	1*	1	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	-DO-	100%	IS-12075 & IS-12065	IS-12075 & IS-12065	-DO-	2	1$	1	$ NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IS	INSPC. REPORT	2	1	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	RELEVANT IS	BHEL SPEC. AND DATA SHEET	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	-DO-	100%	-DO-	-DO-	-DO-	2	1$	1	$ NOTE - 2
		8. NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPC. REPORT	2	1$	1	$ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	IS-3682 IS-8239 IS-8240	IS-3682 IS-8239 IS-8240	TC	2	-	1	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	BHEL SPEC. & DATA SHEET	BHEL SPEC. & DATA SHEET	TC	2	1$	1	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY $ NOTE - 2

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :		
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03			SPECIFICATION : TITLE		
	SHEET 9 OF 9		SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)			SECTION		VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11

NOTES:

1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.

2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.

3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THESE TEST MAY NOT BE REPEATED.

4 WHEREVER CUSTOMER IS INVOLVED IN INSPECTION, AGENCY (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER.

Legends for Inspection agency

1. BHEL/CUSTOMER
2. VENDOR (MOTOR MANUFACTURER)
3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER)

P. PERFORM
W. WITNESS
V. VERIFY

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
		BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E005, REV. 01			SPECIFICATION TITLE:			
	SHEET 1 OF 2	SYSTEM CABLING			ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :			

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS1079	IS1079	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDAL ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APPD. DATA SHEET	IS-1730/ APPD. DATA SHEET	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS-1079	IS-1079	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	TC	3/2	-	1/2	
2.0	IN-PROCESS											
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.
		3.SURFACE FINISH	MA	VISUAL	100%	APPD.DRG.	APPD.DRG.	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING & RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E005, REV. 01			SPECIFICATION TITLE:			
	SHEET 2 OF 2		SYSTEM	CABLING		ITEM : CABLE TRAYS & ACCESSORIES			DOC. NO. :			

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF ZINC BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	2/3	-	-	Galvanization is to be done at galvanisation plant listed in annexure-2 to quality plan.
		2.DROSS	MA	VISUAL	PERIODIC	IS 2629	IS 2629	QC RECORD	2/3	-	-	
		3.RATE OF IMMERSION	MA	VISUAL	100%	IS 2629/ MFR'S PRACTICE	IS2629/ MFR'S PRACTICE	QC RECORD	2/3	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS 2629	FREE FROM BURRS ROUGHNESS, SLAG FLUX. STAIN. ETC.	QC RECORD	2/3	-	-	
3.0	FINISHED ITEMS											
3.1	(CABLE TRAY, ACCESSO-	1.DIMENSIONS	MA	MEASUREMENT	IS-2500 (PART 1)	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	Overall thickness of finished product shall not be less than the thickness of cable tray & accessories defined in technical datasheet.
	RIES & HARDWARES)				LEVEL S-4							Following shall be engraved/ punched on each standard length of cable tray at the center of both sides
		2,SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	INSP.REPORT	2	1	-	of runner:'PEM' (length of letter 90mm & height 30mm). Fasteners shall be of good quality as per IS 1363
		3.RIGIDITY (FOR TRAYS)	MA	DEFLECTION TEST	2 No./ LOT/TYPE	APPD. DRG	APPD. DRG	INSP.REPORT	2	1	-	600MM wide cable tray to be testsed. Maximum deflection shall not exceed 7MM on mid span on uniform loading of 100KG/M.
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745	610 gms/ Sq m (for 2.0mm thick product) 610 gms/ Sq m (for 1.7 mm thick product)	INSP.REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-2633	IS-2633	INSP.REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS-4759	75 MICRONS (minimum), 86 MICRONS (average) for 2.0mm ,3.0mm & 1.7mm thick product	75 MICRONS (minimum), 86 MICRONS (average) for 2.0mm,3.0mm & 1.7mm thick product	INSP.REPORT	2	1	-	
		7.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP.REPORT	2	1	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : 1 - BHEL/ CUSTOMER 2 - VENDOR 3 - SUB- VENDOR P - PERFORM W - WITNESS V - VERIFICATION

ANNEXURE-2 to Quality Plan

(LIST OF BHEL- PEM APPROVED GALVANIZERS)

SL. NO.	ITEM	VENDOR NAME	ADDRESS
1	Galvanising	Jenco Industrial Corporation	Chincholi Bunder Khkar Road Near Link Road Devruwadi Malad (W) Mumbai 400064
2	Galvanising	National Galvanizing Company	66, Barrackpore Kamarhatt Trunck Road Calcutta-700058
3	Galvanising	Sigma Galvanising Pvt. Ltd.	Plot No.C-169, TTC, MIDC Ind Area Navin Mumbai-400705
4	Galvanising	B.P. Projects PVT LTD	167A, Vivekananda Road Kolkata-700006
5	Galvanising	Standard Galvanisers	Makardah Road, Kabar Para, Bankra, Howarah -711403
6	Galvanising	Steel Products	National Highway No. 6, Chamrail, Kona, Howrah-711114
7	Galvanising	Unitech Fabricators & Engineers Pvt. Ltd.	Village- Ajab Nagar, P.O. -Molla Simlla, P.S. - Singur, Dist - Hoogly, Pin-712223
8	Galvanising	Shivam Engineers & Fabricators	A0-282-284, Industrial Area, South Side of G.T. Road, Ghaziabad, U.P.
9	Galvanising	B.G. Shirke Construction Technology Pvt. Ltd	72-76, Mundhawa, Pune - 401 036
10	Galvanising	Galbro Ispat Galvanizers Pvt. Ltd.	GUT 11 AND 12, OPP. Kudus Steel,Rolling Mill, Wada, Thane , Mumbai
11	Galvanising	Eros Metals	G-97, MIDC, Bhutibori , Nagpur
12	Galvanising	Industrial Perforation (India) Pvt. Ltd.	Ganganagr, Katakhal, Kolkata-700132
13	Galvanising	Indmark Formtech Pvt. Ltd.	Phase - 3, E - 11 / 1, M. I. D. C., Chakan, Pune - 410 501, Maharashtra, India.
14	Galvanising	Namdhari Industrial Traders Pvt. Ltd.	Village Latton Dana, Chandigarh Road, Ludhiana
15	Galvanising	Neha Galvaniser	Jalan Industrial Estate, Gate No-1, 1st Right Choise Lane, Near N.G-6, Jangalpur, PO Domjur Howrah - 700071, West Bengal, India
16	Galvanising	Patny Systems (P) Ltd.	Unit-IV, Sy No. -228/9, Plot No. 6, IP Kuchavaram, Toopran(M) Dist.-Medak, Telegana - 502336
17	Galvanising	Parmar Metal Company	Survey No.207,Veraval (Shapar) Dist. Rajkot, India.
18	Galvanising	Passive Infra Projects Pvt. Ltd	8th KM Stone, Sampla Kharkhoda Road, Hassangarh, Rohtak, Haryana
19	Galvanising	Rukmani Electrical & Fabricators Pvt, Ltd.	Urla Industrial Area, Urla Sarora Road, Raipur– 493 221 (Chhattisgarh) Shankharidaha Baniyarah, Jalan Industrial Complex, Gate no.3, Lane no. 4, Domjur, Howrah , W.B .- 71141
20	Galvanising	DMP Projects Pvt.Ltd.	Dulagarh Industrial Park , PS-Sankrail , Howrah -711302
21	Galvanising	Vinfab Engineers India Private Limited	Gut no. 224/1 &2 Bhiwandi Wada State Highway, Village khupri, Dist. Thane, Maharashtra -421303
22	Galvanising	Saral Projects & Processors	B-1, Industrial Area, Site-II, Amawan Road Rae Bareli
23	Galvanising	Jamna Metal Company	D - 1513, DSIDC, Narela Industrial Area Delhi - 110040, India
24	Galvanising	Brahampuri Steels Limited	172 (F) Industrial Area, Jhotwara, Jaipur-302013
25	Galvanising	Indiana Gratings PVT. LTD	F-5, MIDC Jejuri, Pune-412 303

NOTES:

1. ANY CHANGE IN THE ABOVE LIST SHALL BE INFORMED AT THE TIME OF SPECIFIC PROJECT REQUIREMENT AND NO COMMERCIAL IMPLICATION SHALL BE ALLOWED ON THIS ACCOUNT.

2. IT SHALL BE THE RESPONSIBILITY OF THE VENDOR TO GET THE MATERIAL GALVANIZED FROM THE ABOVE LIST WITHOUT ANY COMMERCIAL IMPLICATION TO BHEL.

	MANUFACTURING QUALITY PLAN		QAP DOC. NO.:
	CUSTOMER: PRODUCT: FRP CABLE TRAYS & ACCS.	INSPECTION CATEGORY : BULK ITEMS	REV NO: / DATE: PAGE 1 OF 2

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPT-ANCE NORMS	FORMAT OF RECORD	*D	AGENCY 1	AGENCY 2	AGENCY 3	REMARKS
1.0	**RAW MATERIALS & BOUGHT OUT ITEMS**												
	Glass Mat	Average GSM	-	Review	Lot	Vendor Test Certificate	ISO 3374 / EN 13473-1	Manufacturer Standard	√	H	R	R	TC Review
	Polymer Resin	Type of Resin	-	Review	Lot	Vendor Test Certificate	IS 6746	Manufacturer Standard	√	H	R	R	TC Review
	Stainless Steel	Grade of SS	-	Review	Lot	Vendor Test Certificate	AISI 304	Manufacturer Standard	√	H	R	R	TC Review
2.0	**FINAL INSPECTION & TESTING**												
	Finished Product	Size, Marking, Surface Finish, Quantity as per P.O., Accessories check	-	Visual & Dimensional	Random	Approved Drawings / Approved VPDS	Approved drawings / As Per PO	Manufacturer Standard	√	H	RW	W	3 samples of Each Type & Size per lot
		Load Test & Deflection Test	-	Measure	Random	NEMA FG1 1993 / Approved VPDS	Approved VPDS / NEMA FG1 1993	Manufacturer Standard	√	H	RW	W	3 samples of Each Type & Size of Tray
		Flame Retardancy Test	-	Witness	1 per Lot	ASTM D 635	Ref. Burning Rate of Acrylic	Manufacturer Standard	√	H	RW	W	1 sample per lot
		Oxygen Index Test	-	Witness	1 per Lot	ASTM D 2863	More than 21 / Approved Data Sheet	Manufacturer Standard	√	H	RW	W	1 sample per lot
		Glass Content Test (By Burning & Weighing residue)	-	Witness	1 per Lot	Manufacturer Standard Procedure	Min 55%	Manufacturer Standard	√	H	RW	W	1 sample per lot

LEGEND: W: WITNESS, R: REVIEW, H: HOLD, PS : Approved Purchase Specifications. INDICATION: 1 – GENERAL COMPOSITES (P) LTD. 2 – TPI (Third Party Inspection). 3 – BHEL – PEM, NOIDA. / End User. * FOR ITEMS MARKED ✓ (TICK) IN COLUMN 'D', RELEVANT DOCUMENTS SHALL BE SUBMITTED TO CLIENT FOR RECORDS.	PREPARED BY VENDOR'S SIGNATURE & STAMP	APPROVED BY BHEL SIGNATURE & STAMP	APPROVED BY TPI SIGNATURE & STAMP

	MANUFACTURING QUALITY PLAN		QAP DOC. NO.:	
	CUSTOMER: PRODUCT: FRP CABLE TRAYS & ACCS.	INSPECTION CATEGORY : BULK ITEMS	REV NO:	DATE:
			PAGE 2 OF 2	

SL NO	COMPONENTS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPT-ANCE NORMS	FORMAT OF RECORD	*D	AGENCY			REMARKS
										1	2	3	
		BOQ of Coupler Plates & Fasteners	-	Visual, Dimensional & Quantitative	Random	Approved Datasheet & BOQ of Couplers	Approved Drawings / As per PO	Manufacturer Standard	√	H	RW	W	10 samples per lot
3.0	**PACKING**												
	Packaging		-	Quantity 100%	100%	P.O. / Packing List	As Per Specification	Manufacturer Standard	√	H	R	W	
4.0	**DOCUMENTATION**												
	Documentation & Issue of IRN	Compliance to specifications	-	Review	Lot	-	Internal Inspection Reports, Raw Material TC's, Review of Type Test Certificates for Mechanical & Electrical Properties of Pultruded Profiles, as per approved Data Sheet / BHEL Spec. No. PE-	Inspection Release Note	√	H	H	R	

LEGEND: W: WITNESS, R: REVIEW, H: HOLD, PS : Approved Purchase Specifications. INDICATION: 1 – GENERAL COMPOSITES (P) LTD. 2 – TPI (Third Party Inspection). 3 – BHEL – PEM, NOIDA. / End User. * FOR ITEMS MARKED ✓ (TICK) IN COLUMN 'D', RELEVANT DOCUMENTS SHALL BE SUBMITTED TO CLIENT FOR RECORDS.	PREPARED BY VENDOR'S SIGNATURE & STAMP	APPROVED BY BHEL SIGNATURE & STAMP	APPROVED BY TPI SIGNATURE & STAMP

	QUALITY PLAN		CUSTOMER :		PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :		STANDARD QP NO. : PE-QP-999-507-E007, REV. 0			SPECIFICATION TITLE: TECHNICAL SPEC FOR CABLE TRAY SUPPORT SYSTEM (BOLTABLE)			
	SHEET 1 OF2		SYSTEM CABLING		ITEM : CABLE TRAY SUPPORT MATERIAL & ACCESSORIES (BOLTABLE)			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	**RAW MATERIAL**											
1.1	ROLLED SHEET	1.CHEM.& PHY. PROPERTIES	MA	VERIFICATION OF TC'S	100%	IS1079 (for hot rolled) IS-513 (for cold rolled	IS1079 (for hot rolled) IS-513 (for cold rolled)	MILL TC	3/2	-	1/2	Steel shall be procured from SAIL/TISCO/RINL/BHUSAN/JINDAL STEEL/JINDAL ISPAT/ESSAR/LLOYD/ IISCO/ authorised SAIL Re Rollers.
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS-1730/ APP. DATA SHEET	IS-1730/ APP. DATA SHEET	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS1079 (for hot rolled) IS-513 (for cold rolled	IS1079 (for hot rolled) IS-513 (for cold rolled)	QC RECORD	3/2	-	-	
1.2	ZINC	CHEM.COMP.	MA	CHEM TEST	EACH HEAT	IS-209	IS-209	QC RECORD	3/2	-	1/2	
2.0	**IN-PROCESS**											
2.1	FABRICATION	1.DIMENSIONS	MA	MEASUREMENT	100%	APPD. DRGS.	APPD. DRGS.	QC RECORD	2	-	1	
		2.WELDING QUALITY	MA	VISUAL	100%	GOOD WELDING PRACTICE	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	Welding is to be done by qualified welders in accordance with ASME SEC. IX article III. WPS , PQR & WPQ to be reviewed during inspection.
		3.SURFACE FINISH	MA	VISUAL	100%	FREE FROM DEFECTS & SLAG	FREE FROM DEFECTS & SLAG	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING, PICKLING, RINSING & FLUXING	MA	VISUAL	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2. SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS-2629	IS-2629	QC RECORD	3/2	-	-	Applicability of galvanizing shall be as per Annexure-2 to quality plan.

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : **1 - BHEL/ CUSTOMER** **2 - VENDOR** **3 - SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

		QUALITY PLAN	CUSTOMER :			PROJECT TITLE :			SPECIFICATION NO. :			
			BIDDER/ VENDOR :			STANDARD QP NO. : PE-QP-999-507-E007, REV. 0			SPECIFICATION TITLE: TECHNICAL SPEC FOR CABLE TRAY SUPPORT SYSTEM (BOLTABLE)			
		SHEET 2 OF 2	SYSTEM CABLING			ITEM : CABLE TRAY SUPPORT MATERIAL & ACCESSORIES (BOLTABLE)			DOC. NO. :			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL / MEASUREMENT	100%	IS - 2629 / MFR'S PRACTICE	IS - 2629 / MFR'S PRACTICE	QC RECORD	3/2	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	QC RECORD	3/2	-	-	
3.0	**FINISHED ITEMS**											
3.1	SINGLE / DOUBLE CHANNELS, CANTILEVER ARMS, CLAMPS	1.DIMENSIONS DISTORTION	MA	MEASUREMENT	IS-2500 (PART 1) LEVEL S-4	APPD. DRG	APPD. DRG	INSP. REPORT	2	1	-	FASTENERS SHALL BE OF REPUTED MAKE
		2.SURFACE FINISH	MA	VISUAL	IS-2500 (PART 1) LEVEL S-4	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX. STAIN. ETC.	INSP. REPORT	2	1	-	
		3.MASS OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-6745 / APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		4.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		5.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS-4759	APP. DATA SHEET	APP. DATA SHEET	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	
3.1.1	TYPE TESTING		CR	TEST	1 SAMPLE	APPD. TYPE TEST PROCEDURE	APPD. TYPE TEST PROCEDURE	INSP. REPORT	2	1	-	
3.1.2	WELD INTEGRITY TEST	SOUNDNESS	CR	MAGNETIC PARTICLE INSPECTION (MPI) DIE-PENETRATION (DP)	SAMPLE TESTED DURING TYPE TESTING	APPD. TYPE TEST PROCEDURE	NO DEFECT	INSP. REPORT	2	1	-	AFTER CARRYING OUT TYPE TEST, WELD INTEGRITY TEST TO CHECK THE WELD SOUNDNESS/ ACCEPTANCE SHALL BE DONE BY MANUFACTURER

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

LEGEND : **1 - BHEL/ CUSTOMER** **2 - VENDOR** **3 - SUB- VENDOR** **P - PERFORM** **W - WITNESS** **V - VERIFICATION**

	STANDARD QUALITY PLAN	CUSTOMER :			PROJECT: TITLE			SPECIFICATION NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-507-00-Q-001, R-04			SPECIFICATION : TITLE			
	SHEET 1 OF 5	SYSTEM			ITEM : XLPE Power Cables			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIALS											
1.1	XLPE Compound	1. Physical properties	MA	Physical Tests	Sample/ Lot	IS:7098 & Mfrs Std./ Appd Data Sheet	IS:7098 & Mfrs Std. Appd Data Sheet	Test Report Log Book	3/2	-	1,2	Raw material verification as per approved sub-vendor list
		2. Elec.Properties	MA	Electrical Tests	-do-	-do-	-do-	-do-	3/2	-	1,2	
1.2	Semi Conducting Compound	1. Phy.and Elec. Properties	MA	Phy.and Elec. Tests	-do-	Manufacturer's standard	Manufacturer's standard	-do-	3/2	-	1,2	
1.3	Copper Foil	1. Dimensions	MA	Measurement	-do-	Manufacturer's std./ Appd. Data sheet	Manufacturer's std./ Appd. Data sheet	Log Book	2	-	2	
		2. Physical, Chemical & Elect. Properities	MA	Phy., Chem. & Elect. Tests	-do-	IS:1897	IS:1897	Supplier's test report & log book	3/2	-	2	
1.4	PVC Compound (for sheath)	1. Physical properties	MA	Physical Tests	Sample/ lot	IS:5831/BHEL Specification	IS:5831/BHEL Specification	Log Book/ Test Report	3/2	-	2	
		2. FRLS Properties	MA	Envir/ Chemical	Sample/ lot	ASTMD-2863, ASTMD-2843, IEC-754-1	Appd. Data sheet	Log Book/ Test Report	3/2	-	2	
1.5	Galvanised steel wire/strip	1. Phy. and Elec. Properties	MA	Physical & Electrical Tests	Sample from each batch/ lot	IS:3975/ BHEL Specification/ Appd Data Sheet	IS:3975/ BHEL Specification/ Appd Data Sheet	Log Book/ Test Cert.	3/2	-	2	
		2. Dimension	MA	Measurement	-do-	-do-	-do-	-do-	3/2	-	2	
		3. Galvanization	MA	Galv. requirement	-do-	-do-	-do-	-do-	3/2	-	2	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	STANDARD QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-507-00-Q-001, R-04	SPECIFICATION : TITLE
	SHEET 2 OF 5	SYSTEM	ITEM XLPE Power Cables	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.6	Copper/Aluminium Rods/ Wires	1. Physical Properties	MA	Physical Tests	-do-	IS:613, IS-5484, IS:8130 & BHEL Specification	IS:613, IS-5484, IS:8130 & BHEL Specification	-do-	3/2	-	2	
		2. Chemical Composition & purity	MA	Chemical analysis	-do-	-do-	-do-	-do-	3/2	-	2	
		3.Electrical properties	MA	Electrical Tests	-do-	-do-	-do-	-do-	3/2	-	2	
		4. Dimensions	MA	Measurement	-do-	-do-	-do-	-do-	3/2	-	2	
2.0	IN PROCESS											
2.1	Wire Drawing	1. Physical, Electrical, Finish & dimension	CR	Phy. & Elect. Tests Visual / Meas.	Sample	IS:8130 & BHEL Specn.	IS:8130 & BHEL Specn.	Log Book	2	-	1	
2.2	Stranding of wires	1. No. of wires	MA	Counting	-do-	BHEL Specn, Apprd. Data Sheet & Relevant IS	BHEL Specn, Apprd. Data Sheet & Relevant IS	-do-	2	-	-	
		2. Sequence, lay length & Direction	MA	Visual, Meas.	-do-	-do-	-do-	-do-	2	-	-	
		3 Surface Finish	MA	Visual	-do-	-do-	-do-	-do-	2	-	-	
		4. Dimension	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
2.3	Conductor Screening	1. Radial thickness	MA	-do-	Sample	BHEL Specn & Apprd. Data Sheet	BHEL Specn & Apprd. Data Sheet	Log Book	2	-	-	

BHEL	PARTICULARS	BIDDER/VENDOR	
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

	STANDARD QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-507-00-Q-001, R-04			SPECIFICATION : TITLE			
		SHEET 3 OF 5	SYSTEM			ITEM XLPE Power Cables			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
2.4	Core Insulation (XLPE) (No repair permitted)	1. Surface finish	MA	Visual	100%	-	-do-	Log Book	2	-	1	
		2. Concentricity #	CR	Measurement	Sample	Mfr's Std./Appd. data sheet	Mfr's Std./Appd. data sheet	Log Book	2	-	1	# To be checked at starting & finish end of Extruded Length
		3. Thickness of Insulation	CR	Measurement	-do-	BHEL specn./Apprd. Data Sheet/ IS:7098	BHEL specn./Apprd. Data Sheet/ IS:7098	Inspection Report	2		-	
		4 Dia over insulation	MA	Measurement	-do-	-do-	-do-	-do-	2		-	
		5. Test on XLPE (Tensile & Elongation, Hot Set & Ageing Test)	MA	Tests	-do-	-do-	-do-	-do-	2		1	
		6. Spark test or water immersion test (applicable for LT XLPE cables only)	CR	Electrical	100%	Mnfr's Std	Mnfr's Std	Log Book	2	-	1	
2.5	Insulation Screening, (Non Metallic & Metallic)	1. Surface finish	MA	Visual	Sample	-	Free from bulging burnt particles lumps, cuts & Scratches.	Log Book	2	-	-	
		2. Thickness	MA	-do-	-do-	BHEL Spec./ data sheet	BHEL Spec./ data sheet	-do-	2	-	-	
		3 Overlap of Tape Band	MA	Measurement	-do-	BHEL Spec./ data sheet	BHEL Spec./ data sheet	-do-	2	-	-	
		4 Tightness of Tape Band	MA	Visual	-do-	Plant Std.	Plant Std.	-do-	2	-	-	

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	DATE		BIDDER'S/VENDORS COMPANY SEAL

	STANDARD QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-507-00-Q-001, R-04			SPECIFICATION : TITLE			
	SHEET 4 OF 5	SYSTEM			ITEM XLPE Power Cables			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.6	Core Laying	1. Dia over laid up core	MA	Measurement	Sample	Apprd. Data Sheet	Apprd. Data Sheet	Log Book	2	-	-	
		2.Sequence of lay, & direction	MA	Visual & Meas.	Sample	IS 7098/ Mfrs.Std.	IS 7098/ Mfrs.Std.	-do-	2	-	-	
		3. Lay Length	MA	Meas.	-do-	Mnfrs. Std.	Mnfrs. Std.	-do-	2	-	-	
2.7	InnerSheath Extrusion	1. Surface finish	MA	Visual	100%	--	Free from bulging, burnt particles, lumps cuts & scratches.	-do-	2	-	-	
		2. Sheath thickness	MA	Measurement	Sample	Appd. Data Sheet, IS:7098	Appd. Data Sheet, IS:7098	-do-	2	-	-	
		3. Dia over inner sheath	MA	-do-	-do-	-do-	-do-	-do-	2	-	-	
2.8	Armour	1. No.of wires/Strips	MA	Counting	At the start of the process	BHEL Specn./ Apprd.Data sheet	BHEL Specn./ Apprd.Data sheet	-do-	2	-	-	
		2. Lay Direction	MA	Visual	-do-	IS:7098	IS:7098	-do-	2	-	-	
		3. Lay Length	MA	Meas.	-do-	Plant Standard	Plant Standard	Log Book	2	-	-	
		4. Coverage	MA	Measurement	-do-	BHEL Specn./ Appd. Data Sheet	BHEL Specn./ Appd. Data Sheet	-do-	2	-	-	
		5. Dia over armouring	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
2.9	Outer Sheath Extrusion	1. Surface Finish	MA	Visual	100%	-	Free from Bulging, burnt particles, lumps, cuts & scratches	Log Book	2	-	-	
		2.Sheath thickness	MA	Measurement	Sample	Appd. Data Sheet	Appd. Data Sheet	Log Book	2	-	-	
		3. Dia over outer sheath	MA	-do-	-do-	-do-	-do-	-do-	2	-	-	
		4. Marking	MA	Visual	100%	IS:7098, BHEL Specn & Appd. Data Sheet	IS:7098, BHEL Specn. & Appd. Data Sheet	Test Report	2	-	-	Sequential marking shall be done by printing

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	STANDARD QUALITY PLAN	CUSTOMER :	PROJECT TITLE	SPECIFICATION : NUMBER :
		BIDDER/ VENDOR :	QUALITY PLAN NUMBER PED-507-00-Q-001, R-04	SPECIFICATION : TITLE
	SHEET 5 OF 5	SYSTEM	ITEM XLPE Power Cables	SECTION VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.10	Finished Cable	1. Routine Test	CR	Elec. & Meas.	100%	IS:7098 & BHEL specn	IS:7098 & BHEL specn.	Test Report	2	-	1	
		2. Type Tests *	CR	Physical & Electrical Tests	Sample *	Approved Type & acceptance test schedule	Approved Type & acceptance test schedule & approved Data Sheet	-do-	2	1		* FOR HT: Type tests to be conducted on one size of each voltage grade except FRLS/ Flammability tests & Electrical tests which shall be conducted on every size & voltage grade of cables. * FOR LT: Type tests to be conducted on one size.
3.0	Final Inspection	1. Finish & Length	MA	Visual, Measurement	(See remark)	BHEL specn. & IS:7098	BHEL Specn./ Free from Bulging Burnt particles, lumps, cuts & scratches	-do-	2	1	-	One drum in each Lot
		2. Dimension	MA	Measurement	As per IS	Appd.Data Sheet/ IS:7098, IS:10810	Specn./ Appd. Data Sheet/ IS:7098, IS:10810	-do-	2	1	-	
		3. Armouring - Coverage No.of Wires/Strips	MA	Visual & Meas.	-do-	-do-	-do-	-do-	2	1	-	
		4. Marking & Colour Coding	MA	Visual	-do-	-do-	-do-	-do-	2	1	-	
		5. Acceptance Tests	CR	Phy, Elect. Tests	-do-	Appd Data Sheet/ IS: 7098	Appd Data Sheet/ IS: 7098	-do-	2	1		

NOTES:-

(A) JOINTS IN WIRE SHALL BE AS PERMITTED BY IS / BHEL SPECIFICATION, VENDOR TO CERTIFY THE SAME.

(B) NO REPAIR OF CORE INSULATION PERMITTED

(C) CABLE ENDS SHALL BE SEALED AS PER IS/ BHEL SPECIFICATION

(D) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDORS QC. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER.

(E) FILLERS/DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION

(F) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES AND NOT DEFINED IN QP, THE SAME SHALL BE AS PER SAMPLING PLAN AGREED BY PURCHASER.

(G) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER BHEL SPECIFICATION.

LEGEND : P : PERFORMER W: WITNESSER V: VERIFIER 1- BHEL 2-VENDOR 3- SUB VENDOR CHP:CUSTOMER HOLD POINT WHICH WILL BE DECIDED AT CONTRACT STAGE

	BHEL			PARTICULARS	BIDDER/ VENDOR			
				NAME				
				SIGNATURE				
				DATE				BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-002/02			SPECIFICATION :PE-SS-888-507-E003 TITLE: TECHNICAL SPECIFICATION FOR LT CONTROL CABLES			
		SHEET 1 OF 5	SYSTEM			ITEM :PVC CONTROL CABLE			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	PVC Compound(for insulation and sheath)	1. Physical properties	MA	Physical Tests	Sample	IS-5831/BHEL Specification	IS-5831/BHEL Specification	Log Book/ Test Cert.	3/2	-	2	
		2. Elec.Properties	MA	Electrical Tests	Sample	-do-	-do-	-do-	3/2	-	2	
		3. Make & Type	MA	Visual	100%	Plant Std.	Plant Std.	-do-	2	-	-	
1.2	Galvanised steel wire/strip	1. Phy.and Elec. Properties	MA	Physical & Electrical Tests	Sample*	IS-3975 BHEL Specification	IS-3975/BHEL Specification	-do-	3/2	-	2	* Sample from each Batch/Lot.
		2. Dimension	MA	Measurement	-do-	-do-	-do-	-do-	3/2	-	2	
		3.Galvanization Quality	MA	Galv.Tests	-do-	-do-	-do-	-do-	3/2	-	2	
1.3	Copper/Aluminium Rods/ Wires	1. Physical Properties	MA	Physical Tests	-do-	IS-613 IS-5484 IS-8130 AND BHEL Specification	IS-613 IS-5484 IS-8130 AND BHEL Specification	-do-	3/2	-	2	
		2. Chemical Composition & purity	MA	Chemical analysis	-do-	-do-	-do-	-do-	3/2	-	2	
		3.Electrical properties	MA	Electrical Tests	-do-	-do-	-do-	-do-	3/2	-	2	
		4.Dimension	MA	Measurement	-do-	-do-	-do-	-do-	3/2	-	2	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
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	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-002/02			SPECIFICATION :PE-SS-888-507-E003 TITLE: TECHNICAL SPECIFICATION FOR LT CONTROL CABLES			
		SHEET 2 OF 5	SYSTEM			ITEM :PVC CONTROL CABLE			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	Wire Drawing , Tinning and Annealing	1. Physical, Electr. Finish & dimension	CR	Phy.&Elect. Tests Visual & Meas.	Sample	BHEL Specn. IS-8130	BHEL Specn. IS-8130	Log Book	2	-	1	
		2. Chemical test for Tinning	CR	Chemical Test	Sample	-do-	-do-	-do-	2	-	-	
2.2	Stranding of wires	1. No.of wires	MA	Counting	Sample	Vendors/BHEL Specn. & Apprd. Data Sheet & Relevant IS	Vendors/BHEL Specn. & Apprd. Data Sheet & Relevant IS	-do-	2	-	-	
		2. Sequence, lay length & Direction	MA	Visual, Meas	Sample	-do-	-do-	-do-	2	-	-	
		3 Surface Finish	MA	Visual	Sample	-do-	-do-	-do-	2	-	-	
		4.Dimension	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-	
2.3	Core Insulation (No repair permitted)	1. Surface finish	MA	Visual	100%	-	Free from bulging burnt particles lumps, cuts & Scratches.	-do-	2	-	1	
		2 Insulation thickness	CR	Measurement	Sample	Appd.data sheet IS-1554	Appd.data sheet IS-1554	-do-	2	-	-	

	PARTICULARS	**BIDDER/VENDOR**	
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	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-002/02			SPECIFICATION :PE-SS-888-507-E003 TITLE: TECHNICAL SPECIFICATION FOR LT CONTROL CABLES			
		SHEET 3 OF 5	SYSTEM			ITEM :PVC CONTROL CABLE			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		3. Concentricity #	CR	Measurement	Sample	Mfr's Std./Appd. data sheet	Mfr's Std./Appd. data sheet	Log Book	2	-	1	# To be checked at starting & finish end of Extruded Length
		4 Dia over insulation	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-	
		5. Spark Test or Water Immersion test	CR	Electrical	100%	Mfr's Std.	Mfr's Std.	-do-	2	-	1	
		6. Core identification	MA	Visual	100%	IS-1554	IS-1554	-do-	2	-	-	
2.4	Core Laying	1. Dia over laidup core	MA	Measurement	Sample	-do-	-do-	Log Book	2	-	-	
		2.Sequence of lay, Lay length & direction up core	MA	Visual & Meas.	Sample	Mfrs.Std./relevant IS	Mfrs.Std./relevant IS	-do-	2	-	-	
2.5	InnerSheath Extrusion	1. Surface finish	MA	Visual	100%	--	Free from bulging, burnt particles, lumps cuts & scratches.	-do-	2	-	-	
		2. Sheath thickness	MA	Measurement	Sample	IS-5831, IS-1554 data sheet	IS-5831, IS-1554 data sheet	-do-	2	-	-	
		3.Dia over inner sheath	MA	-do-	-do-	-do-	-do-	-do-	2	-	-	
2.6	Armouring	1. No.of wires/Strips	MA	Counting	At the start of the process	BHEL Specn./ Appd. Data sheet IS-3975 & IS-1554	BHEL Specn./ Appd. Data sheet IS-3975 & IS-1554	-do-	2	-	-	
		2. Lay Direction	MA	Visual	-do-	-do-	-do-	-do-	2	-	-	
			PARTICULARS		**BIDDER/VENDOR**							
	BHEL		**NAME**									
			SIGNATURE									
			DATE						BIDDER'S/VENDORS COMPANY SEAL			

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-002/02			SPECIFICATION :PE-SS-888-507-E003 TITLE: TECHNICAL SPECIFICATION FOR LT CONTROL CABLES			
		SHEET 4 OF 5	SYSTEM			ITEM :PVC CONTROL CABLE			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3. Lay Length	MA	Visual, Meas.	At the start of the process	BHEL Specn./ Appd. Data sheet IS-3975 & IS-1554	BHEL Specn./ Appd. Data sheet IS-3975 & IS-1554	Log Book	2	-	-	
		4. Coverage	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
		5. Dia over armouring	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
2.7	Outer Sheath Extrusion	1. Surface Finish	MA	Visual	100%	-	Free from Bulging Burnt particles, lumps, cuts & scratches	Log Book	2	-	-	
		2.Sheath thickness	MA	Measurement	Sample	IS-5831 & IS-1554 Data Sheet	IS-5831 & IS-1554 Data Sheet	Log Book	2	-	-	
		3. Dia over outer sheath	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-	
		4. Marking	MA	Visual	100%	IS-1554 & BHEL Specn.	IS-1554 & BHEL Specn.	Test Report	2	-	-	Sequential marking shall be done by printing
2.8	Finished Cable	1. Routine Test	CR	Elec. & Meas.	100%	IS-1554 & BHEL Specn	IS-1554 & BHEL Specn	Test Report	2	-	1	
		2. Type & FRLS Tests	CR	Elec., Phy & Meas.	Sample *	-do-/Apprd.data sheet	-do-/Apprd.data sheet	Test Report	2	-	1	* One Drum/Size/Lot
3.0	Final Inspection	1. Finish & Length	MA	Visual	(See remark)	BHEL specn. IS-1554	Free from Bulging Burnt particles, lumps, cuts & scratches	Test Report	2	1	-	One drum each for Power & control cables in a Lot

	PARTICULARS	**BIDDER/VENDOR**	
BHEL	**NAME**		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-507-00-Q-002/02			SPECIFICATION :PE-SS-888-507-E003 TITLE: TECHNICAL SPECIFICATION FOR LT CONTROL CABLES			
	SHEET 5 OF 5		SYSTEM			ITEM :PVC CONTROL CABLE			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		2. Dimension	MA	Measurement	As per IS	Appd.Data Sheet/ IS-1554 & IS-10810	Appd.Data Sheet/ IS-1554 & IS-10810	Test Report	2	1	-	
		3. Armouring - Coverage No.of Wires/Strips	MA	Visual & Meas.	As per IS	-do-	-do-	-do-	2	1	-	
		4. Marking/Colour Coding	MA	Visual	-do-	-do-	-do-	-do-	2	1	-	
		5. Acceptance Tests	CR	Phy & Elect. Tests	-do-	-do-	-do-	-do-	2	1		
		6. Type & FRLS Tests	CR	Measurement	(SEE REMARK)	BHEL Specn. Apprd.Data Sheet	BHEL Specn. Apprd.Data Sheet	-do-	2	1	-	Type Test shall be witnessed on one sample per type(conductor size) of every lot
	NOTES:-											
	(A) JOINTS IN WIRE SHALL BE AS PERMITTED BY IS / BHEL SPECIFICATION. VENDOR TO CERTIFY THE SAME.											
	(B) NO REPAIR OF CORE INSULATION PERMITTED											
	(C) CABLE ENDS SHALL BE SEALED AS PER BHEL SPECIFICATION											
	(D) PURCHASER SHALL HAVE RIGHT TO WITNESS THE SPARK TEST AT CORE STAGE											
	(E) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDORS QC. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER.											
	(F) FILLERS/DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION											
	(G) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES, THE SAME SHALL BE AS PER VENDORS SAMPLING PLAN											
	(H) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER BHEL SPECIFICATION.											
	LEGEND : P : PERFORMER W: WITNESSER V: VERIFIER (1) BHEL/BHEL's CUSTOMER: 2-VENDOR : 3 SUB VENDOR											

	PARTICULARS	**BIDDER/VENDOR**
BHEL	**NAME**	
	SIGNATURE	
	DATE	BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER PED-509-00-Q-001, REV-03			SPECIFICATION : TECHNICAL SPECIFICATION FOR ABOVE GROUND EARTHING & LIGHTNING PROTECTION MATERIALS			
		SHEET 1 OF 2	SYSTEM : GROUNDING			ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			SECTION		VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	**RAW MATERIAL**											
1.1	MILD STEEL (FLATS & RODS) AS PER SPECIFICATION	1.CHEMICAL & PHYSICAL PROPERTIES	MA	VERIFICATION, OF TC'S	100%	IS:2062	IS:2062	MILL TC	3	-	2	REFER NOTE IN REMARK AT SL. NO.3
		2.DIMENSIONS	MA	MEASUREMENT	100%	IS - 1730	IS - 1730	QC RECORD	3/2	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	IS : 1079	IS : 1079	QC RECORD	3/2	-	-	
1.2	ZINC	1.CHEM.COMP.	MA	CHEM.TEST	SAMPLE	IS - 209	IS - 209	QC RECORD	3/2	-	1/2	
2.0	**IN-PROCESS**											
2.1	CUTTING, DRILLING	1.DIMENSIONS	MA	MEASUREMENT	100%	BHEL SPEC	BHEL SPEC	QC RECORD	2	-	1	
		2.SURFACE FINISH	MA	VISUAL	100%	BHEL SPEC	BHEL SPEC	QC RECORD	2	-	1	
2.2	SURFACE PREPARATION	1.CLEANING PICKLING, RINSING, & FLUXING	MA	MEASUREMENT	PERIODIC IN EACH SHIFT	IS:2629	IS:2629	QC RECORD	2	-	-	
		2.SURFACE QUALITY	MA	VISUAL	100%	IS:2629	IS:2629	QC RECORD	2	-	-	

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-509-00-Q-001, REV-03			SPECIFICATION : TECHNICAL SPECIFICATION FOR ABOVE GROUND EARTHING & LIGHTNING			
		SHEET 2 OF 2	SYSTEM : GROUNDING			ITEM : EARTHING & LIGHTNING PROTECTION MATERIALS			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
2.3	GALVANISING	1.TEMPERATURE OF BATH	MA	TEMPERATURE INDICATOR	CONTINUOUS	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	If vendor doesn't have his own galvanizing plant duly approved by BHEL PEM; then galvanizing shall be carried out at BHEL-PEM approved other galvanizing plants as per Annexure-2.
		2. DROSS	MA	VISUAL	PERIODIC	IS - 2629	IS - 2629	QC RECORD	3/2	-	-	
		3. RATE OF IMMERSION	MA	VISUAL/ MEASUREMENT	100%	IS - 2629/ MFRS PRACTICE	IS - 2629/ MFRS PRACTICE	QC RECORD	3/2	-	2	
		4.SURFACE QUALITY	MA	VISUAL	100%	IS - 2629	FREE FROM BURRS, ROUGHNESS, SLAG, FLUX, STAIN ETC.	QC RECORD	3/2	-	-	
3.0	**FINISHED ITEMS**	1. CHEMICAL	MA	CHEMICAL	1 No./LOT/SIZE	IS-2062	IS-2062	LAB TC	2	-	1	NOTE : SAMPLE SHALL BE SELECTED BY BHEL & TESTING
		2.DIMENSIONS	MA	MEASUREMENT	IS 2500 (PART 1 LEVEL S-4	BHEL SPEC	BHEL SPEC	INSP. REPORT	2	1	-	SHALL BE DONE AT NABL/GOVT APPD LAB
		3.SURFACE FINISH	MA	VISUAL	IS 2500 (PART 1 LEVEL S-4	BHEL SPEC	FREE FROM BURRS, SLAG, ROUGHNESS, FLUX, STAIN, ETC.	INSP. REPORT	2	1	-	
		4.MASS OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-6745 / BHEL SPEC	BHEL SPEC	INSP. REPORT	2	1	-	
		5.UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS - 4759	IS-2633	IS-2633	INSP. REPORT	2	1	-	
		6.THICKNESS OF ZINC COATING	MA	ELCOMETER	IS - 4759	BHEL SPEC	BHEL SPEC	INSP. REPORT	2	1	-	
		6.ADHESION	MA	MECH.TEST	IS-4759	IS-2629	IS-2629	INSP. REPORT	2	1	-	

NOTE: INSTRUCTIONS FOR QUALITY PLAN IS ATTACHED AS ANNEXURE-1.

BHEL	**PARTICULARS**	**BIDDER/VENDOR**	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER	PROJECT TITLE					SPECIFICATION NUMBER			
		BIDDER/ VENDOR	QUALITY PLAN NUMBER PED-506-00-Q-005/01					SPECIFICATION TITLE			
	SHEET 1 OF 6	SYSTEM	ITEM :LCC'S / M. BOXES/ JN. BOXES					SECTION			VOLUME III

SL. NO.	NENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	GENCY P	GENCY W	GENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL & BOUGHT OUT CONTROL											
1.1	SHEET STEEL/CHANNELS	1. DUCTILITY	CR	BEND TEST	SAMPLE	IS-1079/IS-513/ IS-226	IS-1079/IS-513/ IS-226	LOG BOOK	3/2	-	2	FOR SHEET STEEL
		2. SURFACE FINISH DEFECTS	MA	VISUAL	100%	FACTORY STD	NO RUSTING	-DO-	3/2	-	-	
		3. THICKNESS	MA	MEASUREMENT	100%	BHEL SPEC./ IS-1730	BHEL SPEC./ IS-1730	-DO-	3/2	-	2	
1.2	WIRES	1. SURFACE DEFECTS.	MA	VISUAL	100%	BHEL SPEC./ IS-1554/IS-694/ RELEVANT. IS	BHEL SPEC./ IS-1554/IS-694/ RELEVANT. IS	-DO-	3/2	-	-	ONLY APPROVED MAKES TO BE USED
		2. IR, HV, IR	MA	ELECTRICAL	SAMPLE	-DO-	-DO-	-DO-	3/2	-	-	
		3. TYPE / ROUTINE TESTS	MA	VERIFICATION OF TYPE / ROUTINE TEST CERTI-FICATE	100%	-DO-	-DO-	MFR'S TEST CERT.	3	-	1,2	
1.3	ZINC INGOT FOR GALVANISING	CHEM. COMP.	MA	CHEM. TEST	EACH	IS-209	IS-209	TEST CERT	3/2	-	1,2	

BHEL	PARTICULARS	BIDDER/VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

FORM NO. PEM-6041-0

	QUALITY PLAN		CUSTOMER			PROJECT TITLE			SPECIFICATION NUMBER			
			BIDDER/ VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-005/01			SPECIFICATION TITLE			
	SHEET 2 OF 6		SYSTEM			ITEM :LCC'S / M. BOXES/ JN. BOXES			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.3	ELECTRICAL COMPONENTS LIKE FUSE, SWITCHES, INDICATING LAMPS, PUSH BUTTON, TERMINALS, GASKETS CABLE GLANDS AND LUGS	1. MAKE TYPE RATING	MA	VISUAL	SAMPLE	BHEL SPEC. & BOM	BHEL SPEC. & BOM	LOG BOOK	3/2	-	-	
		2.OPERATION/ FUNCTIONAL CHECK	CR	ELECTRICAL TEST	SAMPLE	RELEVANT IS AND CATALOGUE	RELEVANT IS AND CATALOGUE	-DO-	3/2	2,1	2	
		3. IR, HV, IR	MA	ELECTRICAL	100%	-DO-	-DO-	-DO-	3/2	2,1	2	
2.0	IN-PROCESS CONTROL											
2.1	NIBBLING/PUNCHING	1. CUTOUT SIZES	MA	MEASUREMENT	100%	APPD. DRGS	APPD. DRGS	LOG BOOK	3/2	-	2,1	STANDARD CUT OUTS TO BE DONE WITH DIES & PUNCHES ONLY
		2.DEBURRING	MI	VISUAL	100%	-DO-	-DO-	-DO-	3/2	-	-	
2.2	PANEL FABRICATION	1. DIMENSIONS	MA	MEASUREMENT	100%	APPR. DRGS	APPR. DRGS	LOG BOOK	3/2	2	-	
		2. ALIGNMENT	MA	MEASUREMENT	100%	MFR'S STD	MFR'S STD	LOG BOOK	3/2	2	-	
		3. WELDING QUALITY	MI	VISUAL	100%	-DO-	-DO-	-DO-	3/2	2	-	

	PARTICULARS	BIDDER/VENDOR	
BHEL	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

FORM NO. PEM-6041-0

	QUALITY PLAN	CUSTOMER		PROJECT TITLE				SPECIFICATION NUMBER				
		BIDDER/ VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-005/01				SPECIFICATION TITLE				
	SHEET 3 OF 6	SYSTEM		ITEM :LCC'S / M. BOXES/ JN. BOXES				SECTION			VOLUME III	
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	GENCY P	GENCY W	GENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.3	SURFACE PREPARATION AND PRE-TREATMENT (7 OR 8 TANK PROCESS)	1. PROCESS PARAMETERS LIKE BATH TEMP, CONCENTRATION, DIPPING/ REMOVAL TIME	MA	PROCESS CHECK	PERIODIC	BHEL SPEC., MFR. SPEC., IS-6005	BHEL SPEC., MFR. SPEC., IS-6005	LOG BOOK	3/2	-	-	IF SAND/SHOT BLASTING, ACID PICKLINGS IS NOT REQUIRED.
		2. SURFACE QUALITY AFTER EVERY DIP	MA	VISUAL	100%	-DO-	-DO-	-DO-	3/2	-	-	
2.4	PRIMER APPLICATION & PAINTING	1. SURFACE FINISH & COVERAGE	MA	VISUAL	100%	MFR. SPEC., IS-6005	MFR. SPEC., IS-6005	LOG BOOK	3/2	-	-	
		2. FILM THICKNESS	MA	MEASUREMENT	100%	-DO-	-DO-	-DO-	3/2	-	2	
		3. SHADE	MA	VISUAL	100%	-DO-	-DO-	-DO-	3/2	-	2	
		4. ADHESION	MA	SCRATCH TEST / CROSS OUT TAPE	TEMPLATE	-DO-	-DO-	-DO-	3/2	-	2	

	PARTICULARS	BIDDER/VENDOR	
BHEL	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

FORM NO. PEM-6041-0

	QUALITY PLAN		CUSTOMER			PROJECT TITLE			SPECIFICATION NUMBER			
			BIDDER/ VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-005/01			SPECIFICATION : TITLE			
	SHEET 4 OF 6		SYSTEM			ITEM :LCC'S / M. BOXES/ JN. BOXES			SECTION			VOLUME III
SL. NO.	NENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	GENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.5	WIRING, GASKET, NAME PLATE, COMPONENT MOUNTING ETC.	1. WIRING LAYOUT	MA	VISUAL	100%	APPD . DRGS & SPEC.	APPD . DRGS & SPEC.	LOG BOOK	3/2	-	-	PVC CHANNELS TO BE USED
		2. WORKMANSHIP AND FINISH CORRECTNESS COMPLETENESS	MA	VISUAL	100%	-DO-	-DO-	-DO-	3/2	-	-	
2.6	GALVANISATION PROCESS	1. TEMP OF ZINC BATH	MA	TEMP. INDICATOR	CONTIN-UOUS	IS-2629	IS-2629	QC RECORD	2	-	-	
		2. DURATION OF DIP	MA	VISUAL	-DO-	MANUFACTURER PRACTICE.	MANUFACTURER PRACTICE.	-DO-	2	-	-	
		3. SURFACE QUALITY	MA	VISUAL	100%	-DO-	FREE FROM ROUGHNESS, FLUX, STAIN ETC.	-DO-	2	-	-	
		4. GROSS QUANTITY & AGITATION	MA	TESTS	PERIODIC	RELEVANT. IS	RELEVANT. IS	-DO-	2	-	-	
3	FINAL INSPECTION											
3.1	COMPLETE JUNCTION BOX/ LCC'S MARSHALLING BOXES	1. WORKMANSHIP & FINISH, PAINT SHADE/GALV. THICKNESS & ADHESION	MA	VISUAL	100%	BHEL SPEC. APPD. DRG RELEVANT. IS	BHEL SPEC. APPD. DRG RELEVANT. IS	INSPN REPORT	3/2	2,1	-	

	PARTICULARS	BIDDER/VENDOR	
BHEL	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

FORM NO. PEM-6041-0

	QUALITY PLAN		CUSTOMER			PROJECT TITLE			SPECIFICATION NUMBER :			
			BIDDER/ VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-005/01			SPECIFICATION TITLE			
	SHEET 5 OF 6		SYSTEM			ITEM :LCC'S / M. BOXES/ JN. BOXES			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		2. UNIFORMITY OF ZINC COATING	MA	CHEM. TEST	IS-5358	IS-2633	IS-2633	INSPN REPORT	2	1	-	
		3. THICKNESS OF ZINC COATING	MA	ELCOMETER	-DO-	BHEL SPEC.	BHEL SPEC.	-DO-	2	1	-	
		4. WIRING LAYOUT	MA	VISUAL	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
		5. COMPONENT LAYOUT & FIXING, ACCESSI-BILITY AND SAFETY	MA	VISUAL	100%	-DO-	-DO-	-DO-	3/2	2,1	-	
		6. COMPONENT IDENTIFICATION (MARKING/ NAME PLATES)	MA	VISUAL	100%	APPD. DRG.	APPD. DRG.	-DO-	3/2	2,1	-	
		7. PROPER WIRE TERMINATION	MA	PULLING	SAMPLE	-DO-	NO LOOSE CONNECTIONS. ALL TERMINATION TO BE LUGGED	-DO-	3/2	2,1	-	
		8. DOOR LOCK FUNCTIONING	MA	OPERATON	100%	APPD. DRG	NO MISMATCH	-DO-	3/2	2,1	-	

	PARTICULARS	BIDDER/VENDOR	
BHEL	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

FORM NO. PEM-6041-0

	QUALITY PLAN		CUSTOMER			PROJECT TITLE			SPECIFICATION NUMBER			
			BIDDER/ VENDOR			QUALITY PLAN NUMBER PED-506-00-Q-005/01			SPECIFICATION TITLE			
	SHEET 6 OF 6		SYSTEM			ITEM :LCC'S / M. BOXES/ JN. BOXES			SECTION			VOLUME III
SL. NO	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		9.OVERALL DIMENSIONS	MA	MEASUREMENT	100%	APPD. DRG.	APPD. DRG.	INSPN. REPORT	3/2	2,1	-	
		10. CONTINUITY	CR	ELECTRICAL	100%	APPD. DRG., BHEL SPEC., & RELEVANT IS	APPD. DRG., BHEL SPEC., & RELEVANT IS	-DO-	3/2	2,1	-	
		11. IR-HV-IR	CR	ELECTRICAL	100%	-DO-	-DO-	-DO-	3/2	2,1	-	IR-HV-IR TEST TO BE DONE
		12.OPERATION INTERLOCKS ETC	CR	ELECTRICAL OPERATION AND FUNCTION IN ENERGISED CONDITION	100%	-DO-	-DO-	-DO-	3/2	2,1	-	BEFORE OPERATIONAL TESTS
		13. TEMP RISE (IF APPLICABLE)	CR	ELECTRICAL	ONE/ TYPE/ SIZE	BHEL SPEC. RELEVANT IS	BHEL SPEC. RELEVANT IS	-DO-	3/2	2,1	-	
		14. DEGREE OF PROTECTION & FLAME/ EXPLOSION PROOF	CR	WATER AND DUST TESTS, FLAME/ EXPLOSION TESTS	ONE/ TYPE	-DO-	-DO-	-DO-	3/2	2	-	FLAME/EXPLOSION PROOF TEST, IF SPECIFIED IN BHEL SPEC.
		NOTE: IF TC'S FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS IS AVAILABLE FROM AN INDEPENDENT LABORATORY FOR IDENTICAL DESIGN (SIZE SHALL BE SMALLER THAN THAT INDICATED IN THE TC) THESE TESTS NEED NOT BE REPEATED.										

	PARTICULARS	BIDDER/VENDOR	
BHEL	NAME		
	SIGNATURE		
	DATE		BIDDER'S/VENDOR'S COMPANY SEAL

		QUALITY PLAN	CUSTOMER : TANGEDCO			PROJECT : TITLE			SPECIFICATION : NUMBER			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-558-00-Q-001/02			SPECIFICATION : STATION LIGHTING SYSTEM TITLE			
		SHEET 1 OF 4	SYSTEM			ITEM :ILLUMINATION			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOC. [Vendor DS / Drg. / Spec.to be duly apprvd. by BHEL (& Cust. If required) ; otherwise BHEL-spec. / Drg. prevails.]	ACCEPT. NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	**LUMINAIRES & LAMPS**	1. ACCEPTANCE TEST										
		a) VISUAL	MA	VISUAL	IS 10322 (PART5 SEC1)	IS 10322 / DS	IS 10322 / DS	INSP. REPORT	3/2	(2),1	-	
		b) IR (Dry)	CR	ELECTRICAL	IS 10322	-DO-	-DO-	INSP./T. REPORT	3/2	(2),1	-	
		c) HIGH VOLTAGE	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	(2),1	-	
		d) DUST PROOF	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2		(2),1	TYPE TEST Cert. BY MFR.
		e) PHOTOMETRIC	CR	ELECTRICAL	-DO-	-DO-	-DO-	-DO-	3/2	(2),1	-	
		2. ROUTINE TEST										
		a) VISUAL	MA	VISUAL	100%	-DO-	-DO-	INSP. REPORT	3/2		(2),1	TYPE TESTS CLEARANCE FROM BHEL/CUSTOMER
		b) IR (Dry)	CR	ELECTRICAL	-DO-	-DO-	-DO-	INSP./T. REPORT	3/2		(2),1	
		c) HIGH VOLTAGE	CR	ELECTRICAL	`	-DO-	-DO-	-DO-	3/2		(2),1	
2.0	**LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS**	1.DIMENSIONS	MA	MEASUREMENT	SAMPLE	DRG.	DRG.	INSP. REPORT	3	2,1	-	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/ MEASUREMENT	-DO-	SPEC/DRG	SPEC/DRG	-DO-	3	2,1	-	
		3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1/SIZE	SPEC / RELEVANT STD.	SPEC / RELEVANT STD.	TEST CERT	3	-	2,1	TYPE TEST Cert. BY MFR.
		4.PERFORMANCE TESTS	MA	ELECT.	100%	SPEC	SPEC	INSP./T. REPORT	3/2	(2),1	-	BHEL SHALL WITNESS ON RANDOM ONE SAMPLE, THOUGH EACH ITEM SHALL BE CHECKED BY THE MANUFACTURER
		5.HV/IR/HV	MA	ELECT	100%	2.5KV AC FOR 1 MINUTE	2.5KV AC FOR 1 MINUTE	-DO-	3/2	(2),1	-	-DO-

	BHEL	LEGEND	LEGEND :	**PARTICULARS**	**BIDDER/VENDOR**
		P-perform	1 - BHEL	**NAME**	
		W-witness	2 - BHEL's Vendor	**SIGNATURE**	
		V-verify	3 - Manufacturer	**DATE**	BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER : TANGEDCO		PROJECT : 2X660 MW ENNORE SEZ TITLE			SPECIFICATION : PE-TS-412-558-E001 R1 NUMBER			
		BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-558-00-Q-001/02			SPECIFICATION : STATION LIGHTING SYSTEM TITLE			
	SHEET 2 OF 4	SYSTEM		ITEM :ILLUMINATION			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOC. [Vendor DS / Drg. / Spec.to be duly apprvd. by BHEL (& Cust. If required) ; otherwise BHEL-spec. / Drg. prevails.]	ACCEPT. NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
3.0	**LIGHTING TRANSFORMER**	1. ROUTINE TEST a) TYPE / RATING	CR	VISUAL	100%	IS 11171 / DS / Spec.	IS 11171 / DS / Spec.	INSP./T. REPORT	3/2		(2),1	
		b) WIND. RESISTANC	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		c) V. RATIO /VECTOR	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		d) Z VOLT/ Z SCKT	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		e) LOAD LOSS/ CURREN	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		f) NO LOAD LOSS	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		g) SOURCE WITHSTAND	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		h) INDUCED O/V	CR	TEST	100%	-DO-	-DO-	-DO-	3/2		(2),1	
		2.TEMP.RISE TEST (FOR COM-PLETE ASSEMBLED LDB)	MA	ELECT	1/RATING	SPEC / RELEVANT STD.	SPEC / RELEVANT STD.	INSP./T. REPORT	3/2	(2),1	-	
		3. TYPE TEST	MA	TEST	1/RATING	-DO-	IS 11171 / BHEL SPEC.	TEST REPORT	3/2		(2),1	TYPE TESTS CLEARANCE FROM BHEL/CUSTOMER
4.0	**CONDUITS** Conduit Type & relevant IS No. : RIGID (Metallic or Nonmetllc) IS 9537 Flexible-Metallic IS 3480 Flexible-Non-metallic IS 6946	1.MATERIAL	MA	VISUAL, MECH, & CHEMICAL	relevant IS	relevant IS	relevant IS	INSP./T. REPORT	3/2		(2),1	
		2.DIMENSIONS	MA	MEASUREMENT	relevant IS	relevant IS	relevant IS	INSP. REPORT	3/2		(2),1	
		3. GALVANISATION TEST										Not appl. for Epxy-coatd mtllc or Non-mtllc type conduit
		a) ZINC COATING	CR	INSP. / TEST	relevant IS	relevant IS	relevant IS	INSP./T. REPORT	3/2		(2),1	
		b) MASS OF ZINC COAT.	CR	TEST	IS:9537	IS-6745/4759/SPEC	IS-6745/4759/SPEC	INSP./T. REPORT	3/2		(2),1	
		c) COATING THICKNESS	CR	TEST	S:9537OR348	IS:9537 OR 3480	IS:9537 OR 3480	INSP./T. REPORT	3/2		(2),1	BY ELCOMETER
		4. EPOXY THICKNESS	MA	VISUAL/PHYSICAL	IS:9537	50 MICRONS	50 MICRONS	INSP./T. REPORT	3/2		(2),1	For Rigid condt Epoxy coated and not galvanised

BHEL	LEGEND	LEGEND :	**PARTICULARS**	**BIDDER/VENDOR**	
	P-perform	1 - BHEL	**NAME**		
	W-witness	2 - BHEL's Vendor	**SIGNATURE**		
	V-verify	3 - Manufacturer	**DATE**		BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER : TANGEDCO			PROJECT : 2X660 MW ENNORE SEZ TITLE			SPECIFICATION : PE-TS-412-558-E001 R1 NUMBER			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-558-00-Q-001/02			SPECIFICATION : STATION LIGHTING SYSTEM TITLE			
	SHEET 3 OF 4	SYSTEM			ITEM :ILLUMINATION			SECTION			VOLUME III

SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOC. [Vendor DS / Drg. / Spec.to be duly apprvd. by BHEL (& Cust. If required) ; otherwise BHEL-spec. / Drg. prevails.]	ACCEPT. NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
5.0	**ELECTRIC POLES**											
5.1	MATERIAL	1.CHEMICAL COMP.	MA	CHEM. ANALYSIS	SAMPLE	IS-2713	IS-2713	TEST REPORT	3/2		(2),1	
		2.PHYSICAL PROP.	MA	PHY.TESTS	-DO-	-DO-	-DO-	-DO-	3/2		(2),1	
5.2	FINAL INSPECTION	1.WORKMANSHIP AND FINISH	MA	VISUAL & MEAS	SAMPLES	DRG./ IS:2713	DRG./ IS:2713	INSP. REPORT	3/2	(2),1	-	FOR DEFLECTION & DROP TEST, TC VERIFICATION BY BHEL
		2.DIMENSIONS	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	(2),1	-	
		3.WEIGHT	MA	-DO-	-DO-	-DO-	-DO-	-DO-	3/2	(2),1	-	
		4.TESTS AS PER IS-2713	MA	-DO-	-DO-	IS-2713	IS-2713	INSP./T. REPORT	3/2	(2),1	-	
6.0	**JUNCTION BOXES & RECEPTACLES**	1.DIMENSIONS	MA	MEASUREMENT	100%	DRG./	DRG./	INSP. REPORT	3/2	-	[2]	COMPONENTS TO BE OF APPROVED MAKE
		2.PAINT SHADE/ THICKNESS	MA	VISUAL/MEAS.	SAMPLE	SPEC/DRG	SPEC/DRG	-DO-	3/2	-	[2]	If galvanised apply tests as per checks 3 a) & b) for conduits.
		3.HV/IR/HV	MA	ELECT.TESTS	100%	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	TEST REPORT	3/2	-	[2]	
		4.DEGREE OF PROTECTION	MA	TEST	1/SIZE	IS:2147	IS:2147	TEST CERT.	3/2		(2),1	
		5.SPECIAL TESTS IF ANY,EXPLOSION PROOF ETC.	MA	TEST	1/SIZE	IS:2148	IS:2148	TEST CERT.	3/2		(2),1	
7.0	**PVC WIRES**	1.SURFACE DEFECTS	MA	VISUAL	SAMPLE	IS:694 / IS:1554	IS:694 / IS:1554	INSP. REPORT	3/2		(2),1	
	NOTE : TO BE PROCURED FROM APPROVED SOURCE ONLY.	2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	3/2		(2),1	
		3.TYPE TESTS	CR	ELEC.TESTS	ONE/TYPE & SIZE	BHEL SPEC. IS:694 / IS:1554	BHEL SPEC. IS:694 / IS:1554	TEST CERT.	3/2		(2),1	
		4.ACCEPTANCE TESTS	MA	-DO-	SAMPLING	-DO-	-DO-	-DO-	3/2	(2),1	-	

BHEL	LEGEND	LEGEND :	**PARTICULARS**	**BIDDER/VENDOR**
	P-perform	1 - BHEL	**NAME**	
	W-witness	2 - BHEL's Vendor	**SIGNATURE**	
	V-verify	3 - Manufacturer	**DATE**	BIDDER'S/VENDORS COMPANY SEAL

	QUALITY PLAN	CUSTOMER : TANGEDCO			PROJECT : 2X660 MW ENNORE SEZ TITLE			SPECIFICATION : PE-TS-412-558-E001 R1 NUMBER			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-558-00-Q-001/02			SPECIFICATION : STATION LIGHTING SYSTEM TITLE			
	SHEET 4 OF 4	SYSTEM			ITEM :ILLUMINATION			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOC. [Vendor DS / Drg. / Spec.to be duly apprvd. by BHEL (& Cust. If required) ; otherwise BHEL-spec. / Drg. prevails.]	ACCEPT. NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		5.ROUTINE TESTS	MA	-DO-	100%	IS:694 / IS:1554	IS:694 / IS:1554	TEST CERT.	3/2		(2),1	
		6.FRLS PROPS.	CR	FRLS TESTS	SAMPLES	BHEL SPEC	BHEL SPEC	-DO-	3/2	(2),1	-	
8.0	**CIRCUIT BREAKERS.**			Insp. checks / tests as per IS 8828					3/2		(2),1	
9.0	**Indicating Instrmts. / Meters**			Insp. checks / tests as per IS1248					3/2		(2),1	
10.0	**Visual Indicating lamps**			Insp. checks / tests as per IS 1901					3/2		(2),1	
11.0	**Contactors**			Insp. checks / tests as per IS / IEC 60947 Part 4					3/2		(2),1	
12.0	**Relays**			Insp. checks / tests as per IS 3231 : Part 1					3/2		(2),1	
13.0	**Timers**			Insp. checks / tests as per IS 3231 : Part 3 : Sec 1					3/2		(2),1	

NOTES:

1. Agency code indication as "3/2" under activity code col. "P" means , it is performed by either agency "3" or agency "2" ; Agency code shown in parantheses as (2), under activity code col. "W" or "V", is applicable if agecy "2" was not involved in activity "p".

2. IN CASE TYPE TEST CERTIFICATE FOR DEGREE OF PROTECTION/EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NO AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB.

3. ITEMS LIKE CEILING FANS, EMERGENCY LIGHTING UNIT, CABLE GLANDS / LUGS, EARTHING WIRE & FLATS, 24V SUPPLY SYS LADDERS, HUME PIPE, SWITCHBOXES, STRUCTURAL STEEL ETC. WILL BE CLEARED BASED ON TEST CERIFICATE VERIFICA BY BHEL.

BHEL	LEGEND	LEGEND :	**PARTICULARS**	**BIDDER/VENDOR**	
	P-perform	1 - BHEL	**NAME**		
	W-witness	2 - BHEL's Vendor	**SIGNATURE**		
	V-verify	3 - Manufacturer	**DATE**		BIDDER'S/VENDORS COMPANY SEAL

ANNEXURE-1

INSTRUCTIONS FOR QUALITY PLAN

The Quality Plan shall include all the Quality Control Measures and Checks adopted by the Vendor to ensure that the material/component/assembly/services supplied by him meet/will meet the requirements as per specifications and good practices. They shall include all stages of operation such as materials, processes, manufacture, assembly, packing and despatch. The following guide lines may be noted:

Column 1- Serial Number

Column 2- Component/Operation- The component and/or operation being checked shall be given here.

Column 3- Characteristics check- The characteristics being checked shall be given here, e.g., chemical composition, mechanical properties, leak tightness, surface defects etc..

Column 4- Category -'CR' stands for critical characteristic - affecting safety of equipment and personnel
'MA' stands for major Characteristic - affecting safety of equipment and personnel
'MI' stands for minor characteristic - affecting appearance etc.

Column 5- Type/Method of check e.g. chemical analysis tensile testing, hydraulic test, visual examination radiography etc.

Column 6- Extent of check, such as, 100, 10, 1 percent etc.

Column 7- Reference Documents - Documents, such as technical specification, drawings, standard specifications (IS, BS ETC.) procedure, etc. according to which check is done.

Column 8- Acceptance Norms - Standards etc. according to which acceptability or otherwise of the characteristics being checked is decided.

Column 9- Format of Record - Formats, log shets, reports, etc. in which the observations are recorded. Standard log sheets, reports, formats etc. of the Vendors shall be numbered and such reference numbers shall be included here.

Column 10- Agency - The agency which performs the test/instruction shall be written in sub-column 'W'
The agency which verifies test certificates/inspection records and carries out audit check of the components/operation shall be written in sub-column 'V'

The agencies are codified as 1,2 & 3

'1' stands for (BHEL)

'1' * means the operation shall be cleared by BHEL before the start of the next operation.

'2' Stands for Vendor

'3' stands for sub-Vendor of the Vendor and so on.

Example :

Entry '3' in column 'P' means test./inspection to be performed by sub-Vendor's QC

Entry '2' in column 'W' means test./inspection to be witnessed by Vendor's QC

Entry '1' in column 'V' means verification shall be done by BHEL and next stage to be started only after the hold point is cleared by BHEL

Column11I- Remarks - Any special remarks shall be given here.

NOTES :

1. In absence of correlation with the test certificate(s) (e.g. material identification) samples shall be drawn bgy BHEL and all tests as per relevent specifications shall be carried out in their presence or in recognized Govemment Laboratory.
2. When materials and components are initially identified and stamped by BHEL QS engineer, the identification marks shall be presserved till despatch. Wherever this is not possible, the identification mark shall be transferred to the components in the presence of BHEL QS Engineer unless other wise agreed.
3. For castings and forgings integral test specimens shall be provided, When this is not possible for casting, they shall be poured in the presence of BHEL QS Engineer unless otherwise, if witnessing of test by BHEL is called for.
4. When welders qualified by reputed inspection agencies or statutory bodies are not available, qualification tests shall be conducted in the presence of BHEL QS Engineer.
5. This Quality Plan is liable to be modified as per the requirements of approved drawings and changes in technical specifications/drawings. If there are contradictions in respect of column 7 & 8 between this Quality Plan and the approved drawings specifications, the latter shall prevail.
6. Wherever inspection by BHELs Purchaser/Third Party/Statutory authorities are mandatory, this shall be compiled with.
7. Inspection reports, log sheets, test reports/certificate. etc. shall be furnished to BHEL at the approproate stages or at the time of final inspection, as required.
8. This Quality Plan is also applicable to spares, if any, under scope of supply of Vendor.
9. The quality plan shall be submitted in minimum 4 copies with a soft copy of the same or in line with contract requirements.

SUB-SECTION - IIC

STANDARD TECHNICAL SPECIFICATION (C &I)

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.:	
		VOLUME	
		SECTION	
		REV. NO. 00	DATE :
		SHEET 1	OF 5

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to site, supervision, erection, and commissioning at site of Local Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a) IS-6005 : 1998 : Code of practice for phosphating of iron and steel.
b) IS-5 : 2007 : Colors for ready mixed paints and enamels.
c) IS-1248:2003 : Direct Acting Indicating Analog Elec Measuring Instruments.
d) IS/IEC 60947:Part 1:2004 : Low Voltage switchgear & control gear: Part-I (General Rules)
e) IS-8828:1996 : Circuit breaker for household and similar installations.
f) IS-13947 (Part-I):1993 : Low Voltage switchgear & control gear : Part-I (General Rules)
g) ISA-18.1:1979 : Annunciator Sequences and Specification
h) NFPA-496:2003 : Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments)
1.6 mm for doors and Not less than 2.0 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.1.5 The panel shall be provided with doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm.The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents.

3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.

3.1.7 The class of protection shall be in accordance with IP-55 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.
The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The TB points in terminal block shall be cage clamp type / screw type. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The panel shall have ten (20) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps / tube lights with shrouded cover of minimum 15W operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 50 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type.

Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex

4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Shee No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- Data sheet A&B for Local Panels : Data sheet no. PES-145A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145A-DS2-0

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		☐ FOLDED ■ WELDED (CRCA) (As per requirement)	
	ENCLOSURE SHEET THICKNESS	FRONT	▌2.0 mm	
		OTHER	▌2.0 mm	
		DOOR	▌2.0 mm	
TECHNICAL	INPUT POWER SUPPLY		☐ 240V 50 Hz AC ☐ 220V DC ■ 415V 3 PHASE	
	NO. OF FEEDERS		☐ ONE ▌ TWO	
	CONTROL SUPPLY		☐ 110V AC ☐ 220V AC ☐ 220V DC ■ During detailed engg. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		AS REQUIRED	
	PAINT TYPE		☐ EPOXY ENAMEL ■ EPOXY POWDER COATED	
	PANEL COLOUR (EXTERNAL)		■ Exterior- Opaline green shade 275 of IS: 5 or equivalent international code ■ Interior- Brilliant White (To be finalized during detailed engineering.)	
	FINISH		■ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL)		■ BRILLIANT WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH		☐ MATT ☐ GLOSSY ■ SEMI GLOSSY	
	CLASS OF PROTECTION		■ IP-42 ☐ IP-65	
	CONTROL HARDWARE		■ RELAY BASED	
	FOUNDATION ARRANGEMENT		■ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)		BIDDER TO SPECIFY	
	PANEL TYPE		☐ PRESSURISED ■ UNPRESSURISED As per Requirement	
	CABLE GLAND		☐ SINGLE COMPRESSION ■ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT)		☐ 1 Amp CT ☐ 4-20 mA As per Requirement	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR LOCAL PANELS	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PES-145A-DS1-0**

Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER		
	CONSTRUCTION		
	ENCLOSURE SHEET THICKNESS	FRONT	
		OTHER	
		DOOR	
TECHNICAL	INPUT POWER SUPPLY		
	NO. OF FEEDERS		
	CONTROL SUPPLY		
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		
	PAINT TYPE		
	PANEL COLOUR (EXTERNAL)		
	FINISH		
	PANEL COLOUR (INTERNAL)		
	FINISH		
	CLASS OF PROTECTION		
	CONTROL HARDWARE		
	FOUNDATION ARRANGEMENT		
	WEIGHT OF PANEL (Kg.)		
	PANEL TYPE		
	CABLE GLAND		
	AAMETER (TYPE OF INPUT)		

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

	5x800 MW TSGENCO YADADRI TPS **CONTROL & INSTRUMENTATION** Technical specification for **NATURAL DRAFT COOLING TOWER**	SPEC NO.: **PE-TS-417-145-IXXX** VOLUME SECTION REV. NO. 00 | DATE : 20.07.2017 SHEET OF

QAP FOR
LOCAL CONTROL PANEL

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	1 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
	INCOMING											
1.0	Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	IS:1079 IS:513	IS:1079 IS:513	Test Certificate	3	---	2	
		2. Bend Test	CR	Mech. test	Sample	IS:1079 IS:513	IS:1079 IS:513	Log Book	2	---	---	
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---	
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---	
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1	
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	IS:2062	IS:2062	Log Book	2	---	---	
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---	
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---	
		4. Mill marking	MA	Visual	100%	IS:2062	IS:2062	Log Book	2	---	1	
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	

LEGEND:
* CR - Critical characteristics; MA - Major characteristics; MI - Minor characteristics
$ P - Agency Performing the Test.; W - Agency Witnessing the Test.; V - Agency Verifying the Test.
1 - BHEL; 2 - Vendor; 3 - Sub-vendor

PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	2 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $ P	Agency $ W	Agency $ V	Remarks
		3. Conductor a) Resistance b) Size c) Sheet colour	 MA MA MA	 Electrical Measurement Visual	 100% 100% 100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	2	---	---	
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and IS:1554 or IS:694	BHEL Spec. and IS:1554 or IS:694	Log Book	3	---	2	
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant IS	Relevant IS	Log Book	2	---	---	
		3. Operation / Functional check	CR	Electrical	Sample+ 100%@	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	+ for relay & contactors only
		4. I.R.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	@ for all components except relays & contactors.
		5. H.V.	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	
		6. Calibration	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	1	
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant Indian Std & Catalogue	Relevant Indian Std & Catalogue	Log Book	2	---	---	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	3 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---	
	IN PROCESS											
6.0	Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---	
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---	
	ASSEMBLY											
8.0	Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	4 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
9.0	Pre-treatment and Painting	1. Pretreatment Process	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		2. Process parameters like bath temp. concentration etc.	MA	Measurement	Periodic	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		3. Dipping / Removal Time	MA	Measurement	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		4. Surface quality after every dip	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		5. Primer after phosphating	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		6. Putty Application & Rubbing after primer	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		7. Paint first coat	MA	Visual, Thickness	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		8. Putty Application and Rubbing after first coat of paint	MA	Visual	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	
		9. Paint second coat	MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & IS: 6005	Factory Standard & IS: 6005	Log Book	2	---	1	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	5 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
10.	Panel Wiring	1. Wiring Layout	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		2. Wiring Termination (Crimped Lugs)	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		3. Ferrule numbers	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	---	
		4. Colour of wiring	MA	Visual	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
		5. Size of Conductor	MA	Measurement	100%	Approved drgs. & Specs.	Approved drgs. & Specs.	Log Book	2	---	1	
11.	Component Mounting	1. Correct components	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
		2. Fixing	MA	Visual	100%	Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM	Log Book	2	---	---	
	FINAL											
12.	Final Inspection	1. Workmanship	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		3. Components identification Marking / Name plates	MA	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	

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PEM :: C&I

STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL

STD QUALITY PLAN NO.:	**PE-QP-999-145-I056**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 22-02-2008
SHEET	6 OF 7

Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency $			Remarks
									P	W	V	
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1	
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1	
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1	
		11. Wire Termination	MA	Pulling manually	Sample	-----	Firm termination	Inspection Report	2	1	1	
		12. Continuity	MA	Electrical	100%	-----	Continuity OK	Inspection Report	2	1	1	

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1 - BHEL; 2 - Vendor; 3 - Sub-vendor

SECTION III

DOCUMENTS TO BE SUBMITTED BY BIDDER

1. Guaranteed Cold water temperature at design capacity & parameters with the working cells — 33 Deg. C

Authorized Signatory

Company Seal

PARTICULARS OF BIDDER/ AUTHORISED REPRESENTATIVE				
NAME	**DESIGNATION**	**SIGNATURE**	**DATE**	**COMPANY SEAL**

COMPLIANCE CERTIFICATE

The bidder shall give his acceptance to the following by signing and stamping this compliance certificate and furnish the same with his offer.

a) The scope of supply, technical details, construction features, design parameters etc. are as per technical specification and there are no exclusions with regard to the same.

b) There are no deviations w.r.t. specification other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations.'

c) We will submit QPs in the event of order based on the guidelines given in the specification & those enclosed therein. QPs will be subject to BHEL/CUSTOMER approval & customer hold points for inspection/testing will be marked in the QPs at the contract stage. BHEL/CUSTOMER will witness inspection/testing as per details in QPs apart from review of various test certificates/ Inspection records etc.

d) All drawings, data sheets, calculations etc., if any submitted along with the offer are for reference and the same will be subject to BHEL/ CUSTOMER approval in the event of order.

e) The offered materials will be either equivalent or superior to those specified in the specification.

For components where materials are not specified, same will be suitable for intended duty and subject to approval in the event of order.

f) We will supply commissioning spares on 'As Required Basis' & prices for same are included in the base price. Prices for special tools & tackles, if any, are also included in the base price.

g) All sub vendors are subject to BHEL/ CUSTOMER approval in the event of order.

h) The Performance guarantees stand valid until at least eighteen (18) months after full load commissioning of CT or as per commercial terms and conditions, whichever is later.

i) Specific compliance to Cl. Nos. 11.0 and their sub clauses of Sec. II of Technical Specification is given.

j) We will carry out hydrostatic testing of piping as per specifications, i.e. at 1.5 times the design pressure.

Bidder's Authorized Signatory

Company Seal

FORM NO PEM 6036-1

	TITLE *** SCHEDULE OF DEVIATIONS** ( ) From Conditions of Contract (Volume – 1) ( ) From General Technical Conditions (Volume – II A) ( ) From Technical Specifications (Volume –II B)	SPECIFICATION NO VOL III SHEET…….. OF……

We the undersigned hereby certify that the above mentioned are the only deviations.

PARTICULARS OF BIDDER / AUTHORISED REPRESENTATIVE				
NAME	DESIGNATION	SIGNATURE	DATE	COMPANY SEAL

1. Guaranteed Cold water temperature at design capacity ..... Deg. C
& parameters of approved Design of NDCT.

Authorized Signatory

Company seal

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 03/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.80

Co-ordinates E=78 N=-113

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 11/04/2018
Completion Date : 12/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.757 M.
Water Struck At :
Standing Water Level : 2.80 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Medium dense, light whitish grey, clayey sandy silt. Observed conch pcs.		3 6 6 (12)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m. Loose, light whitish grey, clayey sandy silt / clayey silty sand. Observed conch pcs.		1 2 3 (5)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			DS-2	3.50
		1 2 2 (4)	SPT-3	4.00-4.45
5.50m. Very dense, light whitish grey, silty sand with decomposed rock.		100 (>100) 10.0 cm Pentn.	*UDS-2	5.00-5.35
		100 2.0 cm Pentn. Refusal	SPT-4	5.50-5.60
6.00m. Highly weathered, light grey, coarse grained, fractured rock.		Refusal	*SPT-5	5.80-5.82
			*SPT-6	6.00-6.02
6.75m. Highly weathered, light grey to light whitish grey, coarse to medium grained, fractured rock.		100 2.0 cm Pentn. NX rotary drilling from 6.00m to 20.00m	R1	CR=27%/RQD=0
			R2	CR=25% RQD=Nil
			R3	CR=27% RQD=Nil
			R4	CR=26% RQD=Nil
			R5	CR=27% RQD=Nil
			R6	CR=28% RQD=Nil
			R7	CR=26% RQD=Nil
11.25m. Highly weathered, light brownish grey / light yellowish grey, medium grained, fractured rock.			R8	CR=28% RQD=Nil
			R9	CR=29% RQD=Nil
			R10	CR=32% RQD=Nil
			R11	CR=38% RQD=Nil
			R12	CR=35% RQD=Nil
			R13	CR=34% RQD=Nil
			R14	CR=37% RQD=Nil
			R15	CR=38% RQD=Nil
17.25m. Highly weathered, light brownish grey / light yellowish grey, medium grained, fractured rock.			R16	CR=24% RQD=Nil
			R17	CR=23% RQD=Nil
			R18	CR=24% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R19	CR=25% RQD=Nil

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-80/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.81

Co-ordinates E=189 N=-125

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	1

Commencement Date : 25/04/2018
Completion Date : 27/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.724 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. Medium dense, light grey, clayey sandy silt conch pcs.		6 7 9 — 16	DS-1	0.50
			SPT-1	1.00-1.45
1.60m. Loose, light grey, clayey sandy silt with conch pcs		2 1 2 — 3	UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			WS-1	2.85
			DS-2	3.50
		2 2 2 — 4	SPT-3	4.00-4.45
5.00m. Very dense, light grey, clayey sandy silt / silty sand with decomposed rock.		100 7.0 cm Pentn. Refusal	SPT-4	5.00-5.07
5.50m. Highly weathered, light grey, coarse grained, fractured rock.		100 3.0 cm Pentn. Refusal	*SPT-5	5.30-5.33
		Refusal	*SPT-6	5.50-5.52
		100 2.0 cm Pentn.	R1	CR=26%/RQD=0
		NX rotary drilling from 5.50m to 40.00m	R2	CR=28% RQD=Nil
7.00m. Highly weathered, light grey, coarse grained, fractured rock. 7.75m.			R3	CR=25% RQD=Nil
Highly weathered, light grey, coarse grained, fractured rock.			R4	CR=27% RQD=Nil
			R5	CR=30% RQD=Nil
			R6	CR=31% RQD=Nil
			R7	CR=27% RQD=Nil
10.75m. Highly weathered, light whitish grey to light yellowish brown, medium grained, fractured rock.			R8	CR=29% RQD=Nil
			R9	CR=28% RQD=Nil
12.25m. Highly weathered, light whitish grey to light yellowish brown, medium grained, fractured rock.			R10	CR=22% RQD=Nil
			R11	CR=21% RQD=Nil
13.75m. Highly weathered, light yellowish grey, medium grained, fractured rock.			R12	CR=21% RQD=Nil
			R13	CR=22% RQD=Nil
			R14	CR=23% RQD=Nil
			R15	CR=22% RQD=Nil
			R16	CR=24% RQD=Nil
			R17	CR=26% RQD=Nil
18.25m. Highly weathered, light whitish grey to light bluish grey, medium grained, fractured rock.			R18	CR=25% RQD=Nil
			R19	CR=24% RQD=Nil
20.10m.				

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 19.75

BH-81/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 03/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.82

Co-ordinates E=137 N=-135

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 : 14/04/2018
Completion Date : 14/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.831 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 whitish grey, clayey sandy silt. Observed conch pcs.		3 4 4 (8)	DS-1	0.50
			SPT-1	1.00-1.45
1.70m. Loose, light whitish grey, clayey silty sand / clayey sandy silt. Observed conch.		2 2 3 (5)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
4.00m. Very dense, light grey, silty sand with decomposed rock.		12 33/65 (>100) 5.0 cm Pentn.	*UDS-2	3.50-3.95
			SPT-3	4.00-4.35
4.80m.		100 3.0 cm Pentn. Refusal	*SPT-4	4.60-4.63
		Refusal	*SPT-5	4.80-4.82
Highly weathered, light grey, coarse grained, fractured rock.		100 2.0 cm Pentn. NX rotary drilling from 4.80m to 20.00m	R1	CR=23%/RQD=0
			R2	CR=28% RQD=Nil
			R3	CR=22% RQD=Nil
			R4	CR=24% RQD=Nil
7.75m. Highly weathered, light grey, coarse grained, fractured rock.			R5	CR=34% RQD=Nil
9.25m. Highly weathered, light grey, coarse grained, fractured rock.			R6	CR=28% RQD=Nil
10.00m. Highly weathered, light grey, coarse grained, fractured rock.			R7	CR=24% RQD=Nil
			R8	CR=29% RQD=Nil
11.50m. Highly weathered, light brownish grey, coarse grained, fractured rock.			R9	CR=28% RQD=Nil
12.25m. Highly weathered, light brownish grey to grey, coarse to medium grained, fractured rock.			R10	CR=22% RQD=Nil
			R11	CR=33% RQD=Nil
13.75m. Highly weathered, light brownish grey to grey, coarse to medium grained, fractured rock.			R12	CR=28% RQD=Nil
14.50m.			R13	CR=23% RQD=Nil
Highly weathered, light brownish grey to grey, coarse to medium grained, fractured rock.			R14	CR=36% RQD=16%
			R15	CR=27% RQD=Nil
			R16	CR=33% RQD=Nil
			R17	CR=26% RQD=Nil
			R18	CR=29% RQD=Nil
			R19	CR=33% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.			R20	CR=28% RQD=Nil
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-82/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallakudi GETEST

Job No : 4115	Created by : SKD	Created on : 19/04/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.83

Co-ordinates E=−119 N=−164

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	1

Commencement Date : 09/04/2018
Completion Date : 10/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.686 M.
Water Struck At :
Standing Water Level : 2.80 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light whitish grey, clayey silt with sand mixture. Observed conch.		3 6 12 (6)	DS−1	0.50
			SPT−1	1.00−1.45
1.45m.				
Stiff to very stiff, light grey, clayey silt with sand mixture & conch pcs.			UDS−1	2.05−2.50
2.50m.		1 2 4 (2)	SPT−2	2.50−2.95
			WS−1	2.80
Loose, light whitish grey, clayey silt with sand mixture & conch.			DS−2	3.50
		2 2 4 (2)	SPT−3	4.00−4.45
4.60m.		100 5.0 cm Pentn. Refusal	SPT−4	4.60−4.65
Very dense, light whitish grey, silty sand with decomposed rock. Observed conch. 5.00m.		100 2.0 cm Pentn. Refusal	*SPT−5	4.80−4.82
		Refusal	*SPT−6	5.00−5.02
		100 2.0 cm Pentn.	R1	CR=24% RQD=Nil
		NX rotary drilling from 5.00m to 15.00m	R2	CR=27% RQD=Nil
Highly weathered, light grey, coarse to medium grained, fractured rock.			R3	CR=25% RQD=Nil
			R4	CR=25% RQD=Nil
8.00m.			R5	CR=27% RQD=Nil
Highly weathered, light grey, coarse to medium grained, fractured rock.			R6	CR=28% RQD=Nil
9.50m.			R7	CR=25% RQD=Nil
Highly weathered, light whitish grey, medium grained, fractured rock.			R8	CR=27% RQD=Nil
10.25m.			R9	CR=29% RQD=Nil
			R10	CR=32% RQD=Nil
Highly weathered, light whitish grey to light brownish grey, medium grained, fractured rock.			R11	CR=33% RQD=Nil
			R12	CR=35% RQD=Nil
			R13	CR=30% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.				

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 → 15.00

BH−83/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 22/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.84

Co-ordinates E=−155 N=−210

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	1

Commencement Date : 10/04/2018
Completion Date : 11/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.680 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. Medium dense, light whitish grey, silty sand. Observed conch pcs.		3 6 7 (13)	DS−1	0.50
			SPT−1	1.00−1.45
1.45m. Very loose, light whitish grey, clayey silt with sand mixture.			*UDS−1	2.00−2.45
		1 2 2 (4)	SPT−2	2.50−2.95
			WS−1	2.85
			DS−2	3.50
		2 2 2 (4)	SPT−3	4.00−4.45
4.80m. Very dense, light whitish grey, silty sand with decomposed rock.		100 8.0 cm Pentn. >100	SPT−4	4.80−4.88
		100 2.0 cm Pentn. Refusal	*SPT−5	5.00−5.02
5.25m.		Refusal	*SPT−6	5.25−5.27
Highly weathered, light grey, coarse to medium grained, fractured rock.		100 2.0 cm Pentn. NX rotary drilling from 5.25m to 15.00m	R1	CR=28% RQD=Nil 5.25−6.00
			R2	CR=29% RQD=Nil 6.00−6.75
			R3	CR=28% RQD=Nil 6.75−7.50
7.50m. Highly weathered, light grey, coarse to medium grained, fractured rock.			R4	CR=24% RQD=Nil 7.50−8.25
8.25m. Highly weathered, light grey, coarse to medium grained, fractured rock.			R5	CR=27% RQD=Nil 8.25−9.00
			R6	CR=28% RQD=Nil 9.00−9.75
9.75m. Highly weathered, light grey, coarse to medium grained, fractured rock.			R7	CR=25% RQD=Nil 9.75−10.50
10.50m. Highly weathered, light grey, coarse to medium grained, fractured rock.			R8	CR=29% RQD=Nil 10.50−11.25
			R9	CR=26% RQD=Nil 11.25−12.00
			R10	CR=28% RQD=Nil 12.00−12.75
			R11	CR=29% RQD=Nil 12.75−13.50
			R12	CR=28% RQD=Nil 13.50−14.25
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.			R13	CR=30% RQD=Nil 14.25−15.00

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.85

Co-ordinates E=−135 N=−235

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 : 27/04/2018
Completion Date : 28/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.637 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 dense, light grey, silty sand. Observed kankar.		4 6 8 (14)	DS−1	0.50
			SPT−1	1.00−1.45
1.50m.				
Loose, brownish grey, silty sand. Observed kankar & conch pcs.		1 2 2 (4)	*UDS−1	2.00−2.45
			SPT−2	2.50−2.95
			*UDS−2	3.50−3.95
3.95m.				
Medium dense, brownish grey, silty sand. Observed kankar & conch pcs.		6 9 13 (22)	SPT−3	4.00−4.45
4.90m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		40 60 10.0 cm Pentn. >100 100 3.0 cm Pentn. Refusal Refusal	SPT−4 *SPT−5 *SPT−6	4.90−5.15 5.20−5.23 5.30−5.33
5.30m.				5.30
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		00 3.0 cm Pentn. NX rotary drilling from 5.30m to 15.00m	R1	CR=22% RQD=Nil 6.00
6.00m.				
			R2	CR=28% RQD=Nil 6.75
			R3	CR=26% RQD=Nil 7.50
			R4	CR=30% RQD=Nil 8.25
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=31% RQD=Nil 9.00
			R6	CR=33% RQD=Nil 9.75
			R7	CR=26% RQD=Nil 10.50
			R8	CR=28% RQD=Nil 11.25
11.25m.				
			R9	CR=26% RQD=Nil 12.00
			R10	CR=30% RQD=Nil 12.75
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R11	CR=33% RQD=Nil 13.50
			R12	CR=35% RQD=Nil 14.25
			R13	CR=38% RQD=Nil 15.00
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.				

BH−85/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.86

Co-ordinates E=137 N=-203

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 : 26/04/2018
Completion Date : 27/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.749 M.
Water Struck At :
Standing Water Level : 3.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Medium dense, brownish grey to light grey, sandy silt to silty sand. Observed kankar & conch pcs.		9 11 7 — 18	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Very loose, light grey, silty sand. Observed conch pcs., kankar & clay binder.		1 1 1 — 2	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			UDS-2	3.50-3.95
3.90m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		14 26 60 — >100 (10.0 cm Pentn.)	SPT-3	4.05-4.45
5.00m.		100 3.0 cm Pentn. Refusal	*SPT-4	4.80-4.83
		Refusal	*SPT-5	5.00-5.02
Highly weathered, deep to light grey, coarse to medium grained, fractured rock.		100 2.0 cm Pentn. NX rotary drilling from 5.00m to 20.00m	R1	CR=28%/RQD=0
			R2	CR=31% RQD=Nil
			R3	CR=27% RQD=Nil
			R4	CR=32% RQD=Nil
8.00m. Completely/highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R5	CR=25% RQD=Nil
		Refusal	R6	CR=19%/RQD=0
9.50m. Highly weathered, deep to light grey, coarse to medium grained, fractured rock.		50 2.0 cm Pentn.	*SPT-6	9.50-9.52
			R7	CR=27%/RQD=0
			R8	CR=27% RQD=Nil
11.00m. Completely/highly weathered, deep to light grey, coarse to medium grained, fractured rock.			R9	CR=25% RQD=Nil
		Refusal	R10	CR=19%/RQD=0
12.50m. Highly weathered, light grey, medium to coarse grained, fractured rock.		50 2.0 cm Pentn.	*SPT-7	12.50-12.52
			R11	CR=25%/RQD=0
			R12	CR=27% RQD=Nil
14.00m. Highly weathered, light grey, medium to coarse grained, fractured rock. Observed reddish spots.			R13	CR=23% RQD=Nil
			R14	CR=25% RQD=Nil
			R15	CR=21% RQD=Nil
16.25m. Highly weathered, light grey, coarse grained, highly fractured rock.			R16	CR=27% RQD=Nil
17.00m. Highly weathered, light to whitish grey, coarse to medium grained, highly to moderately fractured rock.			R17	CR=23% RQD=Nil
			R18	CR=24% RQD=Nil
18.50m. Highly weathered, light to whitish grey, coarse to medium grained, highly to moderately fractured rock.			R19	CR=27% RQD=Nil
20.00m.			R20	CR=28% RQD=Nil

N.B. - '*' means sample could not be recovered / sample slip.

BH-86/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.87

Co-ordinates E=137 N=−274

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 : 29/04/2018
Completion Date : 29/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.386 M.
Water Struck At :
Standing Water Level : 3.00 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Stiff to very stiff, light grey, clayey silt with sand mixture & conch pcs.		6 9 11 — 20	DS−1	0.50
			SPT−1	1.00−1.45
2.00m. Loose to medium dense, light grey, silty sand. Observed conch pcs., kankar & clay binder.		2 2 3 — 5	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
			*UDS−2	3.50−3.95
		5 4 8 — 12	SPT−3	4.00−4.45
4.60m. Very dense, light grey, silty sand with conch pcs. Observed kankar & decomposed rock.		100 5.0 cm Pentn. Refusal	SPT−4	4.70−4.75
5.00m.		100 2.0 cm Pentn. Refusal	*SPT−5	4.90−4.92
		Refusal	*SPT−6	5.00−5.02
		100 2.0 cm Pentn.	R1	CR=23% RQD=Nil (5.00−5.75)
		NX rotary drilling from 5.00m to 15.00m	R2	CR=21% RQD=Nil (5.75−6.50)
Highly weathered, deep grey, coarse grained, highly fractured rock.			R3	CR=23% RQD=Nil (6.50−7.25)
			R4	CR=21% RQD=Nil (7.25−8.00)
			R5	CR=29% RQD=Nil (8.00−8.75)
8.75m. Highly weathered, deep grey, medium grained, fractured rock.			R6	CR=25% RQD=Nil (8.75−9.50)
			R7	CR=32% RQD=Nil (9.50−10.25)
10.25m. Highly weathered, light grey, coarse grained, fractured rock.			R8	CR=21% RQD=Nil (10.25−11.00)
11.00m. Highly weathered, light grey, medium grained, fractured rock. Observed reddish spots.			R9	CR=35% RQD=Nil (11.00−11.75)
11.75m. Completely to highly weathered, light to whitish grey, medium grained, fractured rock. Observed reddish spots.			R10	CR=23% RQD=Nil (11.75−12.50)
			R11	CR=27% RQD=Nil (12.50−13.25)
			R12	CR=16% RQD=Nil (13.25−14.00)
		Refusal	*SPT−7	14.00−14.02
		50 2.0 cm Pentn.	R13	CR=22% RQD=Nil (14.00−15.00)
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.				

BH−87/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.88

Co-ordinates E=67 N=-275

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 : 29/04/2018
Completion Date : 29/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.533 M.
Water Struck At :
Standing Water Level : 2.95 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Stiff to very stiff, light grey, clayey silt with sand mixture & conch pcs.		5 7 7 (14)	DS-1	0.50
			SPT-1	1.00-1.45
2.00m. Loose, light grey, clayey sandy silt. Observed conch pcs.		2 1 2 (3)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			DS-2	3.50
		2 2 2 (4)	SPT-3	4.00-4.45
4.60m. Very dense, light grey, silty sand with decomposed rock.		100 7.0 cm Pentn. Refusal	SPT-4	4.60-4.67
		100 3.0 cm Pentn. Refusal	*SPT-5	4.80-4.83
5.00m. Highly weathered, light grey, coarse grained, fractured rock.		Refusal	*SPT-6	5.00-5.02
5.75m.		100 2.0 cm Pentn.	R1	CR=27%/RQD=0
		NX rotary drilling from 5.00m to 20.00m	R2	CR=25% RQD=Nil
Highly weathered, light grey, coarse grained, fractured rock.			R3	CR=22% RQD=Nil
			R4	CR=23% RQD=Nil
			R5	CR=22% RQD=Nil
			R6	CR=22% RQD=Nil
9.50m. Highly weathered, light grey, coarse grained, fractured rock.			R7	CR=28% RQD=Nil
			R8	CR=29% RQD=Nil
			R9	CR=30% RQD=Nil
			R10	CR=32% RQD=Nil
			R11	CR=33% RQD=Nil
			R12	CR=37% RQD=Nil
14.00m. Highly weatherd, light yellowish grey to light grey, medium grained, fractured rock.			R13	CR=37% RQD=Nil
			R14	CR=39% RQD=Nil
			R15	CR=27% RQD=Nil
			R16	CR=26% RQD=Nil
			R17	CR=29% RQD=Nil
			R18	CR=30% RQD=Nil
			R19	CR=26% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R20	CR=28% RQD=Nil

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

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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.89

Co-ordinates E=−533 N=−289

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	11	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	11
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 12/03/2018
Completion Date : 13/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.466 M.
Water Struck At :
Standing Water Level : 1.35 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m.				
Soft, light grey, clayey silt with sand mixture. Observed conch.		1 1 1 — 2	DS−1	0.55
			SPT−1	1.00−1.45
			*UDS−1	2.00−2.45
2.50m.				
Medium dense, light grey, silty sand. Observed kankar & conch.		5 6 6 — 12	SPT−2	2.60−3.05
			*UDS−2	3.50−3.95
		4 6 7 — 13	SPT−3	4.10−4.55
4.80m.				
Very dense, light grey, sandy silt / silty sand with rock pcs. Observed kankar.		37 73 — >100 (8.0 cm Pentn.)	SPT−4	4.90−5.13
		100 3.0 cm Pentn. Refusal	*SPT−5	5.20−5.23
5.30m.		00 Refusal (2.0 cm Pentn.)	*SPT−6	5.30−5.32 5.30
		NX rotary drilling from 5.30m to 15.00m	R1	CR=22% RQD=Nil — 6.00
Highly weathered, light grey, medium grained, highly fractured rock.			R2	CR=21% RQD=Nil — 6.75
			R3	CR=23% RQD=18% — 7.50
7.50m.				
Highly weathered, light brownish grey, medium to fine grained, highly fractured rock.			R4	CR=29% RQD=Nil — 8.25
			R5	CR=28% RQD=Nil — 9.00
9.00m.				
			R6	CR=21% RQD=Nil — 9.75
			R7	CR=25% RQD=Nil — 10.50
			R8	CR=14% RQD=Nil
		50 Refusal (2.0 cm Pentn.)	*SPT−7	11.25−11.27 11.25
			R9	CR=12% RQD=Nil
Completely to highly weathered, light grey, fine grained, highly fractured rock.		51 Refusal (2.0 cm Pentn.)	*SPT−8	12.00−12.02 12.00
			R10	CR=Nil RQD=Nil
			DS−2	
		53 Refusal (3.0 cm Pentn.)	*SPT−9	12.75−12.78 12.75
			R11	CR=14% RQD=Nil
		50 Refusal (3.0 cm Pentn.)	*SPT−10	13.50−13.53 13.50
			R12	CR=18% RQD=Nil
		51 Refusal (2.0 cm Pentn.)	*SPT−11	14.25−14.27 14.25
N.B. − '*' means sample could not be recovered / sample slip.			R13	CR=21% RQD=Nil
15.00m.				15.00

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.90

Co-ordinates E=133 N=-357

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 : 29/04/2018
Completion Date : 30/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.194 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 to very stiff, light grey, clayey silt with sand mixture & conch pcs.		6 9 10 — 19	DS-1	0.50
			SPT-1	1.00-1.45
2.00m. Loose to medium dense, brownish grey, clayey silty sand. Observed kankar & conch pcs.		2 2 3 — 5	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
		7 10 10 — 20	*UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.80m. Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		35 65 5.0 cm Pentn. >100	SPT-4	4.80-5.00
		100 4.0 cm Pentn. Refusal	*SPT-5	5.10-5.14
5.20m.		100 3.0 cm Pentn. Refusal — Refusal	*SPT-6	5.20-5.23 5.20
			R1	CR=18%/RQD=0
Completely to highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		52 — 2.0 cm Pentn.	*SPT-7	6.00-6.02 6.00
			R2	CR=22%/RQD=0 6.75
7.50m.		NX rotary drilling from 5.20m to 20.00m	R3	CR=24% RQD=Nil 7.50
			R4	CR=26% RQD=Nil 8.25
			R5	CR=30% RQD=Nil 9.00
			R6	CR=32% RQD=16% 9.75
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R7	CR=30% RQD=Nil 10.50
			R8	CR=33% RQD=Nil 11.25
			R9	CR=29% RQD=Nil 12.00
			R10	CR=36% RQD=Nil 12.75
			R11	CR=30% RQD=Nil 13.50
			R12	CR=32% RQD=Nil 14.25
			R13	CR=26% RQD=Nil 15.00
15.00m. Highly weathered, brownish grey, medium grained, highly fractured rock.			R14	CR=29% RQD=Nil 15.75
15.75m. Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R15	CR=24% RQD=Nil 16.50
16.50m.			R16	CR=38% RQD=16% 17.25
Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R17	CR=40% RQD=25% 18.00
			R18	CR=28% RQD=Nil 18.75
			R19	CR=36% RQD=Nil 19.50
N.B. - '*' means sample could not be recovered / sample slip.			R20	CR=34% RQD=Nil 20.00
20.00m.				

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.91

Co-ordinates E=137 N=-414

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 : 02/05/2018
Completion Date : 03/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.287 M.
Water Struck At :
Standing Water Level : 1.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Soft to medium, light grey, clayey silt with sand mixture.		2 2 2 — 4	DS-1	0.50
			SPT-1	1.00-1.45
2.00m. Medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.		3 8 9 — 17	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
3.60m. Very dense, brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock. 4.00m.		45 55 5.0 cm Pentn. >100	SPT-3	3.60-3.80
		100 4.0 cm Pentn. Refusal	*SPT-4	3.90-3.94
		100 3.0 cm Pentn. Refusal	*SPT-5	4.00-4.03
			R1	CR=17%/RQD=0 4.75
		50 3.0 cm Pentn. Refusal	*SPT-6	4.75-4.78
		Refusal	R2	CR=12%/RQD=0 5.50
Completely to highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.		52 2.0 cm Pentn.	*SPT-7	5.50-5.52
			R3	CR=22%/RQD=0 6.25
		NX rotary drilling from 4.00m to 20.00m	R4	CR=24% RQD=Nil 7.00
7.00m. Completely to highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=26% RQD=Nil 7.75
			R6	CR=29% RQD=Nil 8.50
			R7	CR=26% RQD=Nil 9.25
9.25m. Completely to highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock. 10.00m.			R8	CR=22% RQD=Nil 10.00
			R9	CR=28% RQD=Nil 10.75
Completely to highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R10	CR=31% RQD=Nil 11.50
			R11	CR=27% RQD=Nil 12.25
			R12	CR=28% RQD=Nil 13.00
13.00m. Highly weathered, light to deep grey, medium to fine grained, highly fractured rock.			R13	CR=33% RQD=Nil 13.75
			R14	CR=35% RQD=Nil 14.50
			R15	CR=30% RQD=Nil 15.25
			R16	CR=36% RQD=Nil 16.00
			R17	CR=27% RQD=Nil 16.75
			R18	CR=26% RQD=Nil 17.50
			R19	CR=22% RQD=Nil 18.25
			R20	CR=38% RQD=Nil 19.00
N.B. - '*' means sample could not be recovered / sample slip. 20.00m.			R21	CR=30% RQD=Nil 20.00

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.92

Co-ordinates E = 78, N = -448

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	1

Commencement Date : 30/04/2018
Completion Date : 02/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.281 M.
Water Struck At :
Standing Water Level : 1.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light whitish grey, clayey sandy silt. Observed conch pcs.		2 2 1 3	DS-1	0.50
			SPT-1	1.00-1.45
			WS-1	1.40
2.50m.		>100	*UDS-1	2.00-2.45
Very dense, light whitish grey, silty sand with decomposed rock.		40 65	SPT-2	2.50-2.80
		100 3.0 cm Pentn. Refusal	*SPT-3	3.50-3.53
4.10m.		Refusal	*SPT-4	4.10-4.12
		100 2.0 cm Pentn.	R1 CR=29%/RQD=0	4.10
		NX rotary drilling from 4.10m to 40.00m	R2 CR=30%/RQD=0	4.50
			R3 CR=27%/RQD=0	5.00
			R4 CR=29%/RQD=0	5.50
Highly weathered, light grey, coarse to medium grained, fractured rock.			R5 CR=27% RQD=Nil	6.00
			R6 CR=26% RQD=Nil	6.75
			R7 CR=28% RQD=Nil	7.50
			R8 CR=27% RQD=Nil	8.25
			R9 CR=26% RQD=Nil	9.00
			R10 CR=28% RQD=Nil	9.75
			R11 CR=32% RQD=Nil	10.50
11.25m.			R12 CR=35% RQD=Nil	11.25
Highly weathered, light whitish grey, medium grained, fractured rock.			R13 CR=37% RQD=Nil	12.00
			R14 CR=35% RQD=Nil	12.75
			R15 CR=32% RQD=Nil	13.50
			R16 CR=32% RQD=Nil	14.25
			R17 CR=34% RQD=Nil	15.00
			R18 CR=35% RQD=Nil	15.75
			R19 CR=37% RQD=Nil	16.50
			R20 CR=35% RQD=Nil	17.25
			R21 CR=32% RQD=Nil	18.00
			R22 CR=35% RQD=Nil	18.75
			R23 CR=37% RQD=Nil	19.50
20.10m.				

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.92

Co-ordinates E = 78, N = −448

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	1

Commencement Date : 30/04/2018
Completion Date : 02/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.281 M.
Water Struck At :
Standing Water Level : 1.4 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
20.10m.				20.25
			R24 CR=38% RQD=Nil	21.00
			R25 CR=29% RQD=Nil	21.75
			R26 CR=32% RQD=Nil	22.50
			R27 CR=30% RQD=Nil	23.25
			R28 CR=28% RQD=Nil	24.00
Highly weathered, light whitish grey, medium grained, fractured rock.			R29 CR=27% RQD=Nil	24.75
			R30 CR=29% RQD=Nil	25.50
			R31 CR=30% RQD=Nil	26.25
			R32 CR=36% RQD=Nil	27.00
			R33 CR=28% RQD=Nil	27.75
			R34 CR=32% RQD=Nil	28.50
			R35 CR=35% RQD=Nil	29.25
29.25m.			R36 CR=40% RQD=Nil	30.00
			R37 CR=42% RQD=Nil	30.75
			R38 CR=46% RQD=Nil	31.50
			R39 CR=45% RQD=Nil	32.25
			R40 CR=43% RQD=Nil	33.00
Highly to moderately weathered, light yellowish grey, medium to fine grained, light fractured rock.			R41 CR=40% RQD=Nil	33.75
			R42 CR=35% RQD=Nil	34.50
			R43 CR=37% RQD=Nil	35.25
			R44 CR=37% RQD=Nil	36.00
			R45 CR=42% RQD=Nil	36.75
			R46 CR=45% RQD=Nil	37.50
			R47 CR=45% RQD=Nil	38.25
38.25m.			R48 CR=62% RQD=49%	39.00
Slightly weathered, light yellowish grey, meidum to fine grained, light fractured rock. N.B. − '*' means sample could not be recovered / sample slip.			R49 CR=68% RQD=60%	
40.00m.				40.00

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli.			CETEST
Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.93

Co-ordinates E=196 N=-448

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	4
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 03/05/2018
Completion Date : 03/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : -0.153 M.
Water Struck At :
Standing Water Level : 1.50 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Soft, light grey, clayey silt with sand mixture.		1 2 1 — 3	DS-1	0.50
			SPT-1	1.00-1.45
		60 42 — >100	*UDS-1	2.00-2.45
2.50m			SPT-2	2.50-2.70
Very dense, light whitish grey, silty sand with decomposed rock.		5.0 cm Pentn.	*SPT-3	2.80-2.82
3.00m		100 2.0 cm Pentn. Refusal	*SPT-4	3.00-3.02
		Refusal	R1	CR=29%/RQD=0
		100 2.0 cm Pentn.	R2	CR=27% RQD=Nil
		NX rotary drilling from 3.00m to 20.00m	R3	CR=28% RQD=Nil
			R4	CR=30% RQD=Nil
			R5	CR=28% RQD=Nil
			R6	CR=29% RQD=Nil
			R7	CR=32% RQD=Nil
Highly weathered, light grey, coarse to medium grained, fractured rock.			R8	CR=33% RQD=Nil
			R9	CR=30% RQD=Nil
			R10	CR=32% RQD=Nil
			R11	CR=30% RQD=Nil
			R12	CR=32% RQD=Nil
			R13	CR=29% RQD=Nil
			R14	CR=32% RQD=Nil
13.50m			R15	CR=35% RQD=12%
			R16	CR=35% RQD=Nil
			R17	CR=37% RQD=Nil
			R18	CR=40% RQD=21%
Highly weathered, light whitish grey to yellowish grey, medium grained, fractured rock.			R19	CR=38% RQD=Nil
			R20	CR=35% RQD=Nil
			R21	CR=31% RQD=Nil
			R22	CR=32% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip.			R23	CR=37% RQD=Nil
20.00m				

3.00 3.75 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

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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.94

Co-ordinates E=687 N=-396

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 : 03/03/2018
Completion Date : 05/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.098 M.
Water Struck At :
Standing Water Level : 1.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium, light grey, clayey silt with sand mixture. Observed conch pcs.		4 4 2 — 6	DS-1	0.50
			SPT-1	1.00-1.45
2.30m.			*UDS-1	2.00-2.45
Very loose, light grey, clayey silty sand. Observed kankar, conch pcs.		0 1 1 — 2	SPT-2	2.50-2.95
3.80m.			*UDS-2	3.50-3.95
Very dense, light grey, sandy silt / silty sand.		00 — >100 (14.0 cm Pentn.)	SPT-3	4.00-4.14
		100 2.0 cm Pentn. Refusal	*SPT-4	4.30-4.32
4.50m.		00 — Refusal	*SPT-5	4.50-4.52
Highly weathered, light grey to whitish grey, coarse to fine grained, fractured rock.		2.0 cm Pentn.	R1	CR=26% RQD=16%
5.25m.		NX rotary drilling from 4.50m to 15.00m		5.25
			R2	CR=22% RQD=14%
				6.00
			R3	CR=14% RQD=Nil
		50 — Refusal	*SPT-6	6.75-6.77
		2.0 cm Pentn.		6.75
			R4	CR=14% RQD=Nil
		50 — Refusal	*SPT-7	7.50-7.52
		2.0 cm Pentn.		7.50
			R5	CR=18% RQD=14%
		50 — Refusal	*SPT-8	8.25-8.27
		2.0 cm Pentn.		8.25
			R6	CR=22% RQD=Nil
Completely to highly weathered, light grey to whitish grey, coarse to fine grained, fractured rock.				9.00
			R7	CR=20% RQD=Nil
				9.75
			R8	CR=13% RQD=Nil
		50 — Refusal	*SPT-9	10.50-10.52
		2.0 cm Pentn.		10.50
			R9	CR=14% RQD=Nil
		50 — Refusal	*SPT-10	11.25-11.27
		2.0 cm Pentn.		11.25
			R10	CR=25% RQD=Nil
				12.00
			R11	CR=21% RQD=Nil
				12.75
			R12	CR=22% RQD=Nil
				13.50
			R13	CR=23% RQD=Nil
				14.25
14.25m.			R14	CR=32% RQD=19%
Highly weathered, light grey, fine grained, fractured rock. 15.00m.				15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-94/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/03/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.95

Co-ordinates E=−473 N=−809

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 14/03/2018
Completion Date : 15/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.670 M.
Water Struck At :
Standing Water Level : 2.10 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed kankar & conch.		3 5 7 — 12	DS−1	0.50
			SPT−1	1.00−1.45
2.55m.			*UDS−1	2.00−2.45
Dense, light grey, silty sand. Observed kankar & conch.		14 18 21 — 39	SPT−2	2.55−3.00
3.00m.				
Very dense, light grey, silty sand with rock pcs.		32 68 10.0 cm Pentn. >100	SPT−3	3.10−3.35
		100 3.0 cm Pentn. Refusal	*SPT−4	3.45−3.48
3.55m.		Refusal	*SPT−5	3.55−3.57
Highly weathered, light grey, medium grained, highly fractured rock.		00 2.0 cm Pentn.	R1	CR=25% RQD=Nil
4.25m.		NX rotary drilling from 3.55m to 15.00m		4.25
			R2	CR=36% RQD=Nil
				5.00
			R3	CR=37% RQD=Nil
				5.75
Highly weathered, light brownish grey to light grey, medium to fine grained, fractured rock.			R4	CR=39% RQD=24%
				6.50
			R5	CR=36% RQD=Nil
				7.25
			R6	CR=40% RQD=Nil
8.00m.				8.00
Highly weathered, light brownish grey to light grey, medium to fine grained, fractured rock.			R7	CR=22% RQD=Nil
				8.75
			R8	CR=26% RQD=Nil
9.50m.				9.50
			R9	CR=21% RQD=Nil
				10.25
		Refusal	R10	CR=17% RQD=Nil
		51 2.0 cm Pentn.	*SPT−6	11.00−11.02 11.00
Completely to highly weathered, whitish grey, coarse grained, highly fractured rock.			R11	CR=25% RQD=Nil
				11.75
		Refusal	R12	CR=16% RQD=Nil
		50 3.0 cm Pentn.	*SPT−7	12.50−12.53 12.50
			R13	CR=22% RQD=Nil
				13.25
		Refusal	R14	CR=18% RQD=Nil
14.00m.		52 2.0 cm Pentn.	*SPT−8	14.00−14.02 14.00
Highly weathered, light grey, fine grained, highly fractured rock.			R15	CR=27% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.				15.00

BH−95/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.96

Co-ordinates E=705 N=−881

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	9
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 05/03/2018
Completion Date : 06/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.761 M.
Water Struck At :
Standing Water Level : 1.65 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed conch pcs.		5 7 10 — 17	DS−1	0.50
			SPT−1	1.00−1.45
			*UDS−1	2.00−2.45
2.70m.				
Very loose, light grey, silty sand. Observed kankar, conch pcs.		0 1 1 — 2	SPT−2	3.00−3.45
3.60m.				
Very dense, light grey, silty sand with decomposed rock. Observed conch pcs.		100 — >100 14.0 cm Pentn.	SPT−3	4.00−4.14
		100 2.0 cm Pentn. Refusal	*SPT−4	4.35−4.37
4.50m.		100 — Refusal 2.0 cm Pentn.	*SPT−5	4.50−4.52 4.50
			R1	CR=14% RQD=Nil 5.25
Completely weathered, light to deep grey, coarse grained, fractured rock.		50 — Refusal 2.0 cm Pentn.	*SPT−6	5.25−5.27
			R2	CR=13% RQD=Nil 6.00
6.00m.		50 — Refusal 3.0 cm Pentn.	*SPT−7	6.00−6.03
			R3	CR=38% RQD=25% 6.75
Highly weathered, light to deep grey, coarse grained, fractured rock.		NX rotary drilling from 4.50m to 15.00m	R4	CR=41% RQD=22% 7.50
7.50m.			R5	CR=22% RQD=Nil 8.25
Completely to highly weathered, light grey, coarse to medium grained, fractured rock.			R6	CR=26% RQD=Nil 9.00
			R7	CR=18% RQD=Nil
		50 — Refusal 2.0 cm Pentn.	*SPT−8	9.75−9.77 9.75
			R8	CR=22% RQD=Nil 10.50
10.50m.			R9	CR=30% RQD=Nil 11.25
Highly to moderately weathered, light grey, medium grained, fractured rock.			R10	CR=46% RQD=Nil 12.00
			R11	CR=45% RQD=Nil 12.75
12.75m.			R12	CR=21% RQD=Nil 13.50
Completely/highly weathered, whitish grey, coarse to fine grained, fractured rock.			R13	CR=28% RQD=Nil 14.25
N.B. − '*' means sample could not be recovered / sample slip.			R14	CR=14% RQD=Nil 15.00
15.00m.		50 — Refusal 2.0 cm Pentn.	*SPT−9	15.00−15.02

BH−96/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/03/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.97

Co-ordinates E=−260 N=−1148

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 15/03/2018
Completion Date : 17/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.221 M.
Water Struck At :
Standing Water Level : 1.56 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light grey, silty sand. Observed kankar, conch pcs. & clay binder.		2 2 3 (5)	DS−1	0.50
			SPT−1	1.00−1.45
Very loose, light grey, silty sand. (Observed kankar, conch pcs. & clay binder.) 2.45m.		1 2 2 (4)	UDS−1	2.00−2.45
			SPT−2	2.50−2.95
3.00m. Very dense, light grey, silty sand with conch pcs. & decomposed rock.		100 9.0 cm Pentn. >100 100 3.0 cm Pentn. Refusal	SPT−3 *SPT−4	3.10−3.19 3.30−3.33
3.50m.		Refusal	*SPT−5	3.50−3.52 3.50
Completely weathered, light grey, coarse grained, fractured rock. 4.25m.		00 2.0 cm Pentn. NX rotary drilling from 3.50m to 15.00m	R1	CR=20% RQD=Nil 4.25
Highly weathered, deep to light grey, fine to coarse grained, fractured rock. 7.25m.			R2	CR=30% RQD=Nil 5.00
			R3	CR=32% RQD=Nil 5.75
			R4	CR=28% RQD=Nil 6.50
			R5	CR=29% RQD=Nil 7.25
Completely to highly weathered, light to whitish grey, medium to coarse grained, moderately to highly fractured rock.		Refusal 50 2.0 cm Pentn.	R6	CR=25% RQD=Nil 8.00
			R7	CR=24% RQD=Nil 8.75
			R8	CR=24% RQD=Nil 9.50
			R9	CR=18% RQD=Nil
			*SPT−6	10.25−10.27 10.25
			R10	CR=22% RQD=Nil 11.00
			R11	CR=24% RQD=Nil 11.75
			R12	CR=33% RQD=16% 12.50
			R13	CR=25% RQD=Nil 13.25
13.25m. Highly weathered, light grey, medium grained, fractured rock.			R14	CR=29% RQD=Nil 14.00
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.			R15	CR=36% RQD=Nil 15.00

BH−97/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 19/03/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.98

Co-ordinates E=112 N=-1560

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 : 14/03/2018
Completion Date : 15/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.379 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.				
Very loose, light grey, sandy silt / silty sand. Observed kankar, conch pcs., gravel & clay binder.		2 1 1 (2)	DS-1	0.50
			SPT-1	1.00-1.45
			UDS-1	2.00-2.45
		1 1 3 (4)	SPT-2	2.50-2.95
3.40m.				
Very dense, light grey, silty sand. Observed kankar, conch pcs. & decomposed rock.		00 (>100) 9.0 cm Pentn.	*UDS-2	3.50-3.58
		100 2.0 cm Pentn. Refusal	SPT-3	3.90-3.99
		Refusal	*SPT-4	4.20-4.22
4.50m.			*SPT-5	4.50-4.52
Completely to highly weathered, light grey, coarse grained, fractured rock.		100 2.0 cm Pentn. NX rotary drilling from 4.50m to 15.00m	R1	CR=24% RQD=Nil 4.50 - 5.25
			R2	CR=20% RQD=Nil 5.25 - 6.00
			R3	CR=21% RQD=Nil 6.00 - 6.75
6.75m.				
Highly weathered, light to deep grey, medium to coarse grained, fractured rock.			R4	CR=28% RQD=Nil 6.75 - 7.50
			R5	CR=28% RQD=Nil 7.50 - 8.25
			R6	CR=29% RQD=Nil 8.25 - 9.00
9.00m.				
Highly weathered, whitish grey to light grey, medium to coarse grained, fractured rock.			R7	CR=33% RQD=Nil 9.00 - 9.75
			R8	CR=26% RQD=Nil 9.75 - 10.50
			R9	CR=32% RQD=Nil 10.50 - 11.25
11.25m.				
Highly weathered, whitish grey to light grey, medium to coarse grained, fractured rock.			R10	CR=22% 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=28% RQD=Nil 13.50 - 14.25
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.			R14	CR=25% RQD=Nil 14.25 - 15.00

BH-98/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.99

Co-ordinates E=914 N=-1357

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 : 06/03/2018
Completion Date : 07/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.543 M.
Water Struck At :
Standing Water Level : 1.53 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light grey, silty sand. Observed conch pcs., kankar & clay binder.		3 4 6 — 10	DS-1	0.50
			SPT-1	1.00-1.45
2.40m.			UDS-1	2.00-2.45
Very loose, light grey, silty sand. Observed kankar.		0 1 2 — 3	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		1 2 3 — 5	SPT-3	4.00-4.45
4.70m.				
Very dense, brownish grey to light grey, silty sand with mica. Observed gravel & decomposed rock.		00 — >100 (12.0 cm Pentn.)	SPT-4	5.00-5.12
		100 2.0 cm Pentn. Refusal	*SPT-5	5.30-5.32
5.50m.		00 — Refusal (3.0 cm Pentn.)	*SPT-6	5.50-5.53 5.50
		NX rotary drilling from 5.50m to 15.00m	R1	CR=28% RQD=Nil 6.25
			R2	CR=37% RQD=25% 7.00
			R3	CR=30% RQD=16% 7.75
			R4	CR=24% RQD=13% 8.50
Highly weathered, brownish grey to light grey, medium to coarse grained, moderately fractured rock.			R5	CR=37% RQD=17% 9.25
			R6	CR=32% RQD=13% 10.00
			R7	CR=34% RQD=26% 10.75
			R8	CR=33% RQD=Nil 11.50
			R9	CR=29% RQD=Nil 12.25
12.25m.			R10	CR=14% RQD=Nil
Completely to highly weathered, whitish grey to brownish grey, medium grained, lightly fractured rock.		50 — Refusal (3.0 cm Pentn.)	*SPT-7	13.00-13.03 13.00
			R11	CR=18% RQD=Nil
13.75m.		50 — Refusal (2.0 cm Pentn.)	*SPT-8	13.75-13.77 13.75
Moderately weathered, whitish grey to light grey, medium grained, moderately fractured rock.			R12	CR=46% RQD=17% 14.50
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.			R13	CR=48% RQD=28% 15.00

BH-99/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.100

Co-ordinates E=748 N=-1746

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	1

Commencement Date : 07/03/2018
Completion Date : 08/03/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.073 m.
Water Struck At :
Standing Water Level : 1.92 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light grey, silty sand. Observed mica, clay binder & brownish spots.		6 5 8/3	DS-1	0.50
			SPT-1	1.00-1.45
			WS-1	1.92
			UDS-1	2.00-2.45
2.50m.				
Very loose, light grey, silty sand. Observed clay binder with high % of conch pcs. & gravel.		0 0 2/2	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		0 0 1/1	SPT-3	4.05-4.50
4.70m.		100 >100 14.0 cm Pentn.	SPT-4	4.70-4.84
Very dense, light grey, silty sand with conch pcs. & decomposed rock. 5.00m.		00 Refusal 3.0 cm Pentn.	*SPT-5	5.00-5.03
		NX rotary drilling from 5.00m to 15.00m	R1	CR=24% RQD=14% 5.00 - 5.45
			R2	CR=25% RQD=13% 5.45 - 6.20
Completely/highly weathered, light grey, coarse grained, fractured rock.			R3	CR=24% RQD=Nil 6.20 - 6.95
			R4	CR=28% RQD=Nil 6.95 - 7.70
			R5	CR=20% RQD=Nil 7.70 - 8.45
8.45m.				
			R6	CR=29% RQD=17% 8.45 - 9.20
			R7	CR=28% RQD=16% 9.20 - 9.95
			R8	CR=33% RQD=Nil 9.95 - 10.70
Highly to moderately weathered, light to brownish grey, coarse grained, fractured rock.			R9	CR=38% RQD=Nil 10.70 - 11.45
			R10	CR=39% RQD=Nil 11.45 - 12.20
			R11	CR=32% RQD=13% 12.20 - 12.95
			R12	CR=42% RQD=Nil 12.95 - 13.70
			R13	CR=25% RQD=Nil 13.70 - 14.45
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.			R14	CR=27% RQD=Nil 14.45 - 15.00

BH-100/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 04/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.101

Co-ordinates E=−106 N=333

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date : 17/04/2018
Completion Date : 20/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.003 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. Medium dense, light grey, silty sand. Observed kankar.		6 5 5 (10)	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 2 3 (5)	*UDS−1	2.00−2.45
			SPT−2	2.50−2.95
			*UDS−2	3.00−3.45
		7 10 10 (20)	SPT−3	4.00−4.45
5.00m. Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock. 5.60m.		15 35 50 5.0 cm Pentn. >100	SPT−4	5.00−5.34
		100 3.0 cm Pentn. Refusal	*SPT−5	5.50−5.53
			*SPT−6	5.60−5.63
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		100 3.0 cm Pentn. NX rotary drilling from 5.60m to 40.00m	R1	CR=22%/RQD=0 5.60 – 6.25
			R2	CR=26% RQD=Nil 6.25 – 7.00
			R3	CR=22% RQD=Nil 7.00 – 7.75
			R4	CR=24% RQD=Nil 7.75 – 8.50
8.50m. Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=26% RQD=Nil 8.50 – 9.25
			R6	CR=28% RQD=Nil 9.25 – 10.00
			R7	CR=26% RQD=Nil 10.00 – 10.75
			R8	CR=28% RQD=Nil 10.75 – 11.50
12.25m. Highly weathered, brownish grey to deep grey, medium to fine grained, highly fractured rock.			R9	CR=29% RQD=Nil 11.50 – 12.25
			R10	CR=26% RQD=Nil 12.25 – 13.00
13.75m. Highly weathered, brownish grey to deep grey, medium to fine grained, highly fractured rock.			R11	CR=28% RQD=Nil 13.00 – 13.75
			R12	CR=24% RQD=Nil 13.75 – 14.50
			R13	CR=22% RQD=Nil 14.50 – 15.25
			R14	CR=25% RQD=Nil 15.25 – 16.00
			R15	CR=27% RQD=Nil 16.00 – 16.75
17.50m. Highly to moderately weathered, brownish grey to deep grey, medium to fine grained, highly fractured rock.			R16	CR=24% RQD=Nil 16.75 – 17.50
			R17	CR=28% RQD=Nil 17.50 – 18.25
			R18	CR=26% RQD=Nil 18.25 – 19.00
			R19	CR=29% RQD=Nil 19.00 – 19.75
20.10m.				

BH−101/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115 | Created by : SKD | Created on : 04/05/2018 | Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.101

Co-ordinates E=−106 N=333

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	10	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	10
Vane (V)		Disturbed (DS)	5
		Water Sample (WS)	0

Commencement Date : 17/04/2018
Completion Date : 20/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.003 M.
Water Struck At :
Standing Water Level : 2.85 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
20.10m.			R20	CR=30% RQD=Nil 20.50
			R21	CR=28% RQD=Nil 21.25
			R22	CR=31% RQD=Nil 22.00
			R23	CR=36% RQD=Nil 22.75
Highly to moderately weathered, brownish grey to deep grey, medium to fine grained, highly fractured rock.			R24	CR=28% RQD=Nil 23.50
			R25	CR=31% RQD=17% 24.25
			R26	CR=38% RQD=16% 25.00
			R27	CR=38% RQD=17% 25.75
			R28	CR=40% RQD=Nil 26.50
			R29	CR=42% RQD=13% 27.25
27.25m.		45 55 >100 10.0 cm Pentn.	R30/DS−2	CR=0/RQD=0
			SPT−7	28.00−28.25 28.00
Completely weathered, brownish grey, medium grained, fully decomposed & disintegrated rock particles collected as sludge sample.		42 58 >100 5.0 cm Pentn.	R31/DS−3	CR=0/RQD=0
			SPT−8	28.75−28.95 28.75
		30 35 35 >100 5.0 cm Pentn.	R32/DS−4	CR=0/RQD=0
			SPT−9	29.50−29.85 29.50
			R33/DS−5	CR=0/RQD=0
30.25m.		Refusal	*SPT−10	30.25−30.29 30.25
		100 4.0 cm Pentn.	R34	CR=38%/RQD=0
			R35	CR=37% RQD=Nil 31.00
			R36	CR=35% RQD=Nil 31.75
			R37	CR=40% RQD=Nil 32.50
			R38	CR=34% RQD=Nil 33.25
			R39	CR=40% RQD=Nil 34.00
Highly to moderately weathered, light to brownish grey, medium to fine grained, highly fractured rock.			R40	CR=33% RQD=Nil 34.75
			R41	CR=40% RQD=Nil 35.50
			R42	CR=33% RQD=Nil 36.25
			R43	CR=40% RQD=Nil 37.00
			R44	CR=38% RQD=13% 37.75
			R45	CR=36% RQD=Nil 38.50
N.B. − '*' means sample could not be recovered / sample slip.			R46	CR=45% RQD=Nil 39.25
40.00m.				40.00

BH−101/Sheet−2

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 04/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.102

Co-ordinates E=−119 N=311

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 : 16/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.017 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. Medium dense, light grey, silty sand. Observed kankar.		5 6 5 (11)	DS−1	0.50
			SPT−1	1.00−1.45
2.00m. Very soft, light grey, clayey silt with sand mixture.		2 2 4 (6)	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
Medium dense, brownish grey, silty sand with kankar & conch. Observed clay binder. 3.95m. 4.50m.		7 10 12 (22)	UDS−2	3.50−3.95
			SPT−3	4.00−4.45
Dense to very dense, light grey, silty sand with mica, kankar & conch. Observed decomposed rock. 5.70m.		10 15 17 (32)	SPT−4	5.00−5.45
		100 4.0 cm Pentn. Refusal	*SPT−5	5.60−5.64
			*SPT−6	5.70−5.73
Highly weathered, brownish grey, medium grained, highly fractured rock. 6.50m.		100 3.0 cm Pentn.	R1	CR=31%/RQD=0
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock. 8.00m.		NX rotary drilling from 5.70m to 40.00m	R2	CR=25% RQD=Nil
			R3	CR=24% RQD=Nil
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock. 9.50m.			R4	CR=26% RQD=Nil
			R5	CR=34% RQD=Nil
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock. 11.75m.			R6	CR=25% RQD=Nil
			R7	CR=29% RQD=Nil
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock. 14.00m.			R8	CR=24% RQD=Nil
			R9	CR=26% RQD=Nil
			R10	CR=33% RQD=Nil
			R11	CR=29% RQD=Nil
			R12	CR=38% RQD=Nil
			R13	CR=31% RQD=Nil
			R14	CR=40% RQD=Nil
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R15	CR=37% RQD=Nil
			R16	CR=33% RQD=Nil
			R17	CR=31% RQD=Nil
			R18	CR=29% RQD=Nil
			R19	CR=30% RQD=Nil
20.10m.				

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−102/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 04/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.102

Co-ordinates E=−119 N=311

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 : 16/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.017 M.
Water Struck At :
Standing Water Level : 2.85 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
20.10m. Highly weathered, light grey, medium to fine grained, highly fractured rock.			R20 CR=35% RQD=Nil	20.75
			R21 CR=34% RQD=Nil	21.50
			R22 CR=40% RQD=Nil	22.25
22.25m. Highly weathered, light to brownish grey, fine to medium grained, moderately fractured rock.			R23 CR=38% RQD=Nil	23.00
			R24 CR=38% RQD=Nil	23.75
			R25 CR=34% RQD=Nil	24.50
			R26 CR=34% RQD=Nil	25.25
			R27 CR=36% RQD=Nil	26.00
			R28 CR=27% RQD=Nil	26.75
			R29 CR=30% RQD=Nil	27.50
			R30 CR=28% RQD=Nil	28.25
			R31 CR=33% RQD=Nil	29.00
			R32 CR=38% RQD=Nil	29.75
29.75m. Highly weathered, light to brownish grey, fine to medium grained, moderately fractured rock.			R33 CR=25% RQD=Nil	30.50
			R34 CR=22% RQD=Nil	31.25
31.25m. Highly weathered, light to brownish grey, fine to medium grained, moderately fractured rock.			R35 CR=22% RQD=Nil	32.00
			R36 CR=30% RQD=Nil	32.75
			R37 CR=26% RQD=Nil	33.50
33.50m. Highly weathered, brownish grey, medium to fine grained, highly fractured rock.			R38 CR=24% RQD=Nil	34.25
			R39 CR=21% RQD=Nil	35.00
			R40 CR=25% RQD=Nil	35.75
35.75m. Highly weathered, brownish grey, medium to fine grained, highly fractured rock.			R41 CR=26% RQD=Nil	36.50
			R42 CR=28% RQD=Nil	37.25
			R43 CR=26% RQD=Nil	38.00
			R44 CR=32% RQD=Nil	38.75
			R45 CR=36% RQD=Nil	39.50
N.B. − '*' means sample could not be recovered / sample slip. 40.00m.			R46 CR=38% RQD=Nil	40.00

BH−102/Sheet−2

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.103

Co-ordinates E=99 N=-399

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 : 30/04/2018
Completion Date : 30/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.231 M.
Water Struck At :
Standing Water Level : 1.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Stiff to very stiff, light grey, clayey silt with sand mixture & traces of gravel.		9 11 6 (17)	DS-1	0.50
			SPT-1	1.00-1.45
2.00m. Very loose, light grey, sandy silt to silty sand. Observed kankar & clay binder.		1 1 1 (2)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
		54 46 (>100)	*UDS-2	3.20-3.28
3.40m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		13.0 cm Pentn.	SPT-3	3.50-3.78
		100 3.0 cm Pentn. Refusa	*SPT-4	3.90-3.93
4.00m.		100 2.0 cm Pentn. Refusa	*SPT-5	4.00-4.02
		NX rotary drilling from 4.00m to 15.00m	R1	CR=24% RQD=Nil 4.00 / 4.75
Completely to highly weathered, deep to light grey, coarse grained, highly fractured rock.		Refusal	R2	CR=14% RQD=Nil
		50 2.0 cm Pentn.	*SPT-6	5.50-5.52
			R3	CR=21% RQD=Nil 5.50 / 6.25
6.25m. Highly weathered, deep grey, medium grained, fractured rock.			R4	CR=21% RQD=Nil
7.00m. Highly weathered, deep grey, medium grained, fractured rock.			R5	CR=27% RQD=Nil 7.00 / 7.75
			R6	CR=32% RQD=Nil
8.50m. Highly weathered, deep grey, medium grained, fractured rock.			R7	CR=29% RQD=Nil 8.50 / 9.25
9.25m. Highly weathered, deep to whitish grey, medium grained, fractured rock.			R8	CR=24% RQD=Nil
			R9	CR=24% RQD=Nil 10.00 / 10.75
			R10	CR=24% RQD=Nil
12.25m. Highly weathered, light grey, medium grained, highly fractured rock with reddish spots.			R11	CR=21% RQD=Nil 11.50 / 12.25
13.00m. Highly weathered, whitish grey, medium grained, fractured rock.			R12	CR=28% RQD=Nil
			R13	CR=34% RQD=Nil 13.00 / 13.75
			R14	CR=32% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.			R15	CR=26% RQD=Nil 14.50 / 15.00

BH-103/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.104

Co-ordinates E=177 N=-409

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 : 02/05/2018
Completion Date : 02/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.117 M.
Water Struck At :
Standing Water Level : 1.40 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff to very stiff, light grey, clayey silt with sand mixture & traces of gravel.		5 8 3 (11)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
		2 1 1 (2)	SPT-2	2.55-3.00
3.20m.				
Very dense, light grey, silty sand with conch pcs. & decomposed rock. Observed kankar.		100 5.0 cm Pentn. Refusal	SPT-3	3.30-3.35
		100 2.0 cm Pentn. Refusal	*SPT-4	3.50-3.52
3.60m.		100 2.0 cm Pentn. Refusal	*SPT-5	3.60-3.62
			R1	CR=18%/RQD=0
		50 3.0 cm Pentn. Refusal	*SPT-6	4.25-4.28
Completely to highly weathered, deep to light grey, coarse grained, highly to moderately fractured rock.		NX rotary drilling from 3.60m to 15.00m	R2	CR=22% RQD=Nil
			R3	CR=22% RQD=Nil
			R4	CR=19% RQD=Nil
		Refusal		
6.50m.		50 2.0 cm Pentn.	*SPT-7	6.50-6.52
			R5	CR=31% RQD=Nil
Highly weathered, deep to light grey, coarse grained, highly to moderately fractured rock.			R6	CR=30% RQD=Nil
			R7	CR=32% RQD=Nil
			R8	CR=38% RQD=Nil
9.50m.				
Highly weathered, light grey, medium grained, moderately fractured rock.			R9	CR=28% RQD=Nil
10.25m.				
Highly weathered, light to whitish grey, medium grained, moderately to highly fractured rock.			R10	CR=23% RQD=Nil
11.00m.				
Highly weathered, light to whitish grey, medium grained, moderately to highly fractured rock.			R11	CR=29% RQD=Nil
			R12	CR=36% RQD=Nil
12.50m.				
Highly weathered, light to whitish grey, medium grained, moderately to highly fractured rock.			R13	CR=23% RQD=Nil
			R14	CR=23% RQD=Nil
14.00m.				
Highly weathered, whitish grey, medium grained, highly fractured rock. N.B. - '*' means sample could not be recovered / sample slip.			R15	CR=35% RQD=Nil
15.00m.				

3.60
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
15.00

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 04/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.105

Co-ordinates E=144 N=-98

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 : 12/04/2018
Completion Date : 13/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.766 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.				
Loose, light whitish grey, clayey sandy silt. Observed conch.		2 3 6 (9)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m.				
Loose to medium dense, light whitish grey, clayey sandy silt. Observed conch pcs.		1 2 2 (4)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
			DS-2	3.50
		3 5 21 (26)	SPT-3	4.00-4.45
4.50m.		100 5.0 cm Pentn. Refusa	*SPT-4	4.60-4.65
Very dense, light whitish grey, silty sand with decomposed rock.		100 2.0 cm Pentn. Refusa	*SPT-5	4.80-4.82
5.00m.		Refusal	*SPT-6	5.00-5.02
		100 2.0 cm Pentn.	R1	CR=24%/RQD=0 5.00
Highly weathered, light grey, coarse grained, fractured rock.		NX rotary drilling from 5.00m to 20.00m	R2	CR=27% RQD=Nil 5.75
			R3	CR=23% RQD=Nil 6.50
			R4	CR=25% RQD=Nil 7.25
8.00m.			R5	CR=27% RQD=Nil 8.00
Highly weathered, light grey, coarse grained, fractured rock.			R6	CR=29% RQD=15% 8.75
			R7	CR=27% RQD=Nil 9.50
10.25m.			R8	CR=24% RQD=Nil 10.25
Highly weathered, light grey, coarse grained, fractured rock.			R9	CR=27% RQD=Nil 11.00
11.00m.			R10	CR=30% RQD=Nil 11.75
Highly weathered, light grey, coarse grained, fractured rock.			R11	CR=32% RQD=Nil 12.50
12.50m.			R12	CR=26% RQD=Nil 13.25
			R13	CR=38% RQD=38% 14.00
			R14	CR=33% RQD=Nil 14.75
			R15	CR=34% RQD=Nil 15.50
Highly weathered, light brownish grey to light grey, medium grained, fractured rock.			R16	CR=34% RQD=Nil 16.25
			R17	CR=29% RQD=Nil 17.00
			R18	CR=27% RQD=Nil 17.75
			R19	CR=27% RQD=Nil 18.50
N.B. - '*' means sample could not be recovered / sample slip.			R20	CR=34% RQD=Nil 19.25
20.00m.				20.00

BH-105/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 04/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.106

Co-ordinates E = 91, N = −150

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 : 15/04/2018
Completion Date : 16/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.670 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 whitish grey, clayey sandy silt. Observed conch.		3 5 6 (11)	DS−1	0.50
			SPT−1	1.00−1.45
1.60m.				
Loose, light whitish grey, clayey sandy silt. Observed conch.		1 2 2 (4)	UDS−1	2.05−2.50
			SPT−2	2.50−2.95
			DS−2	3.50
		2 2 3 (5)	SPT−3	4.00−4.45
4.90m.				
Very dense, light whitish grey, silty sand with decomposed rock.		100 10.0 cm Pentn. >100 100 2.0 cm Pentn. Refusal Refusal	SPT−4 *SPT−5 *SPT−6	4.90−5.00 5.20−5.22 5.50−5.52
5.50m.				5.50
Highly weathered, light grey, coarse grained, fractured rock.		100 2.0 cm Pentn.	R1	CR=27%/RQD=0
6.25m.				6.25
		NX rotary drilling from 5.50m to 20.00m	R2	CR=25% RQD=Nil
Highly weathered, light grey, coarse to medium grained, fractured rock.			R3	CR=28% RQD=Nil
			R4	CR=23% RQD=Nil
8.50m.				8.50
Highly weathered, light grey, coarse to medium grained, fractured rock.			R5	CR=26% RQD=Nil
			R6	CR=30% RQD=Nil
10.00m.				10.00
			R7	CR=37% RQD=Nil
			R8	CR=38% RQD=Nil
			R9	CR=32% RQD=Nil
			R10	CR=50% RQD=17%
			R11	CR=44% RQD=Nil
			R12	CR=37% RQD=Nil
Highly/moderately weathered, light yellowish grey to light grey, medium grained, fractured rock.			R13	CR=50% RQD=17%
			R14	CR=42% RQD=Nil
			R15	CR=28% RQD=Nil
			R16	CR=27% RQD=Nil
			R17	CR=29% RQD=Nil
			R18	CR=27% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.			R19	CR=29% RQD=Nil
20.00m.				20.00

BH−106/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.107

Co-ordinates E=133 N=-468

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 : 03/05/2018
Completion Date : 03/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.353 M.
Water Struck At :
Standing Water Level : 1.50 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Soft to medium, light grey, clayey silt with sand mixture.		4 4 4 8	DS-1	0.50
			SPT-1	1.00-1.45
2.00m.				
Loose, light grey, clayey silty sand. Observed kankar & conch pcs.		3 3 4 7	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.20m.				
Vrey dense, light to brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock. 3.70m.		37 65 10.0 cm Pentn. >100 100 4.0 cm Pentn. Refusa 100 3.0 cm Pentn. Refusa NX rotary drilling from 3.70m to 15.00m	SPT-3 *SPT-4 *SPT-5 R1	3.20-3.45 3.60-3.64 3.70-3.73 3.70 CR=14% RQD=Nil
		52 3.0 cm Pentn. Refusal	*SPT-6	4.50-4.53 4.50
		Refusal	R2	CR=16% RQD=Nil
		54 2.0 cm Pentn.	*SPT-7	5.25-5.27 5.25
			R3	CR=24% RQD=Nil
Completely to highly weathered, deep grey, medium to coarse grained, highly fractured rock.			R4	6.00 CR=22% RQD=Nil
			R5	6.75 CR=21% RQD=Nil
			R6	7.50 CR=24% RQD=Nil
			R7	8.25 CR=22% RQD=Nil
9.00m.				
Highly weathered, light brown, medium to fine grained, highly fractured rock.			R8	9.00 CR=29% RQD=Nil
			R9	9.75 CR=26% RQD=Nil
			R10	10.50 CR=34% RQD=Nil
11.25m.				
Highly weathered, light brown, medium to fine grained, highly fractured rock. 12.00m.			R11	11.25 CR=25% RQD=Nil
			R12	12.00 CR=32% RQD=Nil
Highly weathered, light brown, medium to fine grained, highly fractured rock.			R13	12.75 CR=33% RQD=Nil
			R14	13.50 CR=28% RQD=Nil
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.			R15	14.25 CR=31% RQD=Nil 15.00

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.108

Co-ordinates E=170 N=−174

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 : 28/04/2018
Completion Date : 28/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.799 M.
Water Struck At :
Standing Water Level : 2.95 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, clayey sandy silt. Observed conch pcs.		6 7 8 (15)	DS−1	0.50
			SPT−1	1.00−1.45
1.60m.				
Loose to medium dense, light grey, clayey sandy silt. Observed conch pcs.		2 1 2 (3)	*UDS−1	2.00−2.45
			SPT−2	2.50−2.95
			DS−2	3.50
		2 2 9 (11)	SPT−3	4.00−4.45
4.60m.				
Very dense, light grey, silty sand with decomposed rock.		100 6.0 cm Pentn. Refusal	SPT−4	4.60−4.66
		100 3.0 cm Pentn. Refusal	*SPT−5	4.80−4.83
5.00m.		Refusal	*SPT−6	5.00−5.02
Highly weathered, light grey, coarse grained, fractured rock.		100 2.0 cm Pentn.	R1	CR=28% RQD=Nil
5.75m.		NX rotary drilling from 5.00m to 15.00m		5.75
			R2	CR=25% RQD=Nil
				6.50
			R3	CR=27% RQD=Nil
				7.25
			R4	CR=24% RQD=Nil
				8.00
			R5	CR=25% RQD=Nil
				8.75
			R6	CR=24% RQD=Nil
				9.50
			R7	CR=27% RQD=Nil
Highly weathered, light grey to light whitish grey, coarse to medium grained, fractured rock.				10.25
			R8	CR=23% RQD=Nil
				11.00
			R9	CR=25% RQD=Nil
				11.75
			R10	CR=22% RQD=Nil
				12.50
			R11	CR=21% RQD=Nil
				13.25
			R12	CR=23% RQD=Nil
				14.00
			R13	CR=27% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.				
15.00m.				15.00

BH−108/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 10/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.109

Co-ordinates E=102 N=-183

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 : 27/04/2018
Completion Date : 28/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.633 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.				
Medium dense, light grey, sandy silt. Observed conch pcs., kankar & clay binder.		9 8 11 — 19	DS-1	0.50
			SPT-1	1.00-1.45
1.50m.				
Very loose, light grey, silty sand to sandy silt. Observed conch pcs. & clay binder.		1 1 2 — 3	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
		Refusal		
		100 6.0 cm Pentn.	*UDS-2	3.50-3.95
4.00m.			SPT-3	4.05-4.11
Very dense, light grey, silty sand with conch pcs. & decomposed rock. Observed kankar.		100 2.0 cm Pentn. Refusa	*SPT-4	4.30-4.32
4.40m.		100 2.0 cm Pentn. Refusa	*SPT-5	4.40-4.42
		Refusal	R1	CR=18%/RQD=0
Completely to highly weathered, deep grey, medium grained, highly to moderately fractured rock.		50 2.0 cm Pentn.	*SPT-6	5.00-5.02
5.75m.		NX rotary drilling from 4.40m to 15.00m	R2	CR=27% RQD=Nil
			R3	CR=23% RQD=Nil
			R4	CR=25% RQD=Nil
Completely/highly weathered, light grey, coarse grained, highly to moderately fractured rock.			R5	CR=16% RQD=Nil
		Refusal	*SPT-7	8.00-8.02
		50 2.0 cm Pentn.	R6	CR=18% RQD=Nil
		Refusal	*SPT-8	8.75-8.77
8.75m.		50 2.0 cm Pentn.	R7	CR=28% RQD=Nil
Highly weathered, light grey, coarse grained, highly to moderately fractured rock.			R8	CR=27% RQD=Nil
10.25m.			R9	CR=21% RQD=Nil
Highly weathered, light grey, coarse grained, moderately fractured rock.			R10	CR=29% RQD=Nil
11.00m.			R11	CR=41% RQD=Nil
Highly/moderately weathered, light to whitish grey, medium to fine grained, fractured rock.			R12	CR=33% RQD=Nil
13.25m.			R13	CR=25% RQD=Nil
Highly weathered, light to whitish grey, medium to fine grained, fractured rock.			R14	CR=21% RQD=Nil
N.B. – '*' means sample could not be recovered / sample slip. 15.00m.				

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

BH-109/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.110

Co-ordinates E=−301 N=511

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 : 04/05/2018
Completion Date : 04/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.847 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 8 9 (17)	DS−1	0.50
1.50m.			SPT−1	1.00−1.45
Loose to medium dense, brownish grey, silty sand with kankar & conch pcs. Observed clay binder.		2 3 3 (6)	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
		4 8 20 (28)	*UDS−2	3.50−3.95
			SPT−3	4.00−4.45
5.00m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		40 60 5.0 cm Pentn. >100	SPT−4	5.00−5.20
5.60m.		100 4.0 cm Pentn. Refusal	*SPT−5	5.40−5.44
		100 3.0 cm Pentn.	*SPT−6	5.60−5.63
		NX rotary drilling from 5.60m to 15.00m	R1	CR=26%/RQD=0
Highly weathered, brownish grey, coarse grained, highly fractured rock.			R2	CR=24% RQD=Nil
			R3	CR=27% RQD=16%
7.75m.			R4	CR=22% RQD=Nil
Highly weathered, brownish grey, coarse grained, highly fractured rock.			R5	CR=23% RQD=Nil
			R6	CR=24% RQD=Nil
			R7	CR=22% RQD=Nil
10.75m.			R8	CR=26% RQD=Nil
Highly weathered, brownish grey, coarse grained, highly fractured rock.			R9	CR=28% RQD=Nil
11.50m.			R10	CR=34% RQD=Nil
Highly weathered, light to brownish grey, fine to medium grained, moderately fractured rock.			R11	CR=28% RQD=Nil
			R12	CR=32% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.			R13	CR=34% RQD=Nil
15.00m.				

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−110/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.111

Co-ordinates E=−118 N=511

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 : 04/05/2018
Completion Date : 04/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.973 M.
Water Struck At :
Standing Water Level : 2.78 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 clay binder. Observed kankar & conch pcs.		2 1 3 (4)	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
			*UDS−2	3.50−3.95
		6 7 11 (18)	SPT−3	4.05−4.50
5.00m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock. 5.50m.		35 65 10.0 cm Pentn. >100 100 4.0 cm Pentn. Refusa Refusal	SPT−4 *SPT−5 *SPT−6	5.00−5.25 5.40−5.44 5.50−5.53 5.50
		00 3.0 cm Pentn.	R1	CR=22% RQD=Nil 6.25
		NX rotary drilling from 5.50m to 15.00m	R2	CR=25% RQD=Nil 7.00
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R3	CR=21% RQD=Nil 7.75
			R4	CR=22% RQD=Nil 8.50
			R5	CR=24% RQD=Nil 9.25
9.25m.				
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R6	CR=26% RQD=Nil 10.00
			R7	CR=28% RQD=Nil 10.75
10.75m.				
Highly weathered, brownish grey, medium to fine grained, highly fractured rock.			R8	CR=22% RQD=Nil 11.50
			R9	CR=24% RQD=Nil 12.25
12.25m.				
Highly weathered, brownish grey, medium to fine grained, highly fractured rock.			R10	CR=26% RQD=Nil 13.00
			R11	CR=28% RQD=Nil 13.75
			R12	CR=30% RQD=Nil 14.50
N.B. − '*' means sample could not be recovered / sample slip. 15.00m.			R13	CR=32% RQD=Nil 15.00

BH−111/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.112

Co-ordinates E=124 N=897

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 : 1.093 M.
Water Struck At :
Standing Water Level : 2.05 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very loose, light to brownish grey, sandy silt to silty sand. Observed kankar, conch pcs. & clay binder.		2 1 1 (2)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Loose, light grey, silty sand. Observed kankar & conch pcs.		3 2 3 (5)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.90m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs. 4.40m.		28 72 (>100)	*UDS-2	3.50-3.95
		6.0 cm Pentn.	SPT-3	4.00-4.21
		100 3.0 cm Pentn. Refusal	*SPT-4	4.30-4.33
		Refusal	*SPT-5	4.40-4.42 4.40
		100	R1	CR=21%/RQD=0
		2.0 cm Pentn.		5.00
Completely/highly weathered, deep to light grey, coarse grained, fractured rock.		NX rotary drilling from 4.40m to 15.00m	R2	CR=21% RQD=Nil
				5.75
			R3	CR=23% RQD=Nil
				6.50
		Refusal	R4	CR=16% RQD=Nil
7.25m. Completely to highly weathered, light to brownish grey, coarse grained, highly to moderately fractured rock.		53	*SPT-6	7.25-7.28 7.25
		3.0 cm Pentn.	R5	CR=21% RQD=Nil
				8.00
		Refusal	R6	CR=14% RQD=Nil
		51	*SPT-7	8.75-8.77 8.75
		2.0 cm Pentn.	R7	CR=23% RQD=Nil
				9.50
		Refusal	R8	CR=19% RQD=Nil
		55	*SPT-8	10.25-10.27 10.25
		2.0 cm Pentn.	R9	CR=21% RQD=Nil
				11.00
			R10	CR=23% RQD=Nil
11.75m. Completely/highly weathered, brownish grey, medium to fine grained, highly fractured rock.				11.75
			R11	CR=21% RQD=Nil
				12.50
			R12	CR=25% RQD=Nil
				13.25
		Refusal	R13	CR=Nil RQD=Nil
		52	*SPT-9	14.00-14.03 14.00
		3.0 cm Pentn.	R14	CR=16% RQD=Nil
		Refusal		
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.		51	*SPT-10	15.00-15.02 15.00
		2.0 cm Pentn.		

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.113

Co-ordinates E=25 N=1586

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 : 05/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.890 M.
Water Struck At :
Standing Water Level : 2.80 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light whitish grey, clayey silty sand. Observed conch pcs.		5 6 7 (13)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m.				
			*UDS-1	2.00-2.45
Loose, light whitish grey, clayey silty sand. Observed conch pcs.		2 1 2 (3)	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		2 2 2 (4)	SPT-3	4.00-4.45
5.00m.				
Very dense, light grey, silty sand with decomposed rock.		100 10.0 cm Pentn. >100 100 3.0 cm Pentn. Refusa	SPT-4 *SPT-5	5.00-5.10 5.30-5.33
5.50m.		Refusal	*SPT-6	5.50-5.52 5.50
		00	R1	CR=27% RQD=Nil 6.25
Highly weathered, light grey, coarse grained, fractured rock.		2.0 cm Pentn. NX rotary drilling from 5.50m to 15.00m	R2	CR=30% RQD=Nil 7.00
			R3	CR=28% RQD=Nil 7.75
7.75m.			R4	CR=23% RQD=Nil 8.50
			R5	CR=22% RQD=Nil 9.25
Highly weathered, light grey, coarse grained, fractured rock.			R6	CR=22% RQD=Nil 10.00
			R7	CR=23% RQD=Nil 10.75
			R8	CR=22% RQD=Nil 11.50
11.50m.			R9	CR=42% RQD=Nil 12.25
			R10	CR=45% RQD=Nil 13.00
Moderately weathered, yellowish grey, medium grained, light fractured rock.			R11	CR=43% RQD=22% 14.00
			R12	CR=45% RQD=Nil 15.00
N.B. - '*' means sample could not be recovered / sample slip. 15.00m.				

BH-113/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.114

Co-ordinates E = 32, N = 1684

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 : 04/05/2018
Completion Date : 04/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.740 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, whitish grey, clayey silty sand. Observed conch.		3 5 6 (11)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m.				
			*UDS-1	2.00-2.45
Loose, whitish grey, clayey silty sand. Observed conch pcs.		2 2 2 (4)	SPT-2	2.50-2.95
			DS-2	3.50
		2 2 2 (4)	SPT-3	4.00-4.45
5.00m.				
Very dense, light grey, silty sand with decomposed rock.		43 68 5.0 cm Pentn. >100 100 5.0 cm Pentn. Refusa	SPT-4 *SPT-5	5.00-5.20 5.30-5.35
5.50m.		Refusal	*SPT-6	5.50-5.52 5.50
		00 2.0 cm Pentn.	R1	CR=28% RQD=Nil 6.25
		NX rotary drilling from 5.50m to 15.00m	R2	CR=27% RQD=Nil 7.00
			R3	CR=30% RQD=Nil 7.75
			R4	CR=32% RQD=Nil 8.50
			R5	CR=30% RQD=Nil 9.25
			R6	CR=34% RQD=Nil 10.00
Highly to moderately weathered, light grey, coarse to medium grained, fractured rock.			R7	CR=30% RQD=Nil 10.75
			R8	CR=35% RQD=Nil 11.50
			R9	CR=37% RQD=Nil 12.25
			R10	CR=38% RQD=Nil 13.00
			R11	CR=42% RQD=Nil 14.00
			R12	CR=43% RQD=Nil 15.00
N.B. – '*' means sample could not be recovered / sample slip. 15.00m.				

BH-114/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.118

Co-ordinates E=−377 N=276

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 : 11/05/2018
Completion Date : 11/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.539 M.
Water Struck At :
Standing Water Level : 2.93 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Stiff, light grey, clayey silt with sand mixture & conch pcs.		2 3 5 (8)	DS−1	0.50
			SPT−1	1.00−1.45
			*UDS−1	2.00−2.45
		1 2 8 (10)	SPT−2	2.50−2.95
3.00m.				
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		100 9.0 cm Pentn. >100 100 2.0 cm Pentn. Refusa Refusal	SPT−3 *SPT−4 *SPT−5	3.20−3.29 3.40−3.42 3.50−3.52
3.50m.				3.50
		100 2.0 cm Pentn.	R1	CR=29% RQD=Nil
		NX rotary drilling from 3.50m to 15.00m		4.25
			R2	CR=28% RQD=Nil
				5.00
Highly weathered, deep grey, coarse grained, fractured rock.			R3	CR=27% RQD=Nil
				5.75
			R4	CR=32% RQD=Nil
				6.50
			R5	CR=28% RQD=Nil
7.25m.				7.25
Highly weathered, deep grey, coarse grained, fractured rock.			R6	CR=24% RQD=Nil
				8.00
			R7	CR=25% RQD=Nil
8.75m.				8.75
Highly weathered, whitish grey, medium to fine grained, fractured rock.			R8	CR=27% RQD=Nil
				9.50
			R9	CR=29% RQD=Nil
10.25m.				10.25
Highly weathered, whitish grey, medium grained, completely fractured rock.			R10	CR=37% RQD=16%
11.00m.				11.00
			R11	CR=23% RQD=Nil
				11.75
			R12	CR=24% RQD=Nil
				12.50
Highly weathered, whitish grey to reddish grey, medium grained, completely fractured rock.			R13	CR=22% RQD=Nil
				13.25
			R14	CR=24% RQD=16%
				14.00
N.B. − '*' means sample could not be recovered / sample slip.			R15	CR=21% RQD=Nil
15.00m.				15.00

BH−118/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.119

Co-ordinates E=—8 N=1743

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 : 10/05/2018
Completion Date : 11/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.889 M.
Water Struck At :
Standing Water Level : 3.10 m.

DESCRIPTION	SYMBOL	N—VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Loose, light grey, silty sand with kankar & conch pcs. Observed clay binder.		2 2 4 (6)	DS—1	0.50
			SPT—1	1.00—1.45
			*UDS—1	2.00—2.45
		2 3 5 (8)	SPT—2	2.55—3.00
			*UDS—2	3.50—3.95
4.00m.		24 35 42 (>100) 10.0 cm Pentn.	SPT—3	4.00—4.40
Very dense, light grey, silty sand with kankar & conch pcs.		100 4.0 cm Pentn. Refusa	*SPT—4	4.40—4.44
4.90m.		Refusal	*SPT—5	4.90—4.93
		100 3.0 cm Pentn.	R1	CR=21%/RQD=0
		NX rotary drilling from 4.90m to 15.00m	R2	CR=22% RQD=Nil
			R3	CR=24% RQD=Nil
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R4	CR=22% RQD=Nil
			R5	CR=24% RQD=Nil
			R6	CR=26% RQD=Nil
			R7	CR=24% RQD=Nil
10.00m.			R8	CR=22% RQD=Nil
Highly weathered, yellowish brown, medium to fine grained, highly to moderately fractured rock.			R9	CR=24% RQD=Nil
11.50m.			R10	CR=35% RQD=Nil
			R11	CR=32% RQD=Nil
Highly/moderately weathered, yellowish brown, medium to fine grained, highly to moderately fractured rock.			R12	CR=30% RQD=Nil
			R13	CR=42% RQD=30%
N.B. — '*' means sample could not be recovered / sample slip.			R14	CR=40% RQD=Nil
15.00m.				

4.90 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—119/Sheet—1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.120

Co-ordinates E= 98 N=−235

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 : 09/05/2018
Completion Date : 09/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.747 M.
Water Struck At :
Standing Water Level : 3.0 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Medium dense, light grey, silty sand. Observed kankar.		4 8 8 (16)	DS−1	0.50
			SPT−1	1.00−1.45
1.50m.				
Loose to medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.		2 2 2 (4)	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
			UDS−2	3.50−3.95
		8 13 17 (30)	SPT−3	4.00−4.45
4.50m.				
Very dense, light grey, silty sand with conch pcs. & decomposed rock.		40 60 5.0 cm Pentn. >100 100 3.0 cm Pentn. Refusa Refusal	SPT−4 *SPT−5 *SPT−6	5.00−5.20 5.40−5.43 5.50−5.53
5.50m.				5.50
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		00 3.0 cm Pentn. NX rotary drilling from 5.50m to 15.00m	R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13	CR=24% RQD=Nil ↓ 6.25 CR=22% RQD=Nil ↓ 7.00 CR=24% RQD=Nil ↓ 7.75 CR=26% RQD=Nil ↓ 8.50 CR=22% RQD=Nil ↓ 9.25 CR=28% RQD=Nil ↓ 10.00 CR=24% RQD=Nil ↓ 10.75 CR=25% RQD=Nil ↓ 11.50 CR=28% RQD=Nil ↓ 12.25 CR=24% RQD=Nil ↓ 13.00 CR=29% RQD=Nil ↓ 13.75 CR=30% RQD=Nil ↓ 14.50 CR=25% RQD=Nil ↓ 15.00
12.25m.				
Highly weathered, yellowish brown, medium grained, highly fractured rock.				
13.00m.				
Highly weathered, yellowish brown, medium to fine grained, highly fractured rock.				
14.50m.				
Highly weathered, yellowish brown, fine grained, highly fractured rock. 15.00m.				

N.B. − '*' means sample could not be recovered / sample slip.

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Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.121

Co-ordinates E=173 N=-235

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 : 07/05/2018
Completion Date : 09/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.794 M.
Water Struck At :
Standing Water Level : 2.78 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Medium dense, brownish grey, silty sand to sandy silt. Observed kankar & conch pcs.		4 7 5 — 12	DS-1	0.50
			SPT-1	1.00-1.45
1.50m. Very loose, brownish grey, silty sand. Observed kankar, conch pcs. & clay binder.		3 2 2 — 4	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.50m. Medium dense, brownish grey, silty sand. Observed kankar, conch pcs. & clay binder.		7 9 11 — 20	*UDS-2	3.50-3.95
			SPT-3	4.00-4.45
4.80m. Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs. 5.40m.		100 8.0 cm Pentn. >100 100 3.0 cm Pentn. Refusa Refusal	SPT-4 *SPT-5 *SPT-6	4.90-4.98 5.20-5.23 5.40-5.42 5.40
		100 2.0 cm Pentn.	R1	CR=21%/RQD=0 6.00
Highly weathered, deep to light grey, coarse to medium grained, highly to moderately fractured rock.		NX rotary drilling from 5.40m to 15.00m	R2 R3 R4 R5 R6	CR=24% RQD=Nil 6.75 CR=21% RQD=Nil 7.50 CR=25% RQD=Nil 8.25 CR=21% RQD=Nil 9.00 CR=25% RQD=Nil 9.75
9.75m. Highly weathered, deep to light grey, coarse to medium grained, highly to moderately fractured rock.			R7 R8	CR=31% RQD=Nil 10.50 CR=29% RQD=Nil 11.25
11.25m. Highly weathered, light grey, medium to fine grained, highly fractured rock.			R9 R10 R11 R12	CR=21% RQD=Nil 12.00 CR=21% RQD=Nil 12.75 CR=23% RQD=Nil 13.50 CR=21% RQD=Nil 14.25
14.25m. Highly weathered, light grey, fine grained, highly fractured rock. 15.00m.			R13	CR=28% RQD=Nil 15.00

N.B. - '*' means sample could not be recovered / sample slip.

BH-121/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.122

Co-ordinates E = 83, N = - 502

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	8
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 08/05/2018
Completion Date : 08/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.325 M.
Water Struck At :
Standing Water Level : 1.52 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Soft to medium, light grey, clayey silt with sand mixture.		2 3 3 — 6	DS-1	0.50
			SPT-1	1.00-1.45
2.00m.				
Medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.		3 5 6 — 11	*UDS-1	2.00-2.45
			SPT-2	2.55-3.00
3.40m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		40 60 5.0 cm Pentn. >100	SPT-3	3.40-3.60
		100 4.0 cm Pentn. Refusa	*SPT-4	3.80-3.84
4.00m.		100 3.0 cm Pentn. Refusa	*SPT-5	4.00-4.03
			R1	CR=16% RQD=Nil 4.00
		50 2.0 cm Pentn. Refusal	*SPT-6	4.75-4.77
			R2	CR=15% RQD=Nil 4.75
		50 2.0 cm Pentn. Refusal	*SPT-7	5.50-5.52
			R3	CR=18% RQD=Nil 5.50
		Refusal	*SPT-8	6.25-6.28
		50 3.0 cm Pentn.	R4	CR=22% RQD=Nil 6.25
Completely to highly weathered, brownish grey, medium to coarse grained, highly fractured rock.		NX rotary drilling from 4.00m to 15.00m	R5	CR=24% RQD=Nil 7.00
			R6	CR=22% RQD=Nil 7.75
			R7	CR=24% RQD=Nil 8.50
			R8	CR=25% RQD=Nil 9.25
10.00m.				
			R9	CR=22% RQD=Nil 10.00
			R10	CR=24% RQD=Nil 10.75
			R11	CR=22% RQD=Nil 11.50
Highly weathered, light to brownish grey, fine grained, highly fractured rock.			R12	CR=24% RQD=Nil 12.25
			R13	CR=26% RQD=Nil 13.00
			R14	CR=25% RQD=Nil 13.75
N.B. - '*' means sample could not be recovered / sample slip.			R15	CR=24% RQD=Nil 14.50
15.00m.				15.00

BH-122/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.123

Co-ordinates E=133 N=-534

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 : 08/05/2018
Completion Date : 08/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.525 M.
Water Struck At :
Standing Water Level : 1.55 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Soft to medium, light grey, clayey silt with sand mixture.		2 3 4 (7)	DS-1	0.50
			SPT-1	1.00-1.45
2.00m.				
Medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.		3 5 5 (10)	*UDS-1	2.00-2.45
			SPT-2	2.50-2.95
3.50m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		35 65 10.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal	SPT-3 *SPT-4	3.70-3.95 4.10-4.14
4.20m.		Refusal	*SPT-5	4.20-4.23 4.20
		100 3.0 cm Pentn.	R1	CR=22%/RQD=0 5.00
		NX rotary drilling from 4.20m to 15.00m	R2	CR=24% RQD=Nil 5.75
			R3	CR=24% RQD=Nil 6.50
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R4	CR=26% RQD=Nil 7.25
			R5	CR=25% RQD=Nil 8.00
			R6	CR=27% RQD=Nil 8.75
			R7	CR=24% RQD=Nil 9.50
9.50m.			R8	CR=22% RQD=Nil 10.25
			R9	CR=24% RQD=Nil 11.00
			R10	CR=26% RQD=Nil 11.75
Highly weathered, light to brownish grey, fine to medium grained, highly fractured rock.			R11	CR=22% RQD=Nil 12.50
			R12	CR=24% RQD=13% 13.25
			R13	CR=24% RQD=Nil 14.00
N.B. - '*' means sample could not be recovered / sample slip.			R14	CR=25% RQD=Nil 15.00
15.00m.				

BH-123/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.124

Co-ordinates E=177 N=−502

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 : 08/05/2018
Completion Date : 08/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.778 M.
Water Struck At :
Standing Water Level : 1.50 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Soft to medium, light grey, clayey silt with sand mixture.		2 4 4 — 8	DS−1	0.50
			SPT−1	1.00−1.45
2.00m.				
Medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.		3 5 7 — 12	*UDS−1	2.00−2.45
			SPT−2	2.55−3.00
3.60m.				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		38 62 10.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal Refusal	SPT−3 *SPT−4 *SPT−5	3.60−3.85 4.00−4.04 4.10−4.13
4.10m.		00 3.0 cm Pentn.		4.10
		NX rotary drilling from 4.10m to 15.00m	R1	CR=22%/RQD=0
				4.75
			R2	CR=21% RQD=Nil
				5.50
			R3	CR=24% RQD=Nil
				6.25
			R4	CR=22% RQD=Nil
				7.00
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=22% RQD=Nil
				7.75
			R6	CR=25% RQD=Nil
				8.50
			R7	CR=24% RQD=Nil
				9.25
			R8	CR=22% RQD=Nil
10.00m.				10.00
			R9	CR=26% RQD=Nil
				10.75
			R10	CR=22% RQD=Nil
				11.50
			R11	CR=23% RQD=Nil
Highly weathered, light grey, medium to fine grained, highly fractured rock.				12.25
			R12	CR=22% RQD=Nil
				13.00
			R13	CR=25% RQD=Nil
				13.75
			R14	CR=27% RQD=Nil
				14.50
N.B. − '*' means sample could not be recovered / sample slip.			R15	CR=22% RQD=Nil
15.00m.				15.00

BH−124/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.125

Co-ordinates E=59 N=-340

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 : 09/05/2018
Completion Date : 09/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.671 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.				
Stiff to very stiff, light grey, clayey silt with sand mixture & conch pcs.		5 7 9 — 16	DS-1	0.50
			SPT-1	1.00-1.45
2.00m.				
			*UDS-1	2.00-2.45
Loose, brownish grey, silty sand. Observed kankar, conch pcs. & clay binder.		2 2 3 — 5	SPT-2	2.55-3.00
			*UDS-2	3.50-3.95
		5 8 7 — 15	SPT-3	4.00-4.45
4.70m.				
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		35 65 10.0 cm Pentn. >100	SPT-4	4.80-5.05
		100 4.0 cm Pentn. Refusa	*SPT-5	5.30-5.34
5.50m.		Refusal	*SPT-6	5.50-5.53 5.50
		100 3.0 cm Pentn.	R1	CR=22% RQD=Nil 6.25
Highly weathered, deep grey, medium grained, fractured rock.		NX rotary drilling from 5.50m to 15.00m	R2	CR=23% RQD=Nil 7.00
7.00m.			R3	CR=24% RQD=Nil 7.75
			R4	CR=21% RQD=Nil 8.50
			R5	CR=27% RQD=Nil 9.25
Highly weathered, light to deep grey, coarse to medium grained, highly to moderately fractured rock.			R6	CR=21% RQD=Nil 10.00
			R7	CR=24% RQD=Nil 10.75
			R8	CR=23% RQD=Nil 11.50
			R9	CR=25% RQD=Nil 12.25
12.25m.			R10	CR=19% RQD=Nil
		50 Refusal	*SPT-7	13.00-13.02 13.00
Completely to highly weathered, whitish grey, fine to medium grained, fractured rock with reddish brown spots.		2.0 cm Pentn.	R11	CR=15% RQD=Nil
		50 Refusal	*SPT-8	13.75-13.77 13.75
		2.0 cm Pentn.	R12	CR=21% RQD=Nil 14.50
N.B. - '*' means sample could not be recovered / sample slip.			R13	CR=22% RQD=Nil 15.00
15.00m.				

BH-125/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.126

Co-ordinates E=-208 N=-230

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 : 09/05/2018
Completion Date : 10/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.638 M.
Water Struck At :
Standing Water Level : 3.10 m.

DESCRIPTION	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Medium dense, light grey, silty sand. Observed kankar.	5 8 9 (17)	DS-1	0.50
		SPT-1	1.00-1.45
1.50m Very loose, light grey, clayey silty sand. Observed kankar & conch pcs.	2 1 2 (3)	*UDS-1	2.00-2.45
		SPT-2	2.50-2.95
		*UDS-2	3.50-3.95
3.95m Medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.	4 8 10 (18)	SPT-3	4.00-4.45
4.70m Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.	25 40 35 5.0 cm Pentn. >100	SPT-4	4.70-5.05
	100 4.0 cm Pentn. Refusal	*SPT-5	5.20-5.24
5.30m	Refusal	*SPT-6	5.30-5.33
	100 3.0 cm Pentn.	R1	CR=22% RQD=Nil 6.00
	NX rotary drilling from 5.30m to 15.00m	R2	CR=24% RQD=Nil 6.75
Highly weathered, deep grey, medium to coarse grained, highly fractured rock.		R3	CR=26% RQD=16% 7.50
		R4	CR=25% RQD=16% 8.25
8.25m Highly weathered, deep grey, medium to coarse grained, highly fractured rock.		R5	CR=28% RQD=16% 9.00
		R6	CR=28% RQD=Nil 9.75
9.75m Highly weathered, deep grey, medium to coarse grained, highly fractured rock.		R7	CR=24% RQD=Nil 10.50
		R8	CR=22% RQD=Nil 11.25
		R9	CR=24% RQD=Nil 12.00
12.00m Highly weathered, deep grey, medium to coarse grained, highly fractured rock.		R10	CR=26% RQD=Nil 12.75
		R11	CR=28% RQD=Nil 13.50
		R12	CR=30% RQD=Nil 14.25
N.B. - '*' means sample could not be recovered / sample slip. 15.00m		R13	CR=32% RQD=Nil 15.00

BH-126/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 18/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.127

Co-ordinates E=-346 N=1800

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 08/05/2018
Completion Date : 09/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.012 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				
Soft, brownish grey to light grey clayey silt with sand. Observed kankar & conch pcs.		3 2 2 (4)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
		2 1 2 (3)	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
4.00m				
Medium dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs.		8 7 11 (18)	SPT-3	4.05-4.50
5.00m				
Very dense, light grey, silty sand with decomposed rock. Observed kankar & conch pcs. 5.50m		100 8.0 cm Pentn. >100 Refusal 100 3.0 cm Pentn. Refusal	SPT-4 *SPT-5 *SPT-6	5.00-5.08 5.30-5.33 5.50-5.52 5.50
		100 2.0 cm Pentn. Refusal	R1	CR=23% RQD=Nil 6.25
		NX rotary drilling from 5.50m to 15.00m	R2	CR=23% RQD=Nil 7.00
Completely to highly weathered, deep to light grey, medium to coarse grained, fractured rock.		52 2.0 cm Pentn. Refusal	R3 *SPT-7 R4	CR=19% RQD=Nil 7.75-7.77 7.75 CR=21% RQD=Nil 8.50
			R5	CR=23% RQD=Nil 9.25
9.25m				
Highly weathered, whitish grey to light grey, medium to coarse grained, highly fractured rock.			R6	CR=24% RQD=Nil 10.00
			R7	CR=21% RQD=Nil 10.75
10.75m				
Highly weathered, whitish grey to light grey, medium to coarse grained, highly fractured rock.			R8	CR=28% RQD=Nil 11.50
			R9	CR=29% RQD=Nil 12.25
			R10	CR=27% RQD=Nil 13.00
13.00m				
Highly weathered, whitish grey to light grey, medium to coarse grained, highly fractured rock.			R11	CR=21% RQD=Nil 13.75
			R12	CR=22% RQD=Nil 14.50
N.B. - '*' means sample could not be recovered / sample slip. 15.00m			R13	CR=22% RQD=Nil 15.00

BH-127/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.128 — Co-ordinates E=-423 N=1300

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	9
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 16/05/2018
Completion Date : 17/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.370 M.
Water Struck At :
Standing Water Level : 2.40 m.

DESCRIPTION	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m			
Very loose, light to brownish grey, clayey silty sand. Observed conch pcs.	1 1 2 (3)	DS-1	0.50
		SPT-1	1.00-1.45
		*UDS-1	2.00-2.45
2.95m	2 2 2 (4)	SPT-2	2.50-2.95
Loose, light to brownish grey, clayey silty sand. Observed conch pcs.			
4.50m	2 2 4 (6)	SPT-3	4.00-4.45
Very dense, brownish grey to greyish brown, silty sand with mica & conch pcs. Observed decomposed rock.	45 100 / 10.0 cm Pentn. (>100)	SPT-4	5.00-5.25
	100 / 4.0 cm Pentn. Refusal	*SPT-5	5.40-5.44
5.50m	100 / 2.0 cm Pentn. Refusal	*SPT-6	5.50-5.52 5.50
	Refusal	R1	CR=14% RQD=Nil
	50 / 3.0 cm Pentn.	*SPT-7	6.25-6.28 6.25
		R2	CR=21% RQD=Nil 7.00
	NX rotary drilling from 5.50m to 15.00m	R3	CR=20% RQD=Nil 7.75
Completely to highly weathered, whitish grey to brownish grey, medium to coarse grained, highly fractured rock.	Refusal	R4	CR=16% RQD=Nil
	50 / 2.0 cm Pentn.	*SPT-8	8.50-8.52 8.50
		R5	CR=24% RQD=Nil 9.25
		R6	CR=21% RQD=Nil 10.00
		R7	CR=22% RQD=Nil 10.75
		R8	CR=21% RQD=Nil 11.50
11.50m		R9	CR=19% RQD=Nil
	Refusal	*SPT-9	12.25-12.28 12.25
	50 / 3.0 cm Pentn.	R10	CR=23% RQD=Nil 13.00
Completely/highly weathered, whitish grey to light grey, medium grained, fractured rock. Observed reddish spots.		R11	CR=32% RQD=22% 13.75
		R12	CR=23% RQD=Nil 14.50
N.B. - '*' means sample could not be recovered / sample slip.		R13	CR=20% RQD=Nil 15.00
15.00m			

BH-128/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.129

Co-ordinates E=−567 N=884

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 16/05/2018
Completion Date : 17/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.529 M.
Water Struck At :
Standing Water Level : 2.80 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Very loose, light grey, clayey silty sand. Observed kankar & conch pcs.		1 2 2 (4)	DS−1	0.50
			SPT−1	1.00−1.45
			*UDS−1	2.00−2.45
2.55m				
Loose, light grey, clayey silty sand. Observed kankar & conch pcs.		1 2 3 (5)	SPT−2	2.55−3.00
			*UDS−2	3.50−3.95
		2 3 4 (7)	SPT−3	4.00−4.45
4.60m		40 60 5.0 cm Pentn. >100	SPT−4	4.60−4.80
Very dense, brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT−5	4.90−4.94
5.00m		100 3.0 cm Pentn. Refusal	*SPT−6	5.00−5.03 5.00
		Refusal	R1	CR=16%/RQD=0 ↓ 5.75
		52	*SPT−7	5.75−5.77 5.75
		2.0 cm Pentn.	R2	CR=21%/RQD=0 ↓ 6.50
		NX rotary drilling from 5.00m to 15.00m	R3	CR=22% RQD=Nil ↓ 7.25
			R4	CR=22% RQD=Nil ↓ 8.00
Completely to highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=24% RQD=Nil ↓ 8.75
			R6	CR=22% RQD=Nil ↓ 9.50
			R7	CR=21% RQD=Nil ↓ 10.25
			R8	CR=22% RQD=Nil ↓ 11.00
11.00m				
			R9	CR=24% RQD=Nil ↓ 11.75
			R10	CR=25% RQD=Nil ↓ 12.50
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R11	CR=28% RQD=Nil ↓ 13.25
			R12	CR=24% RQD=Nil ↓ 14.00
			R13	CR=25% RQD=Nil ↓ 15.00
N.B. − '*' means sample could not be recovered / sample slip. 15.00m				

BH−129/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.130

Co-ordinates E=-600 N=373

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	7
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 17/05/2018
Completion Date : 18/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.626 M.
Water Struck At :
Standing Water Level : 2.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m Very loose, brownish grey to steel grey, clayey silty sand. Observed conch pcs.		1 2 4	DS-1 SPT-1	0.50 1.00-1.45
2.50m Loose, brownish grey to steel grey, clayey silty sand. Observed conch pcs.		2 3 5	UDS-1 SPT-2	2.00-2.45 2.50-2.95
3.70m Very dense, light grey, medium grained, silty sand with conch pcs. Observed decomposed rock. 4.40m		58 100 (7.0 cm Pentn.) 100 (3.0 cm Pentn. Refusal) 100 (2.0 cm Pentn. Refusal) Refusal	SPT-3 *SPT-4 *SPT-5 R1	3.80-4.02 4.20-4.23 4.40-4.42 CR=18%/RQD=0
Completely to highly weathered, brownish grey to whitish grey, medium grained, fractured rock.		50 (2.0 cm Pentn.) NX rotary drilling from 4.40m to 15.00m Refusal 52 (3.0 cm Pentn.)	*SPT-6 R2 R3 *SPT-7 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13 R14	5.00-5.02 CR=21% RQD=Nil CR=18% RQD=Nil 6.50-6.53 CR=23% RQD=Nil CR=25% RQD=Nil CR=23% RQD=Nil CR=22% RQD=Nil CR=25% RQD=Nil CR=27% RQD=Nil CR=24% RQD=Nil CR=22% RQD=Nil CR=25% RQD=Nil CR=28% RQD=Nil CR=25% RQD=Nil
8.00m Highly weathered, light grey, medium grained, moderately fractured rock.				
N.B. - '*' means sample could not be recovered / sample slip. 15.00m				

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

BH-130/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.131

Co-ordinates E=-539 N=-37

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 : 18/05/2018
Completion Date : 18/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.779 M.
Water Struck At :
Standing Water Level : 2.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
			DS-1	0.50
		4		
		1 2 2	SPT-1	1.00-1.45
Loose, light grey, clayey silty sand. Observed kankar & conch pcs.			*UDS-1	2.00-2.45
		7		
		2 3 4	SPT-2	2.50-2.95
		>100	*UDS-2	3.50-3.95
4.00m		35 65 10.0 cm Pentn.	SPT-3	4.00-4.25
Very dense, brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-4	4.40-4.44
4.50m		100 3.0 cm Pentn. Refusal	*SPT-5	4.50-4.53 4.50
		Refusal	R1	CR=16% RQD=Nil 5.25
		53	*SPT-6	5.25-5.27 5.25
		2.0 cm Pentn.	R2	CR=21% RQD=Nil 6.00
		NX rotary drilling from 4.50m to 15.00m	R3	CR=24% RQD=Nil 6.75
Completely to highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock.			R4	CR=23% RQD=Nil 7.50
			R5	CR=24% RQD=Nil 8.25
8.25m			R6	CR=28% RQD=Nil 9.00
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock.			R7	CR=30% RQD=Nil 9.75
9.75m			R8	CR=24% RQD=Nil 10.50
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock.			R9	CR=24% RQD=Nil 11.25
11.25m			R10	CR=28% RQD=Nil 12.00
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock.			R11	CR=26% RQD=Nil 12.75
			R12	CR=29% RQD=Nil 13.50
			R13	CR=30% RQD=Nil 14.25
14.25m			R14	CR=24% RQD=Nil 15.00
Highly weathered, light grey, coarse grained, highly fractured rock. 15.00m				

N.B. - '*' means sample could not be recovered / sample slip.

BH-131/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.132

Co-ordinates E=-503 N=-482

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 : 17/05/2018
Completion Date : 17/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.775 M.
Water Struck At :
Standing Water Level : 3.00 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
			DS-1	0.50
		3		
		1 2 1	SPT-1	1.00-1.45
Loose, light grey, clayey silty sand. Observed kankar & conch pcs.			*UDS-1	2.00-2.45
		4		
		1 2 2	SPT-2	2.50-2.95
			*UDS-2	3.50-3.95
		8		
		3 3 5	SPT-3	4.00-4.45
4.50m.		100 10.0 cm Penth. >100	SPT-4	4.60-4.70
Very dense, brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-5	4.80-4.84
4.90m.		Refusal	*SPT-6	4.90-4.93
		100	R1	CR=22% RQD=Nil
		3.0 cm Penth.		4.90
		NX rotary drilling from 4.90m to 15.00m	R2	CR=23% RQD=Nil
				5.60
			R3	CR=24% RQD=Nil
				6.25
			R4	CR=25% RQD=Nil
				7.00
Highly weathered, brownish grey, medium to coarse grained, highly fractured rock.			R5	CR=22% RQD=Nil
				7.75
			R6	CR=24% RQD=Nil
				8.50
			R7	CR=22% RQD=Nil
				9.25
			R8	CR=26% RQD=Nil
10.75m.				10.00
			R9	CR=25% RQD=Nil
				10.75
			R10	CR=22% RQD=Nil
				11.50
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R11	CR=24% RQD=Nil
				12.25
			R12	CR=20% RQD=Nil
				13.00
			R13	CR=24% RQD=Nil
				13.75
N.B. - '*' means sample could not be recovered / sample slip.			R14	CR=26% RQD=Nil
15.00m.				14.50 15.00

BH-132/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.133

Co-ordinates E=-399 N=-937

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 : 18/05/2018
Completion Date : 18/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.052 M.
Water Struck At :
Standing Water Level : 2.10 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Very loose, light grey, clayey silty sand. Observed conch pcs.		1 2 2 (4)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
2.50m				
Loose, light grey, clayey silty sand. Observed conch pcs.		2 3 4 (7)	SPT-2	2.50-2.95
3.90m		25 35 40 (>100) 5.0 cm Pentn.	SPT-3	3.90-4.25
Very dense, brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-4	4.50-4.54
4.70m		Refusal	*SPT-5	4.70-4.73
		100 3.0 cm Pentn.	R1	CR=22% RQD=Nil 4.70 - 5.50
		NX rotary drilling from 4.70m to 15.00m	R2	CR=24% RQD=Nil 5.50 - 6.25
			R3	CR=26% RQD=Nil 6.25 - 7.00
Highly weathered, brownish grey to light grey, medium to fine grained, highly fractured rock.			R4	CR=24% RQD=Nil 7.00 - 7.75
			R5	CR=21% RQD=Nil 7.75 - 8.50
			R6	CR=21% RQD=Nil 8.50 - 9.25
			R7	CR=24% RQD=Nil 9.25 - 10.00
10.75m			R8	CR=26% RQD=Nil 10.00 - 10.75
Highly weathered, brownish grey to light grey, fine grained, highly fractured rock.			R9	CR=22% RQD=Nil 10.75 - 11.50
			R10	CR=25% RQD=Nil 11.50 - 12.25
			R11	CR=20% RQD=Nil 12.25 - 13.00
			R12	CR=21% RQD=Nil 13.00 - 13.75
13.75m			R13	CR=28% RQD=Nil 13.75 - 14.50
Highly weathered, brownish grey to light grey, fine grained, highly fractured rock.			R14	CR=32% RQD=Nil 14.50 - 15.00
N.B. - '*' means sample could not be recovered / sample slip. 15.00m				

BH-133/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.134 — Co-ordinates E=−80 N=−1264

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	7	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	7
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 18/05/2018
Completion Date : 19/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.372 M.
Water Struck At :
Standing Water Level : 2.25 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Very loose, brownish grey, clayey silty sand. Observed conch pcs.		1 1 1 (2)	DS−1	0.50
			SPT−1	1.00−1.45
			*UDS−1	2.00−2.45
		1 2 1 (3)	SPT−2	2.50−2.95
3.50m				
Loose, brownish grey, clayey silty sand. Observed conch pcs.		2 3 5 (8)	UDS−2	3.50−3.95
			SPT−3	4.00−4.45
4.60m				
Very dense, light grey, medium grained, silty sand with conch pcs. Observed decomposed rock.		100 12.0 cm Penth. >100 100 3.0 cm Pentn. Refusal 100 2.0 cm Pentn. Refusal	SPT−4 *SPT−5 *SPT−6	4.90−5.02 5.20−5.23 5.30−5.32
5.30m		Refusal	R1	CR=18% RQD=Nil
		50 / 2.0 cm Pentn.	*SPT−7	6.00−6.02
			R2	CR=22% RQD=Nil
		NX rotary drilling from 5.30m to 15.00m	R3	CR=24% RQD=Nil
Completely to highly weathered, light to whitish grey, medium grained, completely fractured rock.			R4	CR=27% RQD=Nil
			R5	CR=23% RQD=Nil
9.00m			R6	CR=26% RQD=Nil
Highly weathered, light to whitish grey, medium grained, completely fractured rock.			R7	CR=28% RQD=12%
10.50m			R8	CR=24% RQD=Nil
Highly weathered, brownish grey, medium grained, fractured rock.			R9	CR=29% RQD=Nil
11.25m			R10	CR=31% RQD=Nil
Highly weathered, brownish grey, medium grained, fractured rock.			R11	CR=27% RQD=Nil
			R12	CR=32% RQD=Nil
N.B. − '*' means sample could not be recovered / sample slip.			R13	CR=30% RQD=Nil
15.00m				

5.30
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−134/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.135

Co-ordinates E=241 N=-1704

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 : 19/05/2018
Completion Date : 19/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 0.887 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				
Loose, light grey, clayey silty sand. Observed kankar & ocnch pcs.		1 2 3 (5)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
		2 3 4 (7)	SPT-2	2.55-3.00
3.80m		32 68 (≥100)	SPT-3	3.80-4.05
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		10.0 cm Pentn.	*SPT-4	4.20-4.24
4.30m		100 4.0 cm Pentn. Refusal	*SPT-5	4.30-4.33
		Refusal		4.30
		100 3.0 cm Pentn.	R1	CR=21% RQD=Nil
				5.00
		NX rotary drilling from 4.30m to 15.00m	R2	CR=22% RQD=Nil
				5.75
			R3	CR=24% RQD=Nil
				6.50
			R4	CR=26% RQD=Nil
Highly weathered, brownish grey to light grey, medium to coarse grained, highly fractured rock.				7.25
			R5	CR=22% RQD=Nil
				8.00
			R6	CR=24% RQD=Nil
				8.75
			R7	CR=24% RQD=Nil
				9.50
			R8	CR=25% RQD=Nil
10.25m				10.25
			R9	CR=26% RQD=Nil
				11.00
			R10	CR=24% RQD=Nil
				11.75
			R11	CR=26% RQD=Nil
Highly weathered, light grey, medium to fine grained, highly fractured rock.				12.50
			R12	CR=24% RQD=Nil
				13.25
			R13	CR=28% RQD=Nil
				14.00
			R14	CR=25% RQD=Nil
N.B. – '*' means sample could not be recovered / sample slip. 15.00m				15.00

BH-135/Sheet-1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 23/05/2018	Sheet No:

BORE LOG DATA SHEET — BORE HOLE NO.136 — Co-ordinates E=377 N=276

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 : 20/05/2018
Completion Date : 20/05/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.948 M.
Water Struck At :
Standing Water Level : 3.20 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Loose, light grey, clayey silty sand. Observed kankar.		3 4 6 (10)	DS-1	0.50
			SPT-1	1.00-1.45
			*UDS-1	2.00-2.45
		1 2 3 (5)	SPT-2	2.55-3.00
3.00m				
Medium dense, light grey, clayey silty sand. Observed kankar & conch pcs.			*UDS-2	3.50-3.95
		5 10 20 (30)	SPT-3	4.05-4.50
4.50m				
Dense to very dense, brownish grey, silty sand with kankar & conch pcs. Observed decomposed rock.		30 70 10.0 cm Pentn. >100 100 4.0 cm Pentn. Refusal Refusal	SPT-4 *SPT-5 *SPT-6	4.80-5.05 5.20-5.24 5.30-5.33
5.30m				5.30
Highly weathered, brownish grey to light grey, medium to coarse grained, highly to moderately fractured rock.		100 3.0 cm Pentn. NX rotary drilling from 5.30m to 15.00m	R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13	CR=22% RQD=Nil ↓ 6.00 CR=24% RQD=Nil ↓ 6.75 CR=24% RQD=Nil ↓ 7.50 CR=26% RQD=Nil ↓ 8.25 CR=22% RQD=Nil ↓ 9.00 CR=26% RQD=Nil ↓ 9.75 CR=28% RQD=Nil ↓ 10.50 CR=32% RQD=Nil ↓ 11.25 CR=24% RQD=Nil ↓ 12.00 CR=27% RQD=Nil ↓ 12.75 CR=30% RQD=Nil ↓ 13.50 CR=22% RQD=Nil ↓ 14.25 CR=34% RQD=Nil ↓ 15.00
9.00m				
Highly weathered, brownish grey to light grey, medium to coarse grained, highly to moderately fractured rock.				
11.25m				
Highly weathered, brownish grey to light grey, medium to coarse grained, highly to moderately fractured rock.				
12.00m				
Highly weathered, brownish grey to light grey, medium to coarse grained, highly to moderately fractured rock.				
13.50m				
Highly weathered, brownish grey to light grey, medium to coarse grained, highly to moderately fractured rock.				
14.25m				
Highly weathered, brownish grey to light grey, medium to coarse grained, highly to moderately fractured rock.				
15.00m				

N.B. - '*' means sample could not be recovered / sample slip.

BH-136/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. PMT1 Co-ordinates E=-171 N=315

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 22/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.073 m.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, light grey, silty sand. Observed kankar.		5 6 5 (11)	DS-1	0.50
			SPT-1	1.00-1.45
1.50m			DS-2	2.00
Very loose, light grey, silty sand with kankar & conch pcs. Observed clay binder.		1 2 2 (4)	SPT-2	2.50-2.95
			DS-3	3.50
4.00m				
Medium dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		9 12 14 (26)	SPT-3	4.00-4.45
5.00m		45 55 (>100) 10.0 cm Pentn.	SPT-4	5.00-5.25
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		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=29% RQD=Nil
		NX rotary drilling from 5.50m to 25.50m		6.50
			R2	CR=37% RQD=Nil
				7.50
			R3	CR=37% RQD=Nil
				8.50
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R4	CR=33% RQD=Nil
				9.50
			R5	CR=26% RQD=Nil
				10.50
			R6	CR=29% RQD=Nil
				11.50
			R7	CR=30% RQD=Nil
12.50m				12.50
12.90m				

BH-1/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. PMT1 | Co-ordinates E=-171 N=315

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 22/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.073 m.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
12.90m			R8	CR=30% RQD=Nil
				13.50
			R9	CR=33% RQD=Nil
				14.50
			R10	CR=27% RQD=Nil
				15.50
Highly weathered, light to brownish grey, medium to fine grained, highly fractured rock.			R11	CR=28% RQD=Nil
				16.50
			R12	CR=26% RQD=Nil
				17.50
			R13	CR=28% RQD=Nil
				18.50
			R14	CR=24% RQD=Nil
19.50m				19.50
			R15	CR=27% RQD=Nil
				20.50
			R16	CR=28% RQD=Nil
				21.50
			R17	CR=28% RQD=Nil
Highly weathered, whitish grey, medium grained, highly to moderately fractured rock.				22.50
			R18	CR=29% RQD=Nil
				23.50
			R19	CR=32% RQD=Nil
				24.50
			R20	CR=29% RQD=Nil
N.B. – '*' means sample could not be recovered / sample slip. 25.50m				25.50

BH-1/Sheet-2

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. PMT2 Co-ordinates E=-119 N=123

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 16/04/2018
Completion Date : 17/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.663 m.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, brownish grey, silty sand to sandy silt. Observed kankar.		6 9 9 (18)	DS-1	0.50
			SPT-1	1.50-1.95
2.50m				
Very loose, light grey, silty sand. Observed mica, conch pcs. & clay binder.		0 0 1 (1)	DS-2	3.00
			SPT-2	3.50-3.95
4.50m			DS-3	4.50
Very dense, brownish grey, silty sand with conch pcs. Observed kankar & decomposed rock.		Refusal	DS-4	5.00
		100 4.0 cm Pentn.	*SPT-3	5.50-5.54
5.80m		Refusal	*SPT-4	5.80-5.83
		100 3.0 cm Pentn.	R1	CR=12% RQD=Nil 5.80 - 6.80
		NX rotary drilling from 5.80m to 25.30m	R2	CR=15% RQD=Nil 6.80 - 7.80
			R3	CR=16% RQD=Nil 7.80 - 8.80
Completely weathered, brownish grey to light grey, medium grained, completely fractured rock.			R4	CR=15% RQD=Nil 8.80 - 9.80
			R5	CR=12% RQD=Nil 9.80 - 10.80
			R6	CR=14% RQD=Nil 10.80 - 11.80
			R7	CR=13% RQD=Nil 11.80 - 12.80
12.90m				

BH-2/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. PMT2 Co-ordinates E=-119 N=123

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 16/04/2018
Completion Date : 17/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.663 m.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
12.90m				
Completely weathered, brownish grey to light grey, medium grained, completely fractured rock.			R8	CR=17% RQD=Nil
				13.80
			R9	CR=17% RQD=Nil
14.80m				14.80
			R10	CR=18% RQD=Nil
				15.80
			R11	CR=15% RQD=Nil
				16.80
Completely to highly weathered, whitish grey to light grey, medium grained, fractured rock.			R12	CR=20% RQD=12%
				17.80
			R13	CR=32% RQD=Nil
				18.80
			R14	CR=25% RQD=Nil
19.80m				19.80
			R15	CR=29% RQD=Nil
				20.80
HIghly weathered, whitish grey to light grey, medium grained, fractured rock.			R16	CR=33% RQD=Nil
				21.80
			R17	CR=26% RQD=Nil
22.80m				22.80
HIghly weathered, whitish grey to light grey, medium grained, fractured rock.			R18	CR=24% RQD=Nil
23.80m				23.80
Highly weathered, light grey, medium grained, fractured rock.			R19	CR=28% RQD=Nil
25.30m				25.30

N.B. – '*' means sample could not be recovered / sample slip.

BH-2/Sheet-2

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. PMT3 Co-ordinates E=−155 N=32

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 18/04/2018
Completion Date : 19/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.591 m.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Loose, light whitish grey, clayey sandy silt. Observed conch pcs.			DS−1	0.50
			DS−2	1.00
1.70m		2 4 6	SPT−1	1.50−1.95
Very loose, light whitish grey, clayey silty sand. Observed conch pcs.		1 2 4	SPT−2	2.45−2.90
			DS−3	3.50
		1 1 3	SPT−3	4.00−4.45
4.60m		100 5.0 cm Pentn. Refusal	SPT−4	4.60−4.65
Very dense, light whitish grey, silty sand with decomposed rock.		100 2.0 cm Pentn. Refusal	*SPT−5	4.80−4.82
5.20m		Refusal	*SPT−6	5.20−5.22
		100 2.0 cm Pentn.	R1	CR=27% RQD=Nil 5.20 / 6.20
		NX rotary drilling from 5.20m to 25.20m	R2	CR=29% RQD=Nil 6.20 / 7.20
Highly weathered, light grey, coarse to medium grained, fractured rock.			R3	CR=32% RQD=14% 7.20 / 8.20
			R4	CR=33% RQD=Nil 8.20 / 9.20
9.20m			R5	CR=34% RQD=20% 9.20 / 10.20
			R6	CR=35% RQD=Nil 10.20 / 11.20
Highly weathered, whitish grey, medium grained, moderately fractured rock.			R7	CR=35% RQD=Nil 11.20 / 12.20
12.90m			R8	CR=40% RQD=Nil

BH−3/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. PMT3 Co-ordinates E=-155 N=32

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 18/04/2018
Completion Date : 19/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.591 m.
Water Struck At :
Standing Water Level : Not found

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
12.90m				13.20
Highly weathered, whitish grey, medium grained, moderately fractured rock.			R9 CR=31% RQD=Nil	14.20
			R10 CR=33% RQD=Nil	15.20
15.20m				
			R11 CR=40% RQD=Nil	16.20
			R12 CR=30% RQD=Nil	17.20
Highly weathered, brownish grey to whitish grey, medium grained, fractured rock.			R13 CR=30% RQD=Nil	18.20
			R14 CR=32% RQD=Nil	19.20
			R15 CR=30% RQD=Nil	20.20
20.20m				
Highly weathered, brownish grey to whitish grey, medium grained, fractured rock.			R16 CR=25% RQD=Nil	21.20
21.20m				
			R17 CR=33% RQD=Nil	22.20
Highly weathered, brownish grey to whitish grey, medium grained, fractured rock.			R18 CR=28% RQD=Nil	23.20
23.20m				
Highly weathered, brownish grey to whitish grey, medium grained, fractured rock.			R19 CR=24% RQD=Nil	24.20
24.20m				
Highly weathered, whitish grey, medium grained, completely fractured rock.			R20 CR=30% RQD=Nil	25.20
25.20m				

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 : 04/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. CST1 | Co-ordinates E=−220 N=287

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 : 13/04/2018
Completion Date : 15/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.768 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, brownish grey, silty sand. Observed kankar & conch.		9 5 4 (9)	DS−1	0.50
			SPT−1	1.00−1.45
1.50m				
Very loose, light grey, sandy silt. Observed conch pcs. & clay binder.		1 0 1 (1)	UDS−1	2.00−2.45
			SPT−2	2.50−2.95
			*UDS−2	3.50−3.95
		1 2 2 (4)	SPT−3	4.05−4.50
4.60m				
Very dense, light grey, silty sand with decomposed rock. Observed conch pcs.		11 23 66 (>100) 10.0 cm Pentn.	SPT−4	5.00−5.40
		100 5.0 cm Pentn. Refusal	*SPT−5	5.50−5.53
5.60m			*SPT−6	5.60−5.62
Highly weathered, light grey, medium grained, highly to moderately fractured rock.		100 2.0 cm Pentn. Refusal	R1	CR=30% RQD=Nil
6.25m		NX rotary drilling from 5.60m to 27.00m		6.25
			R2	CR=30% RQD=Nil
				7.00
Highly weathered, light grey, coarse grained, moderately fractured rock.			R3	CR=29% RQD=Nil
				7.75
			R4	CR=29% RQD=Nil
8.50m				8.50
			R5	CR=33% RQD=Nil
				9.25
Highly weathered, light grey, fine to medium grained, highly to moderately fractured rock.			R6	CR=30% RQD=Nil
				10.00
			R7	CR=30% RQD=Nil
				10.75
			R8	CR=28% RQD=Nil
11.50m				11.50
			R9	CR=36% RQD=Nil
				12.25
Highly weathered, light brownish grey, coarse to medium grained, highly to moderately fractured rock.			R10	CR=30% RQD=Nil
				13.00
13.60m			R11	CR=33% RQD=Nil

BH−1/Sheet−1

Project : Geotechnical Investigation Work for 2x660 MW Udangudi STPP at Kallamoli. CETEST

Job No : 4115	Created by : SKD	Created on : 04/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. CST1 Co-ordinates E=−220 N=287

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 : 13/04/2018
Completion Date : 15/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 1.768 m.
Water Struck At :
Standing Water Level : 2.9 m.

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.60m				13.75
			R12 CR=32% RQD=Nil	14.50
Highly weathered, light brownish grey, coarse to medium grained, highly to moderately fractured rock.			R13 CR=34% RQD=Nil	15.25
			R14 CR=33% RQD=Nil	16.00
			R15 CR=28% RQD=Nil	16.75
			R16 CR=34% RQD=Nil	17.50
17.50m				
Highly weathered, light grey, fine grained, moderately fractured rock.			R17 CR=32% RQD=Nil	18.25
			R18 CR=31% RQD=Nil	19.00
19.00m				
Highly weathered, whitish grey, medium grained, moderately fractured rock.			R19 CR=32% RQD=Nil	19.75
			R20 CR=34% RQD=Nil	20.50
			R21 CR=35% RQD=Nil	21.25
			R22 CR=37% RQD=Nil	22.00
			R23 CR=39% RQD=Nil	22.75
			R24 CR=38% RQD=Nil	23.50
23.50m				
Highly to moderately weathered, whitish grey to greenish grey, medium grained, moderately to highly fractured rock.			R25 CR=39% RQD=Nil	24.25
			R26 CR=41% RQD=Nil	25.00
			R27 CR=45% RQD=Nil	25.75
25.75m				
Moderately weathered, whitish grey, fine to medium grained, moderately fractured rock.			R28 CR=52% RQD=Nil	26.50
N.B. − '*' means sample could not be recovered / sample slip. 27.00m			R29 CR=54% RQD=Nil	27.00

BH−1/Sheet−2

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. CST2 | Co-ordinates E=-27 N=318

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	9
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 05/04/2018
Completion Date : 07/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.39 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 grey, sandy silt. Observed conch.			DS-1	0.50
1.00m Medium dense, light brownish grey, sandy silt. Observed kankar & conch.		6 8 9 — 17	SPT-1	1.00-1.45
1.80m Very loose, light grey, clayey sandy silt. Observed conch.			*UDS-1	2.00-2.45
		1 0 1 — 1	SPT-2	2.55-3.00
			*UDS-2	3.50-3.95
		1 1 2 — 3	SPT-3	4.05-4.50
4.60m Very dense, light grey, silty sand. Observed kankar, conch & rock pcs.		36 64 — >100 5.0 cm Pentn.	UDS-3 SPT-4	5.00-5.25 5.35-5.55
5.75m		36 64 5.0 cm Pentn. >100 100 3.0 cm Pentn. Refusal	*SPT-5 *SPT-6	5.65-5.68 5.75-5.78 5.75
Completely weathered, light grey, coarse to medium grained, highly fractured rock.		50 — Refusal 2.0 cm Pentn.	R1 *SPT-7	CR=18% RQD=Nil 6.50-6.52 6.50
7.25m		50 — Refusal 3.0 cm Pentn.	R2 *SPT-8	CR=16% RQD=Nil 7.25-7.28 7.25
		NX rotary drilling from 5.75m to 27.00m	R3	CR=21% RQD=Nil 8.00
Completely/highly weathered, light grey, medium grained, moderately fractured rock.			R4	CR=24% RQD=Nil 8.75
			R5	CR=21% RQD=Nil 9.50
			R6	CR=12% RQD=Nil
10.25m		50 — Refusal 3.0 cm Pentn.	*SPT-9	10.25-10.28 10.25
Highly weathered, light grey, coarse to fine grained, highly to moderately fractured rock.			R7	CR=21% RQD=Nil 11.00
11.75m			R8	CR=24% RQD=Nil 11.75
Highly weathered, light grey, fine grained, moderately fractured rock.			R9	CR=29% RQD=Nil 12.50
12.50m			R10	CR=33% RQD=Nil 13.25
Highly weathered, light grey, medium grained, moderately fractured rock.			R11	CR=37% RQD=Nil
13.75m				

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. CST2

Co-ordinates E=-27 N=318

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	9	Undisturbed (UDS)	3
Cone (Pc)		Penetrometer (SPT)	9
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 05/04/2018
Completion Date : 07/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.39 m.
Water Struck At :
Standing Water Level : 2.75 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
				14.00
Highly weathered, light grey, medium grained, moderately fractured rock.			R12	CR=32% RQD=Nil
13.75m 14.00m				14.75
Highly weathered, light brownish grey, fine to medium grained, fractured rock.			R13	CR=29% RQD=Nil
15.50m				15.50
			R14	CR=24% RQD=Nil
Highly weathered, light grey, fine grained, moderately fractured rock.				16.25
			R15	CR=25% RQD=Nil
17.00m				17.00
			R16	CR=27% RQD=Nil
				17.75
Highly weathered, light grey, fine grained, moderately fractured rock.			R17	CR=34% RQD=13%
				18.50
			R18	CR=28% RQD=Nil
19.25m				19.25
			R19	CR=26% RQD=Nil
Highly weathered, coarse to medium grained, moderately fractured rock.				20.00
			R20	CR=31% RQD=Nil
20.75m				20.75
			R21	CR=30% RQD=Nil
				21.50
Highly weathered, whitish grey, medium to fine grained, highly to moderately fractured rock.			R22	CR=33% RQD=Nil
				22.25
			R23	CR=39% RQD=Nil
23.00m				23.00
			R24	CR=43% RQD=16%
				23.75
			R25	CR=48% RQD=Nil
				24.50
Highly/moderately weathered, whitish grey, fine grained, moderately fractured rock.			R26	CR=34% RQD=Nil
				25.25
			R27	CR=32% RQD=Nil
				26.00
			R28	CR=28% RQD=Nil
27.00m				27.00

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 : 25/05/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO. CST3 | Co-ordinates E=−154 N=96

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 : 12/04/2018
Completion Date : 13/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.14 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, light grey, silty sand. Observed kankar.		5 6 6 (12)	DS−1	0.50
			SPT−1	1.00−1.45
1.50m				
Loose, light grey, silty sand with kankar & conch pcs. Observed 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, light grey, silty sand with kankar, mica & conch pcs. Observed decomposed rock.		8 11 13 (24)	SPT−3	4.00−4.45
4.70m				
Very dense, light grey, silty sand with kankar, mica & conch pcs. 5.25m		25 75 10.0 cm Pentn. >100	SPT−4	4.70−4.95
		100 4.0 cm Pentn. Refusal	*SPT−5	5.10−5.14
		Refusal	*SPT−6	5.25−5.28
		100 3.0 cm Pentn.	R1	CR=21% RQD=Nil
		NX rotary drilling from 5.25m to 26.25m		6.25
			R2	CR=24% RQD=Nil
				7.25
			R3	CR=28% RQD=Nil
				8.25
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R4	CR=24% RQD=Nil
				9.25
			R5	CR=38% RQD=Nil
				10.25
			R6	CR=25% RQD=Nil
11.25m				11.25
			R7	CR=34% RQD=Nil
				12.25
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R8	CR=38% RQD=Nil
				13.25
13.75m			R9	CR=26% RQD=Nil

BH−3/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. CST3 | Co-ordinates E=−154 N=96

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 : 12/04/2018
Completion Date : 13/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.14 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.75m				
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.				
14.25m				14.25
Highly weathered, light to brownish grey, medium to coarse grained, highly fractured rock.			R10	CR=22% RQD=Nil
15.25m				15.25
Highly weathered, brownish grey, coarse grained, highly fractured rock.			R11	CR=29% RQD=Nil
16.25m				16.25
			R12	CR=32% RQD=Nil
				17.25
			R13	CR=34% RQD=Nil
Highly weathered, light grey, medium to fine grained, highly fractured rock.				18.25
			R14	CR=30% RQD=Nil
				19.25
			R15	CR=29% RQD=Nil
20.25m				20.25
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R16	CR=24% RQD=Nil
21.25m				21.25
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R17	CR=26% RQD=Nil
				22.25
			R18	CR=29% RQD=Nil
23.25m				23.25
Highly weathered, light grey, medium to fine grained, highly fractured rock.			R19	CR=24% RQD=Nil
24.25m				24.25
			R20	CR=26% RQD=Nil
Highly weathered, light grey, medium to fine grained, highly fractured rock.				25.25
			R21	CR=30% RQD=Nil
26.25m				26.25

N.B. − '*' means sample could not be recovered / sample slip.

BH−3/Sheet−2

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. CST4

Co-ordinates E=-11 N=126

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	8
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 08/04/2018
Completion Date : 09/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.28 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, brownish grey, silty sand. Observed kankar & conch pcs.		7 11 10 (21)	DS-1	0.50
			SPT-1	1.00-1.45
1.60m			DS-2	2.00
Very loose, brownish grey to light grey, silty sand to sandy silt. Observed conch pcs. & clay binder.		1 1 2 (3)	SPT-2	2.50-2.95
			DS-3	3.50
		2 2 2 (4)	SPT-3	4.00-4.45
4.70m				
Very dense, light grey, silty sand with kankar & conch pcs. Observed decomposed rock.		45 55 10.0 cm Pentn. >100	SPT-4	5.00-5.25
		100 5.0 cm Pentn. Refusal	*SPT-5	5.40-5.45
5.60m		100 3.0 cm Pentn. Refusal	*SPT-6	5.60-5.63 **5.60**
			R1	CR=14% RQD=Nil
		Refusal		
		50 2.0 cm Pentn.	*SPT-7	6.60-6.62 **6.60**
		Refusal	R2	CR=17% RQD=Nil
		50 3.0 cm Pentn.	*SPT-8	7.60-7.63 **7.60**
			R3	CR=22% RQD=Nil
		NX rotary drilling from 5.60m to 26.60m		**8.60**
Completely to highly weathered, brownish grey to light grey, medium to coaerse grained, completely fractured rock.			R4	CR=24% RQD=Nil
				9.60
			R5	CR=26% RQD=Nil
				10.60
			R6	CR=21% RQD=Nil
				11.60
			R7	CR=25% RQD=Nil
12.60m				**12.60**
Highly weathered, brownish grey to light grey, medium to coarse grained, completely fractured rock.			R8	CR=28% RQD=Nil
13.75m				**13.60**

BH-4/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. CST4 | Co-ordinates E=−11 N=126

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	8	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	8
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 08/04/2018
Completion Date : 09/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.28 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.75m				
Highly weathered, brownish grey to light grey, medium to coarse grained, completely fractured rock.			R9	CR=31% RQD=Nil
				14.60
			R10	CR=26% RQD=Nil
15.60m				15.60
			R11	CR=35% RQD=Nil
				16.60
			R12	CR=29% RQD=13%
				17.60
			R13	CR=32% RQD=Nil
				18.60
			R14	CR=26% RQD=Nil
				19.60
			R15	CR=33% RQD=Nil
				20.60
Highly weathered, whitish grey to light grey, medium grained, fractured rock.			R16	CR=33% RQD=Nil
				21.60
			R17	CR=34% RQD=Nil
				22.60
			R18	CR=40% RQD=Nil
				23.60
			R19	CR=37% RQD=Nil
				24.60
			R20	CR=38% RQD=Nil
				25.60
			R21	CR=35% RQD=Nil
26.60m				26.60

N.B. − '*' means sample could not be recovered / sample slip.

BH−4/Sheet−2

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. CST5 | Co-ordinates E=-226 N=28

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 15/04/2018
Completion Date : 16/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.14 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 grey, silty sand. Observed conch pcs.		8 6 4 (10)	DS-1	0.50
			SPT-1	1.00-1.45
1.70m				
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
4.00m		19 81 (≥100)	UDS-2	3.50-3.95
Very dense, light grey, silty sand with decomposed rock.		9.0 cm Pentn.	SPT-3	4.00-4.24
4.50m		100 4.0 cm Pentn. Refusal	*SPT-4	4.40-4.44
		Refusal	*SPT-5	4.50-4.53 4.50
		100 3.0 cm Pentn.	R1	CR=24% RQD=Nil 5.50
		NX rotary drilling from 4.50m to 26.50m	R2	CR=23% RQD=Nil 6.50
Highly weathered, light grey, coase to medium grained, moderately to highly fractured rock.			R3	CR=25% RQD=Nil 7.50
			R4	CR=22% RQD=Nil 8.50
			R5	CR=26% RQD=Nil 9.50
9.50m			R6	CR=21% RQD=Nil 10.50
Highly weathered, whitish grey, medium grained, moderately fractured rock.			R7	CR=23% RQD=Nil 11.50
			R8	CR=22% RQD=Nil 12.50
12.50m			R9	CR=23% RQD=Nil 13.50
Highly weathered, light brownish grey, coarse to medium grained, moderately to highly fractured rock.				
13.75m				

BH-5/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. CST5

Co-ordinates E=-226 N=28

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	5	Undisturbed (UDS)	2
Cone (Pc)		Penetrometer (SPT)	5
		Disturbed (DS)	1
Vane (V)		Water Sample (WS)	0

Commencement Date : 15/04/2018
Completion Date : 16/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.14 m.
Water Struck At :
Standing Water Level : 2.2 m.

DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.75m			R10	CR=22% RQD=Nil
				14.50
Highly weathered, light brownish grey, coarse to medium grained, moderately to highly fractured rock.			R11	CR=24% RQD=Nil
				15.50
			R12	CR=25% RQD=Nil
16.50m				16.50
Highly weathered, light grey, fine grained, highly fractured rock.			R13	CR=23% RQD=Nil
17.50m				17.50
			R14	CR=28% RQD=Nil
				18.50
Highly weathered, light grey, fine grained, highly fractured rock.			R15	CR=29% RQD=Nil
				19.50
			R16	CR=31% RQD=Nil
				20.50
			R17	CR=31% RQD=Nil
21.50m				21.50
			R18	CR=32% RQD=Nil
				22.50
			R19	CR=30% RQD=Nil
				23.50
Highly weathered, whitish grey, fine grained, moderately fractured rock.			R20	CR=33% RQD=Nil
				24.50
			R21	CR=36% RQD=Nil
				25.50
			R22	CR=34% RQD=Nil
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. CST6 | Co-ordinates E=−19 N=28

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	2
Vane (V)		Water Sample (WS)	0

Commencement Date : 17/04/2018
Completion Date : 18/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.26 m.
Water Struck At :
Standing Water Level :

DESCRIPTION	SYMBOL	N−VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m				
Medium dense, light grey, clayey silty sand / clayey sandy silt. Observed conch.		5 6 7 (13)	DS−1	0.50
			SPT−1	1.00−1.45
1.60m				
			*UDS−1	2.00−2.45
		1 2 2 (4)	SPT−2	2.50−2.95
Loose, light whitish grey, clayey sandy silt. Observed conch pcs.			DS−2	3.50
		1 2 3 (5)	SPT−3	4.00−4.45
5.00m		100 10.0 cm Pentn. >100	SPT−4	5.00−5.10
Very dense, light grey, silty sand with decomposed rock.		100 3.0 cm Pentn. Refusal	*SPT−5	5.30−5.33
5.50m		Refusal	*SPT−6	5.50−5.52 5.50
Highly weathered, light grey, coarse grained, fractured rock.		100 2.0 cm Pentn.	R1	CR=27% RQD=Nil 6.50
6.50m		NX rotary drilling from 5.50m to 26.50m	R2	CR=25% RQD=Nil 7.50
			R3	CR=28% RQD=Nil 8.50
Highly weathered, light grey, coarse grained, fractured rock.			R4	CR=25% RQD=Nil 9.50
			R5	CR=26% RQD=Nil 10.50
			R6	CR=24% RQD=Nil 11.50
11.50m				
Highly weathered, light grey, coarse grained, fractured rock.			R7	CR=27% RQD=Nil 12.50
12.50m				
Highly weathered, light whitish grey, medium grained, fractured rock.			R8	CR=28% RQD=Nil 13.50
13.50m				
13.75m				

BH−6/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. CST6 | Co-ordinates E=-19 N=28

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	6	Undisturbed (UDS)	1
Cone (Pc)		Penetrometer (SPT)	6
		Disturbed (DS)	2
Vane (V)		Water Sample (WS)	0

Commencement Date : 17/04/2018
Completion Date : 18/04/2018
Bore Hole Diameter : 150mm / NX.
Level Of Ground : 2.26 m.
Water Struck At :
Standing Water Level :

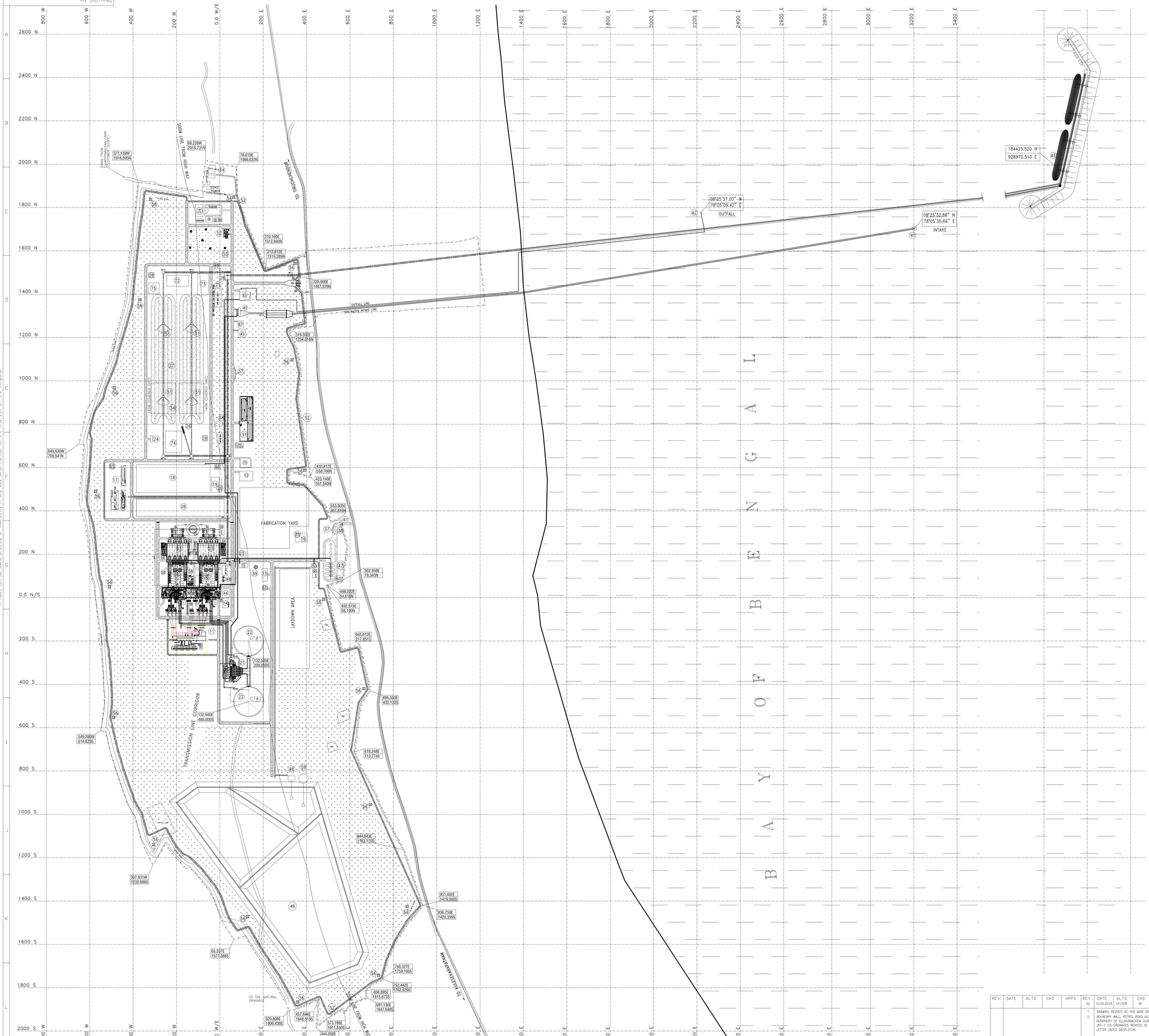
DESCRIPTION	SYMBOL	N-VALUE (EACH DIVN. = 15cm)	SAMPLES Ref. No	SAMPLES Depth (m)
13.75m			R9	CR=25% RQD=Nil
				14.50
Highly weathered, light whitish grey to grey, medium grained, fractured rock.			R10	CR=28% RQD=Nil
				15.50
			R11	CR=24% RQD=Nil
16.50m				16.50
Slightly weathered, light whitish grey to grey, medium grained, fractured rock.			R12	CR=80% RQD=Nil
17.50m				17.50
			R13	CR=29% RQD=Nil
				18.50
Highly weathered, light whitish grey to grey, medium grained, fractured rock.			R14	CR=30% RQD=Nil
				19.50
			R15	CR=32% RQD=Nil
				20.50
			R16	CR=27% RQD=Nil
21.50m				21.50
			R17	CR=24% RQD=Nil
				22.50
Highly weathered, light whitish grey to grey, medium grained, fractured rock.			R18	CR=28% RQD=Nil
				23.50
			R19	CR=25% RQD=Nil
24.50m				24.50
			R20	CR=30% RQD=Nil
Highly weathered, light whitish grey to grey, medium grained, fractured rock.				25.50
			R21	CR=27% RQD=Nil
26.50m				26.50

N.B. – '*' means sample could not be recovered / sample slip.

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

JOB NO.	435
STATUS	CONTRACT
DISTRIBUTION	

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 SG/–	SK SG/–	JJ SG/–
1.	DRAWING REVISED AS PER CUSTOMER'S COMMENT.			

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

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DEPT CODE		NAME	SIGN	DATE
M	DRN	SDK	SG/–	19.02.2018
	DES'N	LP	SG/–	19.02.2018
	CHD	SK	SG/–	19.02.2018
	APPD	JJ	SG/–	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 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)
30	FORK LIFT 5T	5	720.00	710.00
31	FORK LIFT 3T	5	600.00	590.00

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

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
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

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
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

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

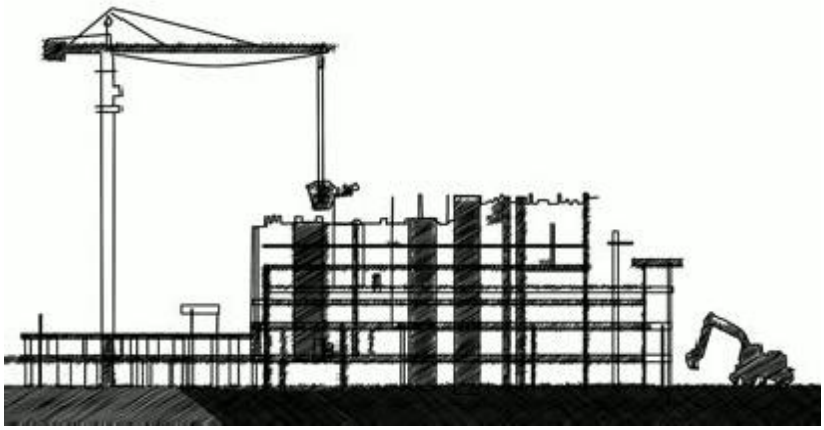
HEALTH, SAFETY and ENVIRONMENT PLAN

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)	

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1.0 PURPOSE

1.1 The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.

1.2 This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents.

1.3 Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.

1.4 In case the customer has any specific requirement, the same is to be fulfilled.

2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations.

3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.

HSE TARGETS

EXPLOSION	**ZERO**
FATALITY	**ZERO**
LOST TIME INJURY	**ZERO**
FIRE	**ZERO**
VEHICLE INCIDENTS	**ZERO**
ENVIRONMENTAL INCIDENTS	**ZERO**

4.0 BHEL POWER SECTOR HEALTH, SAFETY & ENVIRONMENT POLICY

Health, Safety & Environment Policy of BHEL

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, contractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

` **sd/-**

CMD, BHEL

5.0 MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, Power Sector_____Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s_____do hereby also commit to comply with the same HSE Policy while 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:

$$\frac{\text{Number of LTI}}{\text{Average number of manpower deployed}} \times 1000$$

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:

- A high level of stability.
- A safe means of access/egress.
- Suitable and effective service and parking brakes.
- Windscreens with wipers and external mirrors giving optimum all round visibility.
- Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- Provision of seat belts.
- Guards on dangerous parts.
- Driver protection - to prevent injury from overturning and from falling objects/materials.
- Driver protection from adverse weather.
- No vehicle shall be parked below HT/LT power lines.
- 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 **TOOL-BOX TALK**	FORMAT NO: HSEP:14-F04 REV NO.: 00 PAGE NO. 01 OF 01

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			

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 **Inspection of Excavation**	FORMAT NO: **HSEP:14-F13E** REV NO.: 00 PAGE NO. 01 OF 01

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**
	Format for Monthly HSE Planning & Review	REV NO.: 00 PAGE NO. 01 OF 3

Note: This is a template and can be modified in consultation with BHEL			
Name of the Site		**Name of the Subcontractor**	
Scope of Work		**Date**	
PART- A: PLAN OF HSE ACTIVITIES FOR THE MONTH OF……			**PART-B: REVIEW ON ……**
SN.	**Description of HSE Activity & Formats**	**Plan & Targets for the month**	**Review**
1	Availability of First Aid Box at Required Places and Inspection thereof as per Format: F01	Areas 1. … …	
2	Health check-up as per Format: F02	Health check-up for Nos 1. New inductees 2. Drivers & Operators 3. Workers in following high risk areas: a. …	
3	Induction training of newly joined workers as per Format: F03	Minimum No. of workers:	
4	Toolbox talks (TBT) conducted before start of work as per Format: F04	Locations of TBTs & No. of workers **1.** …	
5	PPE usage and issue as per Format: F06		
6	Inspection of T&Ps as per Format: F07	List of T&Ps to be inspected 1.	
7	Identification & Inspection Status of T&Ps as per Format: F08		
8	Inspection of Cranes & Winches as per Format: F09	List of Cranes & Winches & Nos. 1. …	
9	Inspection of Height Working as per Format: F10	Areas: 1. …	
10	Inspection of Welding & Gas Cutting operations as per Format: F11	Areas: 1. …	
11	Inspection of Electrical Installations as per Format: F12	Locations: 1. …	
12	Inspection of Elevators (as applicable) as per Format: F13	Locations: 1. …	
13	Inspection of Excavation as per Format: F13E	**Locations:** **1. …**	

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
14	Job Safety Analysis as per Format F32B	**Activities:** **1. …**	
15	Regular Job Specific Training (Re-training) for workers involved in hazardous activities	Topics/ Hazards & No. of workers **1.** …	
16	Mass housekeeping (HK) drive in work areas	Areas **1.** …	
17	Vertigo Test of Height workers	Minimum No. of workers:	
18	Deployment of qualified HSE Officers as per contract	Location(s) & Nos. **1.** …	
19	Deployment of qualified HSE Stewards as per contract	Location(s) & Nos. **1.** …	
20	Deployment of Safety tools & Equipment (Safety Nets, Lifelines, Fall arrestors, Man-cages, flashback arrestors, scaffolding etc.)	Tool/ Equipment & Location **1.** …	
21	Safety Walks by site in charge of agency (4 -Weekly once)	Dates:	
22	Safety walks by departmental head (8-Weekly twice)	Dates:	
23	Availability/ deployment of Safety posters/ placards/ signage at strategic locations	Locations: Nos. **1.** …	
24	Provision of clean drinking water sources for workers	Locations: Nos. **1.** …	
25	Provision of toilets for workers (separate for male & female workers)	Locations: Nos. **1.** …	
26	Rest sheds for workers during lunchtime, rain, dust storm etc.	Locations: Nos. **1.** …	
27	Availability of following in Labor colony	**1. Clean drinking water** **2. Toilets** **3. Cleanliness & Hygiene** **4. Grass cutting,** **5. Fogging** **6. Electrical Inspection …**	

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
28	Availability of dust/ waste bins at various locations	Locations: **1.** …	
29	Availability of Ambulance (individual/ joint) in each shift	Ambulance No.	
30	Availability of emergency vehicle in each shift	Emergency vehicle	
31	Deployment/ Availability of tested Fire Extinguishers	Locations & Nos. **1.** …	
32	Tree plantation	Locations & Nos. **1.** …	
33	Waste disposal & Scrap Bins	Locations **1.** …	
34	Illumination checks	Locations **1.** …	
35	Safety award function: 1. Display of good practices Award presentation	Minimum 1 per month	
36	**Submission of Daily Reports as per Format No.F31A**	**Daily Reports (Night & Day Shifts)**	

PLAN		**REVIEW**	
Agency Name: Sign: Date:	**BHEL** Name: Sign: Date:	**Agency** Name: Sign: Date:	**BHEL** Name: Sign: Date:

	POWER SECTOR	FORMAT NO: **HSEP:14-F31** A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

Note: Following format to be submitted (preferably) in excel/ soft copy by subcontractor daily at the end of each shift. Any photographs/ records to be attached

Site									**Subcontractor**																				
Year								**Month**														**Day**								
SHIFT	Submitted By	Work Area(s)	Staff	Man-Power	Safety Officers	Safety Stewards	Tool Box (Topics and No. of Participants)	Induction Training (No. of Participants)	Vertigo Test (Numbers Tested)	On-the-Job Training (Topic & participants)	Work Permits	Job Safety Analyses conducted	Height Work Inspection	Other Hazardous Activities Inspection	T&P Inspection (Names & Nos. Inspected)	Safety Walk (Designation, Areas)	HSE Meeting	Safety Reward (Details)	Housekeeping/ Dust Suppression/ Tree Plantation Activities (Locations/Details)	Lost time Accident	Restricted Work Case	Medical Treatment Case	First Aid Case	Near miss	Property Damage/ Fire	Non-Compliances Submitted by BHEL	Complied by Agency	Any other Remarks/ Inputs
Day																													
Night															NA		NA	NA	NA										

	POWER SECTOR **Job Safety Analysis Format**	FORMAT NO: **HSEP:14-F32B** REV NO.: 00 PAGE NO. 01 OF 1

Name of the Site	
Name of the Subcontractor	
Activity, Area	

HAZARDS	**PRECAUTIONS**

(Name)	**Submitted By (Agency HSE)**		**Reviewed By (BHEL Execution)**		**Approved By (BHEL HSE)**	
(Sign)						
(Date)						

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
1a	Induction training for new workers conducted through audio-visual medium & documented ?	M	1	Induction Training Records
1b	Tool box talk conducted regularly as per plan, and documented?	M	1	Toolbox Talk Records
1c	Contractor in charge and safety in charge attended safety meetings?	M	2	Minutes of Meeting
1d	Whether observations in safety meetings are complied before next meeting?	M	2	-do-
1e	Preparation and submission of Monthly HSE report within stipulated time	M	1	Report submission date
1f	Preparation and submission of Incident/near-miss report and RCA Report (as applicable) within stipulated time	M	1	Incident/ Near Miss Records
1g	Carrying out Inspections and submission of Inspection reports within stipulated time	M	1	Inspection Records
1h	Regular Job Specific Training ensured for High Risk Workers (through audio-visual medium) as per plan	M	1	Training & Attendance Records
2a	Whether the contractor is registered under BOCW	M	2	BOCW Registration Certificate
2b	Availability of Qualified safety officer (1 for every 500 labour)	M	2	Safety Officer qualification & experience records
2c	Availability of Qualified safety supervisor (1 for every 100 labour)	M	2	Safety Officer qualification & experience records
2d	All the workers are provided and using safety helmets and safety shoes/gum boots	M	2	PPE Issue Records, Inspection/ non-conformity records
2e	Housekeeping done on regular basis and scrap removal at site	M	1	Housekeeping records, Inspection/ non-conformity records
2f	Usage of Goggles/Face shields and Hand gloves for gas cutter and grinders		1	PPE Issue Records, Inspection/ non-conformity records
2g	Wall openings & floor openings are guarded?		1	Inspection/ non-conformity records
2h	Adequate illumination provided in all working area?		1	Inspection/ non-conformity records
2i	Safety posters, sign boards and emergency contact numbers in all prominent location are displayed?		1	Inspection/ non-conformity records
2j	Availability of automatic reverse horns, Main horn, hook latches for Vehicles, mobile cranes, Hydras		1	Inspection/ non-conformity records
2k	Ban of carrying mobile phones to work place is implemented for workers		1	Inspection/ non-conformity records
2l	Availability of Tags & Inspection Certificates for Cranes of all capacities		1	Master T&P List with internal & external test details
2l.2	Availability of Tags & Inspection Certificates for Winches of all capacities		1	Master T&P List with internal & external test details
2l.3	Availability of Tags & Inspection Certificates, color coding for Chain pulley blocks		1	Master T&P List with internal & external test details
2l.4	Availability of Tags & Inspection Certificates for Vehicles - Trailers, Dozers, Dumpers, Excavators. Mixers etc.		1	Master T&P List with internal & external test details
2l.5	Availability of Tags & Inspection Certificates for Welding machines, grinders, Drilling machines, etc.		1	Master T&P List with internal & external test details
2l.6	Availability of Tags & Inspection Certificates, colour coding for Wire rope slings etc.		1	Master T&P List with internal & external test details
2l.7	Availability of Tags & Inspection Certificates for Batching plants		1	Master T&P List with internal & external test details

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
2m.1	Use of Lifting Permit as per requirement		1	Permit Records
2m.2	Use of Height Permit as per requirement		1	Permit Records
2m.3	Use of Hot Work Permit as per requirement		1	Permit Records
2m.4	Use of Excavation permit as per requirement		1	Permit Records
2m.5	Use of Confined space work permit as per requirement		1	Permit Records
2m.6	Use of Grating removal and safety net removal permit as per requirement		1	Permit Records
2m.7	Use of Lockout-Tag out permit as per requirement		1	Permit Records
2m.8	Use of Radiography permit as per requirement		1	Permit Records
2m.9	Use of Night/ Holiday Work Permit as per requirement		1	Permit Records
2m.10	Use of Any other Applicable Permit as per requirement		1	Permit Records
3a	Material safety data sheet(MSDS) available for all chemicals and displayed in usage and storage area?		1	Inspection/ non-conformity records
3b	Spillages of oil/concrete and other chemical is controlled and cleaned by proper method in case of spill?		1	Inspection/ non-conformity records
3c	Availability of adequate number of urinals in workplace and in elevations and maintained	M	1	
3d	Availability of rest rooms for workers at site	M	1	
3e	Availability of Drinking water facility at work spot		1	
3f	Hygienic Labour colony is provided for workers.		1	
4a	Is heavy/complex critical lifting permit obtained for heavy, complex materials before handling/erection activity?		1	Work Permit records
4b	Whether area below lifting activities barricaded		1	Inspection/ non-conformity records
4c	Availability of experienced rigging foreman		1	Experience details of rigging foreman
4d	Is agency is following proper storage and handling procedure as per manufacturer standard for all hazardous material?		1	Procedure for storage & handling
4e	Are oxygen and acetylene cylinders are transported to work place from storage area in trolleys		1	
5a	Whether all deep excavation has been protected by barrier		1	Inspection/ non-conformity records
5b	Sloping/benching & shoring provided for excavation as per requirement?		1	-do-
5c	Proper access and egress provided for excavations?		1	-do-
5d	Blasting is done in controlled manner?		2	-do-
6a	Whether Electrical booth is equipped with Co_2 fire extinguishers and fire buckets filled with sand?		2	Inspection/ non-conformity records
6b	Availability of Illumination lamp in electric booth?		1	-do-
6c	whether Caution Boards have been displayed?		1	-do-
6d	Usage of Metal Plug top for all hand power tools ?		1	-do-
6e	Usage of Insulated welding cables.		1	-do-
6f	Electrical Booth/Distribution Board to be covered by proper Canopy.		1	-do-
6g	Availability of functional & individual 30ma ELCB / RCCB and MCB for protection and conducting periodical check-up?		1	-do-
6h	Double earthing for panel boards and all machinery & proper earth pit with regular inspection available?		1	-do-
6i	Whether Electrician is qualified and experienced		1	Qualification & Experience records of electrician
6j	Availability and usage of Rubber hand gloves by electrician?		1	Inspection/ non-conformity records

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
7a	Whether Scaffolding pipes made with steel or aluminum, are being used and checked periodically by experienced/ certified scaffolder?		2	Inspection/ non-conformity records
7b	8mm Stainless Steel wire rope with plastic cladding is provided for life line (Vertical / Horizontal) during height work?		2	-do-
7c	Availability of emergency lighting in case of power failure		1	-do-
7d	Whether all the openings are covered with Safety Nets made of fire proof Nylon?		1	-do-
7e	Whether MS pipe rails around staircases & platforms in usage are provided with top, middle rails and toe guard ?		1	-do-
7f	Whether Ladder with vertical life line /Fall arrestor is available to climb?		1	-do-
7g	Whether all workers deployed for working at height have been issued height pass after undergoing vertigo test?		1	Height Pass records
7h	Whether all workers deployed for height work / climbing ladder are provided and using Double lanyard safety belt?		1	PPE Issue records, inspection/ non-conformity reports
7i	Is all hand tools/Small material used by height workers is tied firmly to prevent fall?		1	-do-
8a	Flash back arrestors for all gas cutting sets is available on Torch side and cylinder side		1	Inspection/ non-conformity records
8b	Oxygen/Acetylene/LPG cylinders not in use have caps in place and stored separately?		1	-do-
8c	Availability of Face screen, Hand gloves, and Apron, for welders		1	-do-
8d	Protection from falling hot molten metal during metal cutting / welding at height by providing GI sheet below the cutting area especially in fire prone areas		1	-do-
9a	Pre-employment medical check-up done for all workers and submitted?		1	Medical check records
9b	Availability of first aid center, with MBBS doctor(Own or Sharing basis)	**M**	2	Attendance records
9c	Availability of Ambulance facility 24 hours (Own or sharing basis)	**M**	2	-do-
9d	Is First aid trained personnel's are available and their names are displayed at site?	**M**	1	-do-
9e	Availability of Emergency vehicle at site		1	
9f	Periodical medical check-up is conducted for all the workers and submitted?		1	Medical check records
9g	Availability of sufficient number of first aid box as per standard list and maintaining record		1	Inspection records
10a	Availability of Fire extinguishers, buckets at all vulnerable points		2	Fire extinguisher records
10b	Periodic fire mock drill conducted?		1	Fire, Mock drill records
10c	Are all flammable materials are stored separately?		1	
10d	Periodic grass cutting is done in material storage area?		1	
10e	Availability of 24V DC lighting in confined space work area		1	
10f	Availability of exhaust fan in confined space work area		1	

Note:

- **M: Mandatory; O: Optional**. Points other than mandatory can be excluded with appropriate justification (scope etc.) by BHEL
- Additionally: 30 Marks for each Fatal Accident and 10 mark for each major accident shall be deducted.

	SAFETY WORK CLEARANCE	**Permit no.**
	Project:	**Emergency Contact Nos:**
	Subcontractor:	

BURNING/WELDING /HOT WORK PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign:_____

Name of Work Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrestor provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

SAFETY WORK CLEARANCE	Permit no.
Project:	Emergency Contact Nos:
Subcontractor:	

LIFTING ACTIVITY PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign: Name of Work

Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Unwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorized/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked an in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

SAFETY WORK CLEARANCE	Permit no.
Project:	Emergency Contact Nos:
Subcontractor:	

WORKING AT HEIGHT PERMIT

Area :_____Date:_____Time:_____

Name of Site Engineer (Permit Requesting Authority):_____Sign: Name of Work

Performing Contractor: _____

Name of Package In charge:_____Sign:_____Date:_____

Description of Work: _____

_____

Work Execution Date:_____Time Valid from:_____to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes (non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting / tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer:_____Sign:_____Date:_____Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____Sign:_____Date:_____Time:_____

Name of BHEL Safety Representative:_____Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____Sign:_____Date:_____Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____Sign:_____Date:_____Time:_____

Name of Site Engr. (Permit Requesting Authority):_____Sign:_____Date:_____Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____Sign:_____Date:_____Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

बी एच ई एल
BHEL

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 Measurement	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	

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)

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)

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.

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

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 etc.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(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.

Annexure-AA to Form F-15

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:

- 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.
- 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):

SI. 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.

Form WAM 23

PROFORMA OF BANK GUARANTEE (in lieu of EARNEST MONEY if permissible under Works Policy)

(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

Dear Sirs,

In accordance with the terms and conditions of Invitation for Bids/Notice Inviting Tender No……[1] (Tender Conditions), M/s. ……[2] having its registered office at ……[3] (hereinafter referred to as the 'Tenderer'), is submitting its bid for the work of……[4] invited by Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai – 600097.*

The Tender Conditions provide that the Tenderer shall pay a sum of Rs ……[5] as Earnest Money Deposit in the form therein mentioned. The form of payment of Earnest Money Deposit includes Bank Guarantee executed by a Scheduled Bank.

In lieu of the stipulations contained in the aforesaid Tender Conditions that an irrevocable and unconditional Bank Guarantee against Earnest Money Deposit for an amount of .....[6] is required to be submitted by the Tenderer as a condition precedent for participation in the said Tender and the Tenderer having approached us for giving the said Guarantee,

we, the .....(Name & address of the Bank) ..... having our Head Office at ……..(hereinafter referred to as the Bank) being the Guarantor under this Guarantee, hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer without any demur, merely on your first demand any sum or sums of Rs.....[6] (in words Rupees.....) without any reservation, protest, and recourse and without the beneficiary needing to prove or demonstrate reasons for its such demand.

Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____.[6]

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Tenderer in any suit or proceeding pending before any Court or Tribunal, Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment hereunder and the Tenderer shall have no claim against us for making such payment.

We …….. Bank further agree that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Tender or to extend the time of submission of from time to time or to postpone

for any time or from time to time any of the powers exercisable by the Employer against the said Tenderer and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Tenderer or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Tenderer or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Tenderer and notwithstanding any security or other guarantee that the Employer may have in relation to the Tenderer's liabilities.

This Guarantee shall be irrevocable and shall remain in force upto and including…….[7] and shall be extended from time to time for such period as may be desired by the Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Tenderer but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms hereof. However, unless a demand or claim under this Guarantee is made on us in writing on or before the ……[8] we shall be discharged from all liabilities under this Guarantee.

We, …… Bank lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[6]
b) This Guarantee shall be valid up to ……[7]
c) Unless the Bank is served a written claim or demand on or before _____[8] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

(Signature of Authorised signatory)

Date…….
Place of Issue…….

[1] Details of the Invitation to Bid/Notice Inviting Tender (Tender Ref. No. Eg. - BHEL PSSR SCT XXXX)
[2] Name of Tenderer
[3] REGISTERED Office Address of the Tenderer
[4] Details of the Work i.e Tender Description
[5] EMD Amount as mentioned in Notice Inviting Tender
[6] BG Amount in words and Figures (BG Amount shall be Minimum of EMD amount less Rs. 2 Lakhs)
[7] Validity Date
[8] Date of Expiry of Claim Period (Claim Period shall be minimum of 3 Months after the validity date of Bank Guarantee)

Note:
1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.

2. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)
      b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.
      b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.
      b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

PROFORMA OF BANK GUARANTEE (in lieu of RETENTION AMOUNT)

(On non-Judicial paper of appropriate value)

Bank Guarantee No……
Date……

To
Bharat Heavy Electricals Limited,
Power Sector Southern Region,
Tek Towers, No.11, Old Mahabalipuram Road,
Okkiyam Thoraipakkam,
Chennai – 600097

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 reference No._____ dated _____[3] valued at Rs _____[4] (Rupees _____)[4] (hereinafter called the said Contract), of Retention Amount 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 _____ (indicate the name and address of the Bank) having its Head Office at _____ (address of the Head Office) (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 _____ .

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

PROFORMA OF BANK GUARANTEE (in lieu of RETENTION AMOUNT)

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 Authorized signatory)

PROFORMA OF BANK GUARANTEE (in lieu of RETENTION AMOUNT)

[1] NAME OF THE VENDOR /CONTRACTOR / SUPPLIER.

[2] ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER.

[3] DETAILS ABOUT THE NOTICE OF AWARD/CONTRACT REFERENCE

[4] CONTRACT VALUE

[5] BG AMOUNT IN FIGURES AND WORDS

[6] VALIDITY DATE

[7] DATE OF EXPIRY OF CLAIM PERIOD

Note:

1. Units are advised that expiry of claim period may be kept 3-6 months after validity date. It may be ensured that the same is in line with the agreement/ contract entered with the Vendor.

2. 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.

3. In line with the GCC, SCC or contractual terms, Unit may carry out minor modifications in the Standard BG Formats. If required, such modifications may be carried out after taking up appropriately with the Unit/Region's Law Deptt.

4. 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). The BG Format provided to them should clearly specify the same.