TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION. LTD.

UDANGUDI S.C.T.P.P. STAGE-I: 2x660 MW PROJECT UDANGUDI, TAMIL NADU

TECHNICAL SPECIFICATIONS(CIVIL) FOR NATURAL DRAFT COOLING TOWER

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

CONTENTS

SECTION 5.10.2

NATURAL DRAUGHT COOLING TOWERS

TABLE OF CONTENTS

5.10.2.1 GENERAL

This specification covers the general requirements of engineering for material, design, supply, manufacture, construction, testing and commissioning for satisfactory performance of natural draught cooling tower(s) including all associated appurtenances and equipments as well as electrical works.

5.10.2.2 CODES AND STANDARDS

The latest version of the following codes shall be adopted for analysis, design and construction of Cooling Tower.

A. Materials

i	IS:432	Mild steel and medium tensile steel and bars (parts 1 & 2) and hard drawn steel wire for concrete reinforcement.
ii	IS:1785	Plain hard drawn steel wire for pre-stressed (parts 1&2) concrete.
iii	IS:1786	High strength deformed steel bars and wires for concrete reinforcement.
iv	IS:2062	Steel for general structural purposes.
v	IS:3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3mm - 2032mm).
vi	IS:8112	43 Grade Ordinary Portland Cement
vii	IS:12330	Sulphate resisting portland cement.

B. Codes of Practice

i	IS:456	Code of practice for plain and reinforced concrete.
ii	IS:800	Code of practice for general construction in steel.
iii	IS:875	Code of practice for design loads (other than (part 1 to part 5) earthquakes for building and structures).
iv	IS:1080	Code of practice for design and construction of simple spread foundations.
v	IS:1343	Code of practice for pre-stressed concrete.
vi	IS:1893	Criteria for earthquake resistant design of structures.
vii	IS:2309	Code of practice for the protection of buildings and allied structures against lightning.
viii	IS:2629	Recommended practice for hot dip galvanising on iron and steel.
ix	IS:2911	Code for practice for design and construction of (part 1 to 4) pile foundations.
x	IS:2950	Code for practice for design and construction of (part 1) raft

foundation.

xi	IS:3043	Code of practice for earthing.
xii	IS:3370	Code of practice for concrete structures for (part 1 to 4) storage of liquids.
xiii	IS:11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
xiv	IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
xv	BS:4485 (All parts)	Specification for water cooling towers.
xvi	BS:8007	B.S.Code of Practice for design of Concrete structures for retaining aqueous liquid.

The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order.

a) Bureau of Indian Standards.
b) British Standards Institution.

Wherever the above Standards are in conflict with the stipulations of this specification, the latter shall govern.

5.10.2.3 GENERAL REQUIREMENTS

The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters.

The scope of the CONTRACTOR'S work for a cooling tower shall include preparation of detailed designs and construction drawings and execution of work including but not limited to supply of all material for foundations, shell, basin, fill with its supporting structure, staircases/walkways/platforms with hand railing, cold water outlet channels including gates, screens with handling arrangement, painting, access doors, water distribution system, aviation warning system, lighting, lightning protection system, with their associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.

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

In the event, CONTRACTOR has quoted in collaboration with another firm (either Indian or foreign), each and every drawing and design calculations submitted shall bear collaborator's seal and signature indicating their approval. CONTRACTOR shall also furnish, along with the offer, back-up guarantee for the performance of the cooling tower from the collaborator.

5.10.2.4 CONCRETE

Portland Pozzolana Cement / Slag cement shall be used for all concrete works. Same brand of cement shall be used as far as possible throughout the construction of the entire structure to enable to achieve uniform colour and surface finish throughout the shell.

Minimum grade of concrete to be used for all the structural elements shall be as specified below considering environmental conditions as per Table 3 of IS: 456.

	Structural Concrete	Minimum Grade
a)	Foundations	M30
b)	Basin	M30
c)	Diagonal Columns	M40
d)	Shell	M35
e)	Precast works (Fill Supporting Structure)	M30

The minimum cement content per cubic meter of concrete as per Table 5 of IS: 456 for 'Very severe' exposure for super structure, basin and foundation:

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

5.10.2.5 REINFORCEMENT STEEL

Reinforcement for the shell shall be corrosion resistant steel.

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

5.10.2.6 STRUCTURAL STEEL

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

All exposed steel work shall be protected by hot dip galvanising. The minimum coating of zinc shall be 900 gm/sq.m and comply with the requirements of IS:2629 and IS:2633. In addition, galvanising shall be followed by the application of one coat of etching primer conforming to IS:5666 and 2 coats of bituminous paint conforming to IS:9862.

5.10.2.7 LOADINGS

5.10.2.7.1 Wind Load

Basic wind speed as well as factors K1/K2/K3 shall be taken from IS:875. Additional intensification factor to be considered due to natural turbulence in the incident wind / induced turbulence owing to nearby tall structures shall be as per BS4485, Part 4, or based on wind tunnel studies, whichever is higher.

Steady pressure distribution around the shell for the wind loading shall be as per clause 5.1.3 of IS:11504, for cooling towers not more than 120m in height and not more than 100 m in base diameter. The value obtained shall be increased by 10 percent to take into account any geometrical imperfections.

For cooling towers of height more than 120m and/or more than 100m in base diameter, wind pressure distribution shall be as determined by model test in a wind tunnel. The wind tunnel test shall be completed and report submitted for approval within 6 months of award of contract.

Magnification factor of 1.43 may be considered in the preliminary design in the absence of wind tunnel test reports.

5.10.2.7.2 Earthquake Load

The coefficient of horizontal acceleration shall be for seismic zone as per IS:1893

5.10.2.7.3 Dead Load

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

The loadings brought upon the shell by permanent fixings shall be minimised to the greatest extent possible. However, when these attachments are made, their effect upon the structure shall be thoroughly investigated.

5.10.2.7.4 Constructional Loadings

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

5.10.2.7.5 Miscellaneous Loads

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

a) Thermal restraint loads
b) Subsoil deformation.

5.10.2.8 LOAD COMBINATIONS AND PERMISSIBLE STRESSES

All structural components except stairs of the cooling tower shall be designed by working stress.

The structure shall be designed for the worst load combinations as per IS 456 and IS 11504.

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

Since cooling tower is a wind predominant structure, increase in permissible stresses shall not be allowed. Increase in safe bearing capacity for design of foundation under wind load combination shall also not be permitted.

5.10.2.9 FOUNDATIONS

The design and construction of cooling tower foundations shall be in accordance with the requirements stipulated in IS:1080/ IS:2911/ IS:2950 as applicable. Continuous annular pile cap shall be provided for cooling towers.

All lateral force shall be resisted only by piles. Effect of pile cap & basin wall shall not considered for resisting lateral load transferred from superstructure.

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

a) Thermally induced local loading where supply culverts pass through the foundation structure without structural isolation.
b) Cold water basin floor loading.
c) Surcharge load of 20 KN /sq.m at the ground / grade level.
d) In case of subsoil with varying degrees of stiffness, non uniform settlements due to the varying stiffness have to be determined. The redistribution of stresses resulting from interaction effects between the subsoil and the shell structure have to be taken into account.

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

5.10.2.10 BASIN AND COLD WATER OUTLET

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

The basin floor of each compartment shall be sloped towards a collecting sump for effectively draining the water to permit de-silting / de-sludging. To minimise obstructions to the flow of water, only the columns supporting the fill structure shall be projected above the basin floor. Water shall be drained out from the sump into a drain chamber outside the basin by CI drain pipe embedded below the basin floor. Suitable sluice gates of the rising spindle type conforming to IS:3042 or sluice valve conforming to IS:780 shall be provided in the drain chamber.

A minimum of 300 mm free board shall be provided for the basin over the maximum design water level. The basin wall shall project a minimum of 500 mm over the surrounding grade level.

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

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

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

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

The basin walls, floor slab and outlet channels shall be of reinforced concrete construction. The design and construction of these water retaining structures shall be in accordance with IS:3370 with provision of construction/ contraction and expansion joints. Resistance to cracking shall be checked as per Cl. 3.3.1 and Cl. 3.4.1 of IS:3370 (PART II). Minimum thickness of structural concrete elements shall be 230mm.

The basin and channel walls shall be designed for a minimum surcharge load of 20 kN/sq.m. to allow for construction plant operating in the vicinity.

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

Construction of the basin and channel shall be watertight with the provision of 225mm wide approved quality PVC ribbed water stops conforming to relevant standards at all construction joints and expansion joints.

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

of the OWNER.

All round cold water basin, PCC paving of M15 grade, 100 mm thick shall be provided for a width of 1.0m sloping away from the basin. Dry rubble soling of 150mm thickness shall be provided below the PCC.

Similar paving shall be provided for a width of 7.0 m from the raker columns around the cooling tower.

Pressure relief valves shall not be provided in the basin raft.

5.10.2.11 TOWER SHELL

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

5.10.2.11.1 Thickness

The tower shell shall have a minimum thickness of 200mm.

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

5.10.2.11.2 Design

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

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

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

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

5.10.2.11.3 Reinforcement and Cover

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

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

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

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

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

Minimum size of deformed bars used shall be 8mm for circumferential reinforcement and

10mm for Meridional steel.

The minimum clear cover to shell reinforcement shall be 50mm.

5.10.2.11.4 Tolerances

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

5.10.2.12 FILL

For detailed specification refer to the Mechanical section of this document.

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

5.10.2.13 FILL SUPPORTING STRUCTURE

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

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

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

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

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

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

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

b) Loading due to scaffolding for the erection crew if so envisaged to be supported.

c) loading of personnel during maintenance of pipe work and sprinkler system. The appropriate parts of the pack support structure shall be designed to support a point load of 1.5 kN at any position.

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

5.10.2.14 MAINTENANCE ACCESS FACILITIES

All areas of the cooling tower requiring inspection, cleaning, repairs and/or adjustment

shall be easily and safely accessible by suitable provision of stairs, platforms, etc., as per the requirement described herein below:

5.10.2.14.1 Stairs

The tower shall be provided with two numbers external RC staircase, leading to a heavy duty door giving access to the distribution system.

Staircase shall be minimum 1000 mm wide (clear), with landings of minimum width of 1000 mm at not more than 2500 mm height intervals unless approved otherwise.

The steps shall have a rise of about 125 mm and tread of about 250 mm. Anti-skid nosing at each step shall be provided.

Stairs shall give access to the water distribution system through hot dip galvanised steel doors. All access doors shall be of size minimum 1200 mm wide and 2100 mm height, minimum.

5.10.2.14.2 Platforms

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

5.10.2.14.3 Walkways

Walkways having a minimum clear width of 1.20 m shall be provided allround the circumference inside the cooling tower above the fill to provide access for inspection and maintenance of all hot water distribution pipes/ducts and nozzles. Walkways shall be supported independent of the Fill structure.

5.10.2.14.4 Ladders

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

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

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

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

5.10.2.14.5 Hand railings

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

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

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

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

5.10.2.15 PAINTING TO CONCRETE SURFACES

5.10.2.15.1 Inside Cooling Tower

All concrete surfaces in direct contact with sea water / water spray shall be applied with tar extended two component coating system.

a) Basin floor.

b) Internal and external surfaces of basin wall including the partition wall.

c) Diagonal columns over complete height.

d) Fill support columns and beams for the full height and length respectively.

e) Internal and external surfaces of hot water duct.

f) Internal and external surfaces of cold water channel.

g) Internal and external surfaces of the drain chamber.

h) Complete internal surface of the shell for at least 2 meter at the top and bottom and for at least 1 meter on the outside of the shell at top and bottom.

i) All concrete surfaces which are in contact with the earth.

High Performance Moisture Compatible Corrosion Resistant Coating System shall be as per technical specifications of Central Electrochemical Research Institute, Karaikudi (CSRI affiliate institute), Tamilnadu, PIN-630006.

The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

The coating system shall confirm to the following:

Properties of Paint

Base	High Performance Moisture Compatible Corrosion Resistant Coating System CECRI know-how system
Volume Solids	70 %
Specific Gravity (ASTM-D-1475)	1.25 ± 0.1

Dry Film Thickness (ASTM-D-1186)	160 ± 10 μm per coat
Coverage	4 – 4.5 sq.m per litre
Touch Dry	2 Hours
Recoating	24 Hours

Properties of Coating

Salt Spray (ASTM-B-115)	2000 Hours
Resistance to sea water (carried out upto 6 months)	Passes
Coating Resistance (carried out upto 6 months)	$10^9\ \Omega\ cm^2$
Adhesion (ASTM-D-4541)	4.5 kN minimum
Flexibility (ASTM-3363	1/8 " passes
Elongation	33 %
Impact (ASTM-G-14-04)	45 cm passes

Paint material and its application method shall be obtained from any manufacturer who has been granted license by CECRI, Karaikudi for technical know-how for High Performance Moisture Compatible Corrosion Resistant Coating System.

The application method of coating shall be got duly approved by CECRI, Karaikudi.

5.10.2.15.2 Outside Cooling Tower

Two (2) coats of Aliphatic acrylic protective coating system to concrete shall be applied to exposed outside the cooling tower as per the following specifications.

The coating system shall confirm to the following:

Adhesion (ASTM-D-4541-02)	3.3 N/mm^2
Water vapour permeants (ASTM-D-1653)	> 20 gm/sq.m/day at 75 % R.H. at 25^o C
Electrochemical polarization test	3 volts constant applied voltage for rebar in cylindrical specimens in 3.5% NaCl.
Efficiency factor, after 34 days	
Chloride penetration	Efficiency factor of minimum 10
Rebar weight loss method	Efficiency factor of minimum 15

The system should have minimum seven (7) years successful usage history in Indian conditions.

5.10.2.16 WATER DISTRIBUTION SYSTEM

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

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

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

5.10.2.17 LIGHTNING PROTECTION

For detailed specification of lightning protection system refer electrical section of this specification.

5.10.2.18 AVIATION WARNING SYSTEM, LIGHTING AND POWER RECEPTACLES

For detailed specification refer to the Electrical section of this document.

1.00.00	**GEO-TECHNICAL INVESTIGATION DATA**
1.01.01	Owner had carried out preliminary geo-technical investigation in the proposed plant site. The sub-strata details encountered at various bore holes (BH-7, 9, 12, 20 & 23) in the project site are enclosed as Annexure-1. The geotechnical data attached herewith is for guidance and reference purpose only.
1.01.02	Detailed geo-technical Investigation for proposed site is under progress. Geotechnical Investigation Report shall be made available to the successful bidder during contract stage. Bidder shall note that the net safe bearing capacity in case of open foundations and safe load carrying capacity of pile in case of pile foundations to be adopted for design during detailed engineering stage shall be as per Geotechnical Investigation Report furnished by BHEL during contract stage.

ANNEXURE-1

Project: Proposed 2X800MW Thermal Power Plant at Udangudi Village.
Coordinate: S-21.7,W-62

Location: Switch Yard East Side RL of G.L.: 0.786 m R.L. of G.W.T: 1.800 m

Bore Hole No.: BH- 7 Started on : 14/11/08 Ended on : 15/11/08 Dia. of Bore : 150mm

Stratification Data				SPT - Data						Type of Sample	
Depth Below G.L.(m)	G.W.T. (m)	Soil Profile	Description of Soil	Depth of SPT (m)	No. of Blows for Pent. (cm) 0-15	15-30	30-45	N	0 10 20 30 40 50 60 70 80 90	Depth of Sample(m)	Type of Sample
1.800	▼		Greyish V.Loose Clayey silty sand Mixed with Marine Sediments **Angle of Shearing Resistance 28^0**	1.500	1	0	0	0		1.500	SS
3.000				3.000	10cm Penet for 65Blows					3.000	SS
4.500			Greyish V.Dense Clayey Silty Sand with Lime Nodules **Angle of Shearing Resistance 42.5^0**	4.500	10cm Penet for 55Blows					4.500	SS(F)
				6.000	35	8cm Penet for 40Blows				6.000	SS
					CRR=7% RQD=0%						
			Greyish Weathered Calcareous Sand Stone **Angle of Shearing Resistance 42.5^0**	7.500						7.500	SS
					SPT Hammer Rebounded						
				9.000						9.000	SS(F)
					CRR=43% RQD=0%						
10.500				10.500						10.500	CS
					CRR=35% RQD=0%						
				12.000						12.000	CS
			Greyish to Whitish Calcareous Sand Stone **Angle of Sheraring Resistance 45^0**		CRR=8% RQD=0%						
				13.500						13.500	CS
					CRR=6% RQD=0%						
				15.000						15.000	CS

Borehole terminated at 15 m depth below E.G.L.

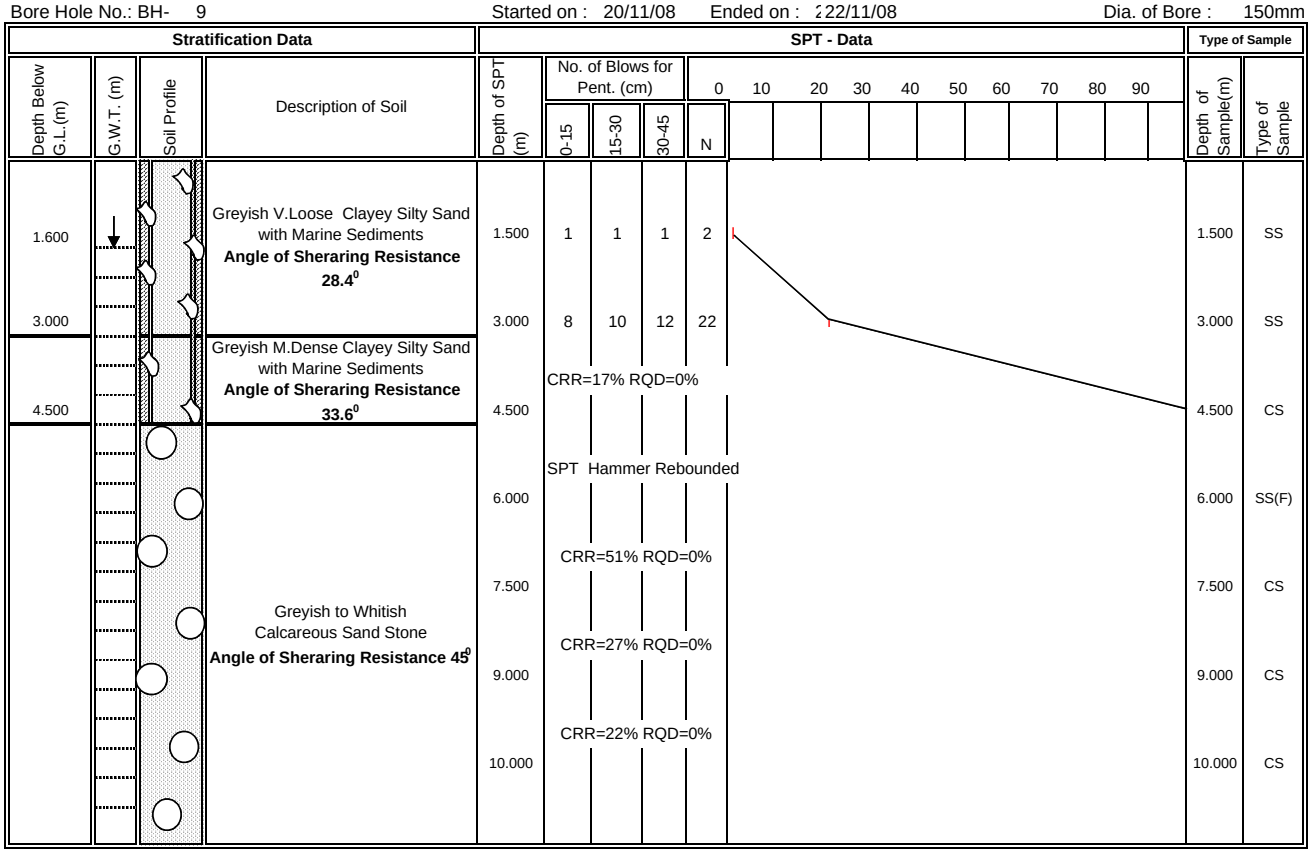
FIG.2.7Sub Soil Profile at BH-7Location

SS-Split Spoon Sample
CS-Core Sample
CRR-Core Recovery Ratio
RQD-Rock Quality Designation

Project: Proposed 2X800MW Thermal Power Plant at Udangudi Village.
Coordinate: N-24.3,W-236.6

Location: Transformed Area West RL of G.L.: 0.837 m R.L. of G.W.T: 1.600 m

Bore Hole No.: BH- 9 Started on : 20/11/08 Ended on : 22/11/08 Dia. of Bore : 150mm



Borehole terminated at 10 m depth below E.G.L.

FIG.2.9Sub Soil Profile at BH-9Location

SS-Split Spoon Sample
CS-Core Sample
CRR-Core Recovery Ratio
RQD-Rock Quality Designation

Project: Proposed 2X800MW Thermal Power Plant at Udangudi Village.
Coordinate: S-327.5,W-55.6

Location: Switch Yard West RL of G.L.: 0.727 m R.L. of G.W.T: GL m

Bore Hole No.: BH- 12 Started on : 26/12/08 Ended on : 27/12/08 Dia. of Bore : 150mm

Stratification Data				SPT - Data						Type of Sample	
Depth Below G.L.(m)	G.W.T. (m)	Soil Profile	Description of Soil	Depth of SPT (m)	No. of Blows for Pent. (cm) 0-15	15-30	30-45	N	0 10 20 30 40 50 60 70 80 90	Depth of Sample(m)	Type of Sample
0.800			**Water Level**								
			Greyish to Whitish V.Soft Silty Clay with Lime **Undrained Shear Strength 6.67kPa**	1.500	1	0	1	1		1.500	SS
3.000				3.000	4	5	7	12		3.000	SS(F)
			Greyish to Whitish Stiff Silty Clay with Lime Stone **Undrained Shear Strength 80kPa**		CRR=17% RQD=0%						
4.500				4.500						4.500	CS
					CRR=30% RQD=0%						
				6.000						6.000	CS
					CRR=34% RQD=0%						
				7.500						7.500	CS
			Greyish to Whitish Calcareous Sand Stone **Angle of Sheraring Resistance 45^0**		CRR=20% RQD=0%						
				9.000						9.000	CS
					CRR=33% RQD=0%						
				10.250						10.250	CS

Borehole terminated at 10.25 m depth below E.G.L.

FIG.2.12Sub Soil Profile at BH-12Location

SS-Split Spoon Sample
CS-Core Sample
CRR-Core Recovery Ratio
RQD-Rock Quality Designation

Project: Proposed 2X800MW Thermal Power Plant at Udangudi Village.
Coordinate: N-105.3,E-78.9

Location: Cooling Water Pump House RL of G.L.: 0.962 m R.L. of G.W.T: GL m

Bore Hole No.: BH- 20 Started on : 22/01/09 Ended on : 23/01/09 Dia. of Bore : 150mm

Stratification Data				SPT - Data						Type of Sample	
Depth Below G.L.(m)	G.W.T. (m)	Soil Profile	Description of Soil	Depth of SPT (m)	No. of Blows for Pent. (cm) 0-15	15-30	30-45	N	0 10 20 30 40 50 60 70 80 90	Depth of Sample(m)	Type of Sample
0.450	▼		**Water Level**								
			Greyish to Whitish Soft Silty Clay with Lime Stone **Undrained Shear Strength 20kPa**	1.500	1	1	2	3		1.500	SS
3.000				3.000	35	10cm Penet for 50Blows				3.000	DS
			Greyish to Whitish Hard Silty Clay with Lime Stone **Undrained Shear Strength 400kPa**								
4.500				4.500	SPT Hammer Rebounded					4.500	SS(F)
				6.000	SPT Hammer Rebounded					6.000	SS(F)
				7.500	SPT Hammer Rebounded					7.500	SS(F)
			Greyish to Whitish Calcareous Sand Stone **Angle of Sheraring Resistance 45^0**	9.000						9.000	CS
					CRR=12% RQD=0%						
				10.500						10.500	CS
					CRR=11% ROD=0%						
				12.000						12.000	CS

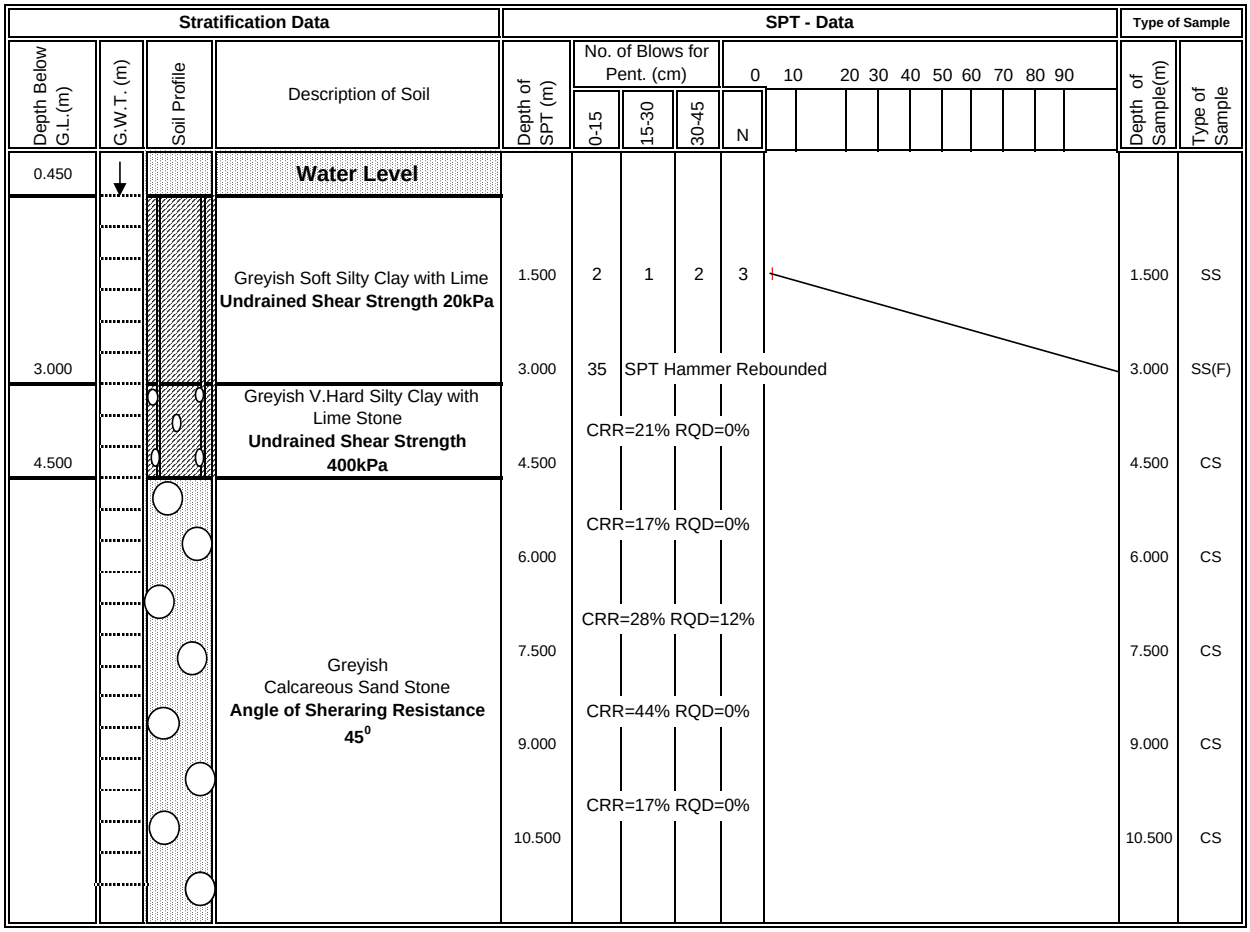
Borehole terminated at 12 m depth below E.G.L.

FIG.2.20Sub Soil Profile at BH-20Location

Project: Proposed 2X800MW Thermal Power Plant at Udangudi Village.
Coordinate: N-90.8,E-295.5

Location: ADM Building RL of G.L.: 1.051 m R.L. of G.W.T: GL m

Bore Hole No.: BH- 23 Started on : 28/01/09 Ended on : 29/01/09 Dia. of Bore : 150mm



Borehole terminated at 10.5 m depth below E.G.L.

FIG.2.23Sub Soil Profile at BH-23Location

SS-Split Spoon Sample
CS-Core Sample
CRR-Core Recovery Ratio
RQD-Rock Quality Designation

Sl.N.	VOL./ SEC.	CLAUSE NO.	PAGE	AS PER TECHNICAL SPECIFICATIONS	PREBID CLARIFICATION	TANGEDCO's Reply
1	Vol. II, Section 5.0	**5.10.2.9**	Page : 5 of 12	The design and construction of cooling tower foundations ……. All lateral force shall be resisted only by piles. Effect of pile cap & basin wall shall not considered for resisting lateral load transferred from superstructure….	The referred clauses are contradictory. Type of foundation for all structures shall be as per approved final geotechnical investigation report. Please confirm.	All references to pile foundation in Clause 5.10.2.9 shall be considered applicable if pile foundation is recommended for NDCT in the approved soil investigation report.
2	Vol. II, Section 5.0	**5.1.5.2**	Page : 8 of 17	Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit……		