

TENDER SPECIFICATION

BHEL:PSSR:SCT: 1338

FOR

**CIVIL WORK –
TOPOGRAPHICAL SURVEY
AND GEO TECHNICAL
INVESTIGATION FOR 2 X 500
UNIT 1 & 2**

AT

**TUTICORIN THERMAL POWER STATION
TUTICORIN , TAMILNADU**

PART – I TECHNICAL BID

BOOK NO :



BHARAT HEAVY ELECTRICALS LIMITED

(A Government of India Undertaking)

Power Sector – Southern Region

690, Anna Salai, Nandanam, Chennai – 600 035.

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INVESTIGATION AND TOPOGRAPHICAL SURVEY AT
TUTICORIN 2 X 500 MW ,UNIT 1 & 2**

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**BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India Undertaking)
Power Sector, Southern Region
690, Anna Salai, Nandanam, Chennai – 35**

Tender Specification No. BHEL:PSSR:SCT: 1338

Messrs

Date :

Dear Sir,

Sub: Topographical Survey and Geotechnical investigation for Unit 1 & 2 of 2 x 500 MW at Tuticorin Thermal Power Station, Tamilnadu

Please find enclosed one set of non-transferable tender documents containing **113** pages alongwith General Conditions of Contract and Rate schedule for the above work.

You are requested to go through the tender documents, and offer your most competitive rate and submit the tender documents duly filled in as per procedure indicated in the tender specification along with requisite EMD of Rs.40,000/- (Rupees Forty Thousand only) in the form Demand Draft drawn in favour of M/s Bharat Heavy Electrical Limited Chennai - 35. **Bids with Deviations from the tender conditions will be rejected.**

A SEPARATE LETTER SHALL BE FURNISHED INDICATING THAT THERE ARE NO DEVIATIONS FROM THE TENDER CONDITIONS (As in Page 08.)

The completed quotations shall reach the office of the under signed on or before **03.03.2009 at 15.00 Hrs.** The Technical bids, will be opened on the same day at **15.30 hrs.** We shall separately intimate the date for opening the price bids only to those parties who are technically qualified. You are requested to depute your authorized representative at the time of opening.

ANY REVISION OF RATES / PRICES WHAT SO EVER AFTER THE TIME AND DATE MENTIONED IN TENDER SPECIFICATION FOR SUBMISSION OF COMPLETED QUOTATIONS SHALL NOT BE ENTERTAINED UNLESS CALLED FOR SPECIFICALLY BY BHEL.

Kindly acknowledge the receipt of the tender documents and confirm your participation.

Kindly note that BHEL reserves the right to reject any or all tenders without assigning any reason.

Thanking you,

Yours faithfully,
For and on behalf of
BHARAT HEAVY ELECTRICALS LIMITED

Additional General Manager / Contracts

This Tender document is not transferable.

Place : Chennai -35.

BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India undertaking)
Power Sector : Southern Region
690, Anna Salai, Nandanam, Chennai – 600 035.

SPECIAL INSTRUCTIONS TO BIDDERS

The Bidder must submit their bids as requested in a sealed cover prominently superscribing the Tender Specification number, due date and time of submission as mentioned in the **TENDER NOTICE**.

The following information shall be furnished by the Bidder along with their offer (Technical Bid cover)

01. Details of previous experience during the last seven years indicating contract value, duration, completion period and present engagement as per G.C.C.
02. Organisation structure of the Company as per GCC.
03. Financial status of the firm enclosing balance sheet and profit and loss account for the past 3 years and certificate from the Company's Banker as per G.C.C
04. Turnover of the Company in last 3 Financial years
05. Latest Income Tax clearance certificate.
06. BIO DATA of key personnel presently in the Rolls of the company and proposed site organization for carrying out the work including deployment of Engineers and Supervisors.
07. Declaration sheets as per Appendix of Tender Specification.
08. Checklist and Schedule of General particulars as per Appendix in GCC.
09. T & P owned/deployment details as per G.C.C.
10. Technical manpower deployment details as per G.C.C
11. Other relevant details as per GCC and checklist.

12. THE BIDDERS ARE REQUESTED TO FURNISH THE DOCUMENTS LIKE COPIES OF LOI'S, WORK ORDER'S ETC PERTAINING TO THE EXPERIENCE INDICATED IN QUALIFYING REQUIREMENTS, AS GIVEN BELOW.

13. QUALIFICATION REQUIREMENT

- a) The bidder should have executed geo -technical investigation in the preceding three (3) years, reckoned as on date of bid opening for a minimum value of Rs 13 lakhs works in any single project.
- b) The bidders should have a minimum average financial turn over of 53 Lakhs per year in the preceding three financial years ending 31st March 2008.

The Bidder must have earned profit in any one of the last three financial years ending 31.03.2008 and should have positive net worth as on 31.03.2008.

Bidder should submit audited balance sheet and profit & loss account of the company for last three years ending 31.03.2008 in support of above requirement.

- c) Notwithstanding the above, BHEL reserves the right to reject any Tender or all the Tenders for reasons whatsoever beyond our control and the decision of BHEL is final.

LD / Penalty shall be leviable as per the applicable clauses of GCC.

14. The bidders have to furnish a declaration sheet indicating that there is no deviation from the tender documents (as in the page 08).Bidders may further note that this declaration is a prerequisite for BHEL to consider their bids. Bids submitted without " **No deviation Declaration** " will be rejected by BHEL.

15. SAFETY PLAN

Bidder may further note that the submission of safety plan is a prerequisite for BHEL to consider their bids.

BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India undertaking)
Power Sector : Southern Region
690, Anna Salai, Nandanam, Chennai – 600 035.
PROCEDURE FOR SUBMISSION OF SEALED BIDS

The Tenderers must submit their bids as required in two parts in separate sealed covers prominently superscribed as Part I “**Technical Bid**” and Part II “**Price Bid**” and also indicating on each of the covers the tender specification number and due date and time as mentioned in the Tender Notice.

Part I (Technical Bid) Cover I

Excepting Rate Schedule, all other schedules, data sheets and details called for in the specification shall be enclosed, in part I Technical Bid only.

Part II (Price Bid) Cover II

All indications of price shall be given in this part II Price Bid.

Tenderers are requested to quote their rates, only in the price bid (part II) provided by BHEL. Quoting of rates in any other form / formats will not be entertained.

These two separate cover I & II (Part I and Part II) shall together be enclosed in a third envelope (Cover III) along with requisite EMD as indicated and this sealed cover shall be superscribed and submitted to Additional General Manager/Contracts at the above mentioned address before the due date as indicated. The Tenderers will be intimated separately in case any clarifications are required.

NOTE: Tenderers are issued with 2 Nos. of Technical Bids, 2 Nos. of Price Bids and 2 Nos. of GCC booklet., out of which one set of each document shall be retained by them for their reference. Balance one set shall be submitted along with their offer as per procedure indicated above.

EMD amount for this Tender is Rs.40,000/- (Rupees Forty Thousand only). This EMD amount shall be submitted in the form demand draft only drawn in favour of M/s. Bharat Heavy Electricals Limited, Chennai – 35.

EMD amount in the form of Bank Guarantee / fixed deposit receipt or in any other form will not be Accepted.

**ANY REVISION OF RATES / PRICES WHAT SO EVER AFTER THE
TIME AND DATE MENTIONED IN TENDER SPECIFICATION FOR
SUBMISSION OF COMPLETED QUOTATIONS SHALL NOT BE
ENTERTAINED UNLESS CALLED FOR SPECIFICALLY BY BHEL.**

Additional General Manager/Contracts.

BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India Undertaking)
Power Sector, Southern Region
690, Anna Salai, Nandanam, Chennai – 35

TENDER NOTICE

Tender Specification No. BHEL:PSSR:SCT:1338

Description	EMD
Civil Work – Topographical survey and Geotechnical investigation for Unit 1 & 2 of 2 x 500 MW at Tuticorin Thermal Power Station, Tuticorin , Tamilnadu.	Rs. 40,000/- (Rupees Forty Thousand only)

Cost of Tender Documents (Including all Taxes)	:	Rs.1040 /-	
Sale Starts on	:	16.02.2009	
Sale closes on	:	02.03.2009	
Due date and Time for Submission	:	03.03.2009	15.00 Hrs.
Date and time for opening Of Technical Bids	:	03.03.2009	15.30 Hrs

QUALIFICATION REQUIREMENT

- a) The bidder should have executed geo –technical investigation in the preceding **three (3) years**, reckoned as on date of bid opening for a minimum value of **Rs 13 lakhs** works in any single project.
- b) The bidders should have a minimum average financial turn over of **53 Lakhs per year** in the preceding three financial years ending 31st March 2008.

The Bidder must have earned profit in any one of the last three financial years ending 31.03.2008 and should have positive net worth as on 31.03.2008.

Bidder should submit audited balance sheet and profit & loss account of the company for last three years ending 31.03.2008 in support of above requirement

- c) Notwithstanding the above, BHEL reserves the right to reject any Tender or all the Tenders for reasons whatsoever beyond our control and the decision of BHEL is final.

LD / Penalty shall be leviable as per the applicable clauses of GCC.

Interested parties can get the Tender documents from the office of the Additional General Manager / Contracts on all working days by remitting the cost of tender documents either by Cash or A/c Payee Demand Draft drawn in favour of **M/s. Bharat Heavy Electricals Limited, Chennai – 600 035**. Money order, Cheques and Postal Orders will not be accepted.

The Bharat Heavy Electricals Limited takes no responsibility for any delay, loss or non-receipt of tender documents sent by post and also reserves the right to reject any or all the tender without assigning any reason therefor. **TENDER NOT ACCOMPANIED BY THE PRESCRIBED EARNEST MONEY DEPOSIT ARE LIABLE TO BE SUMMARILY REJECTED.**

ADDITIONAL GENERAL MANAGER/CONTRACTS

TENDER SPECIFICATION: BHEL:PSSR;SCT:1338

CERTIFICATE FOR NO DEVIATION

I, _____ of

M/s _____

hereby certify that there is no deviation from the Tender conditions either technical or commercial and I am agreeing to all the terms and conditions mentioned in the Tender Specification.

SIGNATURE OF THE TENDERER

OFFER OF CONTRACTOR

Additional General Manager/ Contracts
Bharat Heavy Electricals Limited,
Power Sector : Southern Region
690, Anna Salai,
Nandanam,
Chennai – 600 035.

Sir,

I/We hereby offer to carry out the work detailed in Tender Specification No. **BHEL:PSSR:SCT:1338** issued by Bharat Heavy Electricals Limited, Power Sector : Southern Region, in accordance with the terms and conditions thereof.

I/We have carefully perused the following documents connected with the above work and agree to abide by the same.

1. Instructions to Tenderer
2. General Conditions of Contract
3. Special conditions of Contract
4. Other Section, Appendices and Schedules

I/We have deposited/forwarded herewith the Earnest Money Deposit/a sum of Rs.40,000/- (Rupees Forty Thousand only) vide DD.No. _____ Dt. _____ which shall be refunded should our offer not be accepted. Should our offer be accepted, I/We further agree to deposit such additional sum which along with the sum of Rs.40,000/- (Rupees Forty Thousand only) mentioned above, to make up the Security Deposit for the work as provided for in the Tender Specification within the stipulated time as may be indicated by BHEL, Power Sector : Southern Region, Chennai – 600 035.

I/We further agree to execute all the works referred to in the said documents upon the terms and conditions obtained or referred to therein and as detailed in the appendices annexed thereto.

DATE: CONTRACTOR:

PLACE: ADDRESS:

Witness with their address

Signature

Name

Address

PROJECT INFORMATION

1.0	INTRODUCTION	
	The project site at Tuticorin has the advantage of having coastal shipping facility for transportation of coal and water source from sea and all other existing infrastructures like access road, railway connection etc.,	
2.0	POWER PLANT SITE	
	The power plant comprising 2 x 500 MW unit is to be located adjacent to the south of the existing TNEB power station	
3.0	GENERAL PROJECT INFORMATION	
	Owner	M/s NLC Tamilnadu Power Ltd., A Joint Venture Company between NLC Ltd., Neyveli , Tamilnadu and TNEB Chennai, Tamilnadu.
	Consultant	M/s MECON Limited., Ranchi - 834002
	Project title	2 x 500 MW Tuticorin Thermal Power Project
	Location	8 Kms from Tuticorin , Tuticorin district , Tamilnadu (640 Kms south of Chennai city) India
	Latitude	8 ^o 45' 38.09" N
	Longitude	78 ^o 10'15.85"N
	Elevation above sea level	1.46 m
	Nearest railway station	Tuticorin at 8 kms (Broad Gauge)
	Nearest Harbour	Tuticorin

	Nearest Airport	Madurai
	Nearest Aerodrom	Tuticorin
	Road link	NH-7A
	Ambient Tempertures	
	Max Dry bulb temperature	37.4 ^o C
	Min Dry bulb temperature	22.1 ^o C
	Max monthly average dry bulb temperature	33 ^o C
	Design temperature for Electrical Equipment	50 ^o C
	Relative Humidity	
	Maximum	88%
	Minimum	51%
	Average	76%
	Rainfall	
	Annual average	650 mm
	Period	Oct – Dec monsoon showers
	Design cooling water temperature	30 ^o C
	Design Temperature for Electrical Equipment	50 ^o C

	Seismic Data	
	Seismic Zone	Zone -II (As per IS - 1893)
	Wind Data	
	Max wind speed	39 m / sec
	Wind direction is predominantly in west direction	
	Languages spoken in the region	Tamil,English
	Official Languages for the bidder to deal with	English

Section III

Common Conditions of Contract

3.1 SCOPE OF CONTRACT

- 3.1.1 The Contractor shall carry out the work in accordance with instructions/drawings/specifications/standard
- 3.1.2 Provisions of all types of labour, supervisors, watch and ward as required, tools and tackles as required consumables as required under various clauses of Tender Specifications.
- 3.1.3 Completion of work in time
- 3.1.4 Good quality and accurate workmanship.

3.2 FACILITIES TO BE PROVIDED BY BHEL

- 3.2.1 BHEL will not provide open space for construction of temporary office & storage shed .Contractor has to make his own arrangements for his labour tenements and office and storage shed.

3.2.2 ELECTRICITY

The power supply to be arranged by the contractor at their cost.

The required power generating sets (DG Sets) with fuel and other consumables shall be arranged by the contractor at his cost, and the operation and maintenance of the same shall be borne by the contractor.

- 3.2.3 BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variation in Voltage / frequency or interruptions in power supply.

3.2.4 WATER

Contractor has to make his own arrangements for construction and drinking water. Contractor has to provide / arrange for sufficient required quantum of water for continuous operation without any stoppage. The required water storage containers shall be arranged at the site by the contractor. Water should not be a shortage for construction purposes and as well as for curing. No structure should get damaged because of lack of curing. Any damage caused because of this, BHEL decision in charging a lump sum amount deduction is final. Contractor has to put enough number of people for curing as decided by the BHEL Engineer. Decision of BHEL Engineer is final.

3.2.5 TOOLS & PLANTS

BHEL will not provide any tools and plants for the execution of this work. The contractor shall provide tools, plants at his cost.

3.2.6 MATERIALS

All the materials that are necessary for the satisfactory completion of work including cement, reinforcement steel, structural steel, aggregates etc., shall have to be arranged by the contractor at his own cost.

3.2.7 CONSUMABLES:

All the necessary consumables that are necessary for the satisfactory completion of work including oxygen/Acetylene, electrodes etc. shall have to be arranged by the contractor at his cost.

3.3 FACILITIES TO BE PROVIDED AND DEVELOPED BY THE CONTRACTOR AT HIS COST.

- 3.3.1 It shall be the responsibility of the contractor to construct his own office shed, with all facilities like electricity, water supply, sanitary arrangements .

- 3.3.2 Distribution of water for construction purpose by arranging storing sumps or tankers and as well as drinking purposes, shall be contractor's responsibility and at his cost.
- 3.3.3 Provision and distribution of electrical power 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/requirement.
- 3.3.4 Adequate lighting facilities such as flood lamps and hand lamps and area lightings shall be arranged by the contractor at the site of construction, contractor's material storage area, etc., at his cost.
- 3.3.5 On completion of work, all the temporary buildings, structures, pipelines, 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 the clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

3.4 SUPERVISORY STAFF AND LABOUR

- 3.4.1 The contractor shall engage all the unskilled and specially skilled labour including surveyors, brick masons, carpenters, plumbers, electricians, fabricators and fitters etc., and supervisory staff. Only trained and competent personnel with previous experience in the job shall be employed. However, BHEL reserves the right to decide on the suitability of the workers and other personnel who will be employed by the contractor. BHEL reserves the right to insist on removal of any employee of the contractor at any time, if found unsuitable, the contractor shall remove him immediately.
- 3.4.2 All the materials like steel bars, steel wires, steel Pipes, Steel Flats, bricks, cement, sand, doors & windows for office shed, painting materials, putty, glazing tiles etc., shall be arranged by the contractor as per the specification mentioned in Tender/Indian standard specification. The contractor is required to quote item rates for construction of office shed,

Storage shed, civil and electrical works inclusive of cost of materials, labour etc., BHEL reserves the right to inspect and reject any material/work not found satisfactory.

3.5 GENERAL

- 3.5.1 During execution of the job, it is very essential that proper and adequate inspection should be made constantly by the contractor to maintain quality of workmanship and to ensure that deviations from the BHEL drawings not exceed the permissible limits, which shall be approved by BHEL.
- 3.5.2 The contractor shall visit the site and ascertain the local conditions, entry and traffic restrictions, all construction in the area and also ascertain all site conditions and particularly the sub soil conditions etc., The contractor shall allow for extras likely to be incurred due to such condition and no extra claim shall be entertained on this account under any circumstances from the contractor.
- 3.5.3 The contractor shall provide and maintain at his own cost pumps and other equipment to keep the works free from water and continue to do so until handing over of the work. The contractor shall clear all trees, rubbish, vegetation, rod, brickbats etc., and dispose them suitably in allotted areas at his own cost.
- 3.5.4 The contractor shall take adequate precautions to ensure complete safety and prevention of accidents at site. The safety precautions shall conform to IS codes wherever applicable.
- 3.5.5 The items though not specifically mentioned either in the drawings or in the tender specifications/rate schedule but are needed to complete the construction of office cum storage shed as stipulated under the specifications are also to be erected to entire satisfaction of BHEL Engineer and as per IS specification.
- 3.5.6 The detailed drawings and specifications will form part of the tender documents. BHEL reserves the right to modify/alter the tender drawings, if necessary and the price will remain firm as per item rates quoted.

3.5.7 The contractor shall submit the labour and staff strength (skill wise) details to Engineer in charge every month and promptly notify whenever variation occurs.

3.6.0 PROGRESS OF WORK

During the course of erection, 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 workman like, Surveyors, Masons, Carpenters, Electricians etc., employed are not sufficient, BHEL will induct required additional workmen to improve the progress and recover from the contractors bills, all charges incurred on this account including all expenses together with BHEL overheads.

The progress reports shall indicate the progress achieved against planned with reasons indicating delays if any, shall also furnish in detail the reason for the same and shall give remedial action which the contractor intends to take to make good the slippage on lost time, so that further works can proceed as per the original programme and the slippage do not accumulate and affect the overall programme.

The contractor shall submit daily, weekly and monthly progress reports, manpower reports, material reports, consumables report and other reports considered necessary by the engineer.

The manpower reports shall clearly indicate the manpower deployed category-wise daily, specifying also the activities in which they are engaged. The periodicity of the reports will be decided by BHEL engineer at site.

The contractor shall arrange for weekly progress review meetings with engineer at site during which actual progress during the week vis-à-vis scheduled programme shall be discussed for action to be taken for achieving targets. The programme for subsequent week shall also be presented by contractor for discussions. The contractor shall constantly update/revise his work programme to meet the overall requirement and suit the material availability.

The contractor shall submit detailed monthly plan after discussion with BHEL Engineer and the same has to be forwarded by the first week of the month (working month or calendar month).

3.7.0 SAFETY

- a. T & P used by contractor should be tested quality bearing ISI marks. Necessary test certificates to be produced by the contractor for all the T & P received by him at site for acceptance by BHEL Engineer. BHEL will reject any T & P without IS test certificate and the same cannot be utilized on job.
- b. Only trained and experienced personnel to be used on the job. Signaling for rigging operations must be given by workers who are possessing required skill and experience in handling materials.

3.8.0 Contractor shall strictly follow all safety conditions as per Clause 2.27 and its sub clauses of G.C.C. Booklet.

3.10. Specific Requirement for ISO 9001 - 2000

Important note

Contractor shall make all efforts that all their staff/employees are exposed to periodical training programme conducted by qualified agencies/personnel on ISO 9002 standards.

Contractor shall ensure that the quality is maintained in all the works connected with this contract at all stages to the requirement of BHEL.

Contractors shall ensure that all inspection, measuring and testing equipment that are used, whether owned by the contractors or used on loan, are calibrated by the authorized agencies and the valid calibration certificate will be available with team for verification by BHEL. A list of such instruments possessed by contractor at site with its calibration status is to be submitted to BHEL Engineer for verification and on demand.

Contractor shall arrange for the inspection of the works at various stages as required by BHEL. Immediate corrective action shall be taken by the contractors for the non conformances, if any, observed and pointed out by BHEL and records updated.

HSE SPECIFIC REQUIREMENT

OCCUPATIONAL HEALTH & SAFETY MANAGEMENT SYSTEM

SUB CONTRACTOR TO ENSURE COMPLIANCE OF THE FOLLOWING HEALTH RELATED POINTS

01. Sub-contractor to identify nearest hospital for Health check up of his staff and workers and intimate BHEL site office & PSSR HQ.
02. To arrange for occupational health check up / screening of contractor's staff and workers engaged in sub contracting activities. In this, category of workmen such as welders, gas cutters, grinders, radiographers, crane operators are to be given exclusive attention in respect of health screening.
03. Sub-contractor to arrange an ambulance vehicle or emergency vehicle on a continuous basis to meet any emergency situation arising at site work in which his staff and workers are engaged.
04. To provide appropriate facilities for prompt first aid treatment of injuries and illness at work. One first Aider for each sub contractor to be provided. First Aider should undergo training on first aid.
05. To provide filtered drinking water at selected place in a clean container.

SUB CONTRACTOR TO ENSURE COMPLIANCE OF THE FOLLOWING SAFETY RELATED POINTS

01. Personnel Protective Equipment (**PPEs**): Required number of following PPEs (Confirming to Relevant IS Standards) to be made available to workmen at site and ensure that they are used .
 - Helmet
 - Safety goggles
 - Welding face shields
 - Safety belts for working at heights
 - Safety shoes
 - Ear plugs
 - Rubber gloves and mats for low tension (L.T) electrical works
 - Gum boots & aprons
 - Other items as required by BHEL site
 - Hand clothes
02. Sub contractor to liaise with nearest fire station and inform contact telephone number and contact person to meet any emergency.
03. To provide appropriate fire fighting equipment at designated work place and to provide fire fighting training to selected persons in his group of workmen to meet emergencies.
04. To provide adequate number of 24 V power supply points to work in a constrained and enclosed space.
- 05 . All power tapping points / switch boards /power & control cabling should fulfill required electrical safety aspects as per relevant IS standard.
- 06 ELCB's (Earth leak circuit breakers) at all electrical distribution points to be provided.
07. Red and white caution tape of proper width (1.5 to 2 inch) to be used for cordoning unsafe area such as open trench, excavated area, etc.
08. To provide sub-contractors company logo or clothing to all staff and workers for identification including identity cards with photographs approved by BHEL.

09. High pressure and structural welders to be identified with colour clothing and to display copy of welders certificate with photographs of welder at the work place. They also should be in possession of valid welding procedure.
10. To display safe handling procedure for all chemicals such as lube oil, grease, sealing compound, kerosene, diesel etc. at stores & respective work place.
11. Contractor should authorize a person at site to stop work if there is a unsafe work noticed, as per his knowledge.
12. Fitness for use of erected scaffolding to be certified by the contractors approved scaffolder and the certificate should be displayed on the scaffolding itself. If the scaffolding is unsafe , the same will not be used. the certificate to be updated daily. The scaffolding to be made as per the relevant IS standard.
13. For making platform on the scaffolding , proper thickness and size of the plank of required quality wood to be used. The safe working load of the platform to be displayed on the scaffolding itself. Proper use of platform to be explained to the user.
14. All plant equipment should have inspection report before put in to use.
15. All T&Ps should be of reputed brand and having quality certificates..
16. All IMTEs should have valid calibration certificate from recommended institution / testing lab and these should be in place.
17. All lifting tackle and plant equipment should have safe working load certificate.
18. The right worker should be deployed for right job and the resume of site in charge, supervisors, and key workers to be submitted before commencement of work.
19. Sub-contractor should submit inspection / testing matrix of all T&Ps and to be approved by BHEL.

20. Sub-contractor to display safety slogan, safety board, caution boards wherever required in consultation with BHEL.
21. Sub-contractor to provide gas detectors of reputed make at desired locations.
22. Sub-contractor to conduct emergency mock drills. one drill per 6 month and submit report to BHEL.
- 23. Safe handling and storing of all equipment with adequate space to be ensured.**
24. Sub contractor to deploy safety supervisor till the completion of the project.
25. Sub contractor to comply the safety reporting procedure of BHEL as practiced at present and also additional requirements that may arise out of future improvements in the safety management system. This includes computation of safety indices such as frequency rate, severity rate & incident rate.
26. Sub contractor to identify probable emergency situations such as electric shocks to workmen , caving in of shored earth , fall from height, collapse of scaffolding fire etc., and should have clear action plan to overcome them. Sub contractor to take required guidance from BHEL in this regard.
27. Sub contractor to identify hazardous activities which he may carryout and should train his workmen in those activities with the relevant operation control procedures. Sub contractor to take required guidance from BHEL in this regard.
28. Safe work permit system to be followed while working in confined space / near electric systems.

SUB CONTRACTOR TO ENSURE COMPLIANCE OF THE FOLLOWING ENVIRONMENT RELATED POINTS

1. **HOUSE KEEPING** : Sub contractor to carry out daily house keeping of work areas / stores through a check list prepared in consultation with BHEL.
2. Sub contractor shall adopt pollution prevention / reduce /control approach in all his site activities. this shall include:
 - a. Transporting of oil / chemicals from stores to site safely without causing spillage. In case of any spillage, the area shall be cleaned and the remnant spilled oil disposed off to a safe place, identified for such disposal.
 - b. To use required containers / cans / safety gadgets /appliances for transporting and for usage of oil / chemicals at site.
3. Sub contractor shall arrange for segregation / collection of scraps and dispose off to the identified place meant for scrap collection.
4. Sub contractor to adopt good erection practices / procedures with the objective of reduction of waste generation / rework

OTHER HSE REQUIREMENTS TO BE COMPLIED BY SUB CONTRACTOR

1. Sub contractor to clearly understand and accept the HSE policy of PSSR with a commitment to comply the requirements of the policy.
2. Sub contractors to arrange for daily meeting of their supervisors and work force before they disperse for their daily planned activities where in the relevant health, safety and environment aspects of the job and use of PPEs are explained
3. Sub contractor to conduct monthly HSE meeting (internal) and submit the report to BHEL.
4. HSE slogans to be displayed in a proper board – hoarding at designated places in consultation with BHEL.
5. Sub contractor to submit a structured programme for training & occupational Health Screening of their work force at site after the Award of LOI.

SECTION — VI

SPECIAL CONDITIONS OF CONTRACT

1.0 SCOPE OF WORK:

Conducting Geo-technical Investigation and Topographical Survey at 2x500 MW Unit 1 & 2 of Tuticorin Thermal Power Project, Tuticorin , Tamilnadu.

2.0 **SPECIFICATIONS FOR GEO-TECHNICAL INVESTIGATION AND TOPOGRAPHICAL SURVEY:** THE SAME IS DEALT IN TECHNICAL SPECIFICATION IN DETAIL.

3.0 **TIME SCHEDULE:**

- 3.1 The contractor should complete Geo-technical Investigation and Topographical Survey including submission of Final Report with in **Two (2)** months from the actual commencement of work at site.
- 3.2 The contractor shall start the work within one week from the date of issue of Fax letter of intent.
- 3.3 The rates quoted shall remain firm throughout the contract period till the entire construction work is completed in all respects to the entire satisfaction of BHEL.
- 3.4 For the above purposes, the work under the specification will be deemed to be completed in all respects, only after successful handing over of the works to BHEL and certified so by BHEL Engineer.
- 3.5 During the tenure of contract, if BHEL is not satisfied with the progress of work, BHEL have the right to withdraw any portion of work / balance work and get the same done either directly employing their own personnel or through other agency at the risk & cost of the Contractor. The contractor shall not be entitled for any compensation whatsoever in this regard.

4.0 TERMS OF PAYMENT :

- 4.1 90% of the accepted item rate in the rate schedule shall be paid as certified by BHEL Engineer.
- 4.2 5% of the accepted item rate in the Rate Schedule shall be paid on the entire execution of work and completion of the same as envisaged in the tender documents duly certified by BHEL Engineer and on submission and acceptance of final bill.
- 4.3 Balance 5% of the accepted item rate in the rate schedule will be payable after expiry of **6 (Six)** months after taking over of the entire scope of work by BHEL.

5.0 IMPORTANT CONDITIONS FOR PAYMENT :

It may be noted that the first running bill will be released only on production of the following.

- i. PF Regn. No.
- ii. Labour Licence No.
- iii. Workmen Insurance Policy No.
- iv. Un Qualified Acceptance to Detailed L.O.I.
- v. Initial 50% Security Deposit.
- vi. Rs. 100/- Stamp Paper for Preparation of contract agreement

6.0 SPECIAL CONDITIONS OF CONTRACT-GENERAL

1. The quantities indicated in the rate schedule are approximate and may vary depending on site conditions and any changes in design at the time of construction. The payment in unit rate will be made only based on actual measurement jointly taken at site and certified by BHEL Engineer. No extra claim due to variation in quantities will be entertained. Contractor to make a note of this and to quote accordingly.
2. Price quoted above shall include supply of all materials, their transport, storage and preservations.

3. BHEL reserves the right to reject materials of substandard/not conforming to IS Specifications purchased by the contractor.
4. For fluorescent fitting at appropriate safe height when will be decided at site during construction. Contractor to make a note of the same and quote accordingly.
5. Contractor to note that necessary scaffolding for doing any type of job including painting, electrical works etc., even if not specifically mentioned in the rate schedule is in the scope of the contractor.
6. All the electrical fittings, including bulbs, tube lights, flood lights etc., mentioned above shall carry IS markings on them and shall be subject to the approval of BHEL site Engineer prior to their installations and shall be as per make of materials schedule enclosed in Appendix. The contract shall be executed on "FIRM PRICE" basis with no escalations payable on any amount whatsoever rates quoted shall be for all leads, lifts, and heights.
7. Rates quoted shall be inclusive of supply of materials, like cement, sand, bricks, stone, aggregate, lime, jelly, iron and steel materials, all kinds of paints, materials for doors and windows, ventilators, all fittings electrical fittings and their accessories, wooden materials, reinforcement steel, screws, bolts, nuts, washers, 'J' bolts etc., etc., Necessary transport, loading unloading etc all shall be borne by the contractor. All tools and plants required consumables shall be provided by the contractor at his cost.
8. All electrical fittings like fans, Exhaust fans, Tube lights etc., shall be marked / identified with running serial numbers before handing over of the sheds, to enable BHEL to keep inventory of the fittings and for effective control.
9. The contractor is requested to take care of the following statutory clearance which are under the scope of contractor.

The contractor is also requested to refer clause 2.16 of G.C.C. booklet.

- a. Labour License
- b. Provident Fund
- c. Insurance for Bidder's scope of work
- d. Workmen compensation
- e. Local rules governing the works like Electrical Inspectorate etc. Factory Inspectorate.
- f. Professional Tax
- g. Safety Rules & Regulations
- h. Competent Authority approval for Installation works
- i. Employees State Insurance Scheme
- j. Sales Tax on work contract.

7.0 PROVIDENT FUND & MINIMUM WAGES :

You are required to extend the benefit of Provident Fund to the labour employed by you in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, you are hereby required to get yourself registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to you by the Provident Fund authorities within one month from the date of issue of 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.

The contractor shall ensure the payments of minimum labour wages to the workmen under him as per the rules applicable from time to time in the state.

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

8.0 **TAXES :**

8.1 **Value added Tax (VAT) for the works**

Price quoted shall be inclusive of ALL TAXES except service tax.

Price quoted shall be inclusive of VAT except service tax.

In this civil works, as transfer of property in goods is involved, Works Contract Tax under VAT Act as applicable shall be included in the quoted price by the bidder. The bidder shall get registered with Tamil Nadu State VAT authorities and the registration certificate shall be forwarded to BHEL immediately after commencement of work. In case the bidder had already registered under Tamilnadu VAT, they must quote their registration Number and forward copy of Registration Certificate while submitting this tender. Deduction of VAT at source would be enforced from the running bills at the rates prescribed unless exemption certificate is produced from the concerned authorities. Tax invoice if required under the relevant State VAT Law shall be submitted along with other compliances as per Tamilnadu State VAT Act. The bidder has to obtain VAT clearance certificate from the concerned authorities, for the completed project, and submit along with the final bill as one of the document for contract closure.

The bidder while quoting the total price including VAT, they shall specify(1) The value of VAT included in the total price (2) Rate of tax adopted and (3) On what value etc. as additional information along with price bid.

The bidder shall quote very competitive price after taking into consideration of above points.

19.2 **SERVICE TAX**

Price quoted shall be exclusive of Service Tax. The service tax as statutorily leviable and payable by the bidder under the provisions of service tax Law / Act shall be paid by BHEL as per bidder claim through various running bills. **The bidder shall furnish proof of service tax registration with Central Excise Department specifying the name of services covered under this contract.** Registration Certificate should

also bear the endorsement for the premises from where the billing shall be done by the bidder on BHEL for this project. The bidder shall obtain prior consent of BHEL before billing the service tax amount.

19.3 OTHER TAXES

Any other taxes and duties (except VAT & Service Tax) viz. Entry Tax, Octroi, Seigniorage, Licenses, Deposits, Royalty, Stamp Duty, other charges / levies, etc. prevailing / applicable on the date of opening of technical bids and any variation thereof during the tenure of the contract are in the scope of bidder. In case BHEL is forced to pay any such taxes, BHEL shall have the right to recover the same from the bidder either from running bills or otherwise as deemed fit.

19.4 NEW LEVIES & TAXES :

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

19.5 STATUTORY VARIATIONS :

Statutory variations are applicable only in the cases of Value Added Tax and Service Tax. The changes implemented by the Central / State Government in the VAT Act / Service Tax during the tenure of the contract viz. increase / decrease in the rate of taxes, applicability, etc. and its impact on upward revision / downward revision shall be 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 including extended period, if any.

19.6 DIRECT TAXES

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/Rules.

19.7 OTHER STATUTORY REQUIREMENTS

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 alongwith the first running bill.
2. The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. Incase 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.
3. The contractor shall submit monthly running bills alongwith the copies of monthly wages (of the preceding month) u/r 78 (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.

4. The Contractor shall submit copies of Final Settlement statement of disbursement of retrenchment benefits on retrenchment of each workman under I D Act 1948, copies of Form 6-A(Annual Return of PF Contribution) along with Copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act 1948 (If applicable) to BHEL along with the Final Bill.
5. In case of any dispute pending before the Appropriate authority under I D act 1948, WC Act 1923 or ESI Act 1948 and PF Act 1952, BHEL reserves 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.
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.

20.0 PRICE ESCALATION

The quoted / accepted rate has to be kept firm for the entire contractual period including total extended period if any and no claim for revision of rates is allowed under any circumstances.

However the contractor shall maintain sufficient work force and other resources required for completion of the job expeditiously for the entire contractual period including total extended period

TENDER SPECIFICATION

BHEL:PSSR:SCT: 1338

FOR

**CIVIL WORK – GEO TECHNICAL
INVESTIGATION AND
TOPOGRPHICAL SURVEY**

FOR

**Tuticorin Thermal Power Project
2 x 500 MW**

PART – II TECHNICAL SPECIFICATION

BOOK NO :



BHARAT HEAVY ELECTRICALS LIMITED

(A Government of India Undertaking)

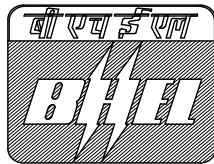
Power Sector – Southern Region

690, Anna Salai, Nandanam, Chennai – 600 035.

BHARAT HEAVY ELECTRICALS LTD

**TECHNICAL SPECIFICATION
FOR
GEOTECHNICAL INVESTIGATION OF
2 x 500 MW TUTICORIN THERMAL POWER STATION**

SPECIFICATION NO. PE-TS-G47-603-002



JANUARY, 2009

**PROJECT ENGINEERING MANAGEMENT
POWER SECTOR, PPEI BUILDING
PLOT NO. 25, SECTOR-16A, NOIDA (U.P.)-201301**



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**TECHNICAL SPECIFICATION
FOR
GEOTECHNICAL INVESTIGATION**

1.0 GENERAL

1.1 This specification covers the technical requirements for a detailed “Geotechnical investigation and submission of a detailed geotechnical report”. The detailed geotechnical investigation shall be carried out onshore to provide the designer with sufficiently accurate information both general and specific about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation for various structures and equipments of the power station can be designed rationally. Such structures would include main power house, chimney, boiler foundation, turbo-generator foundation, foundation for vibratory equipments, deep pits, reservoir, ash pond, pipe supports and all other related structures of the power station etc. The above list is indicative and not exhaustive. The range of load intensities from the various structures are expected to be between 50 kN/sqm and 500 kN/sqm.

2.0 SCOPE

2.1 The work shall include mobilization of all necessary equipments, providing necessary engineering supervision and technical personnel, skilled and unskilled labours, arranging water for drilling etc as required to carry out the entire field as well as laboratory investigation, analysis and interpretation of test data collected and preparation of a geotechnical report. The entire field as well as laboratory investigation work shall be supervised by a graduate in civil engineering with atleast 5 years of site experience in respective areas of geotechnical investigation work. A geologist shall also be deputed at site during investigation whenever rock drilling is undertaken. The scheduling of laboratory tests, analysis and interpretation of test results, drafting of report and recommendations shall be carried out by a post graduate in geotechnical engineering with atleast 5 years of experience.



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- 2.2 The contractor shall make his own arrangements for locating the co-ordinates and position of bore holes, trial pits and other field tests as per the drawings/sketches supplied to him and for determining the reduced levels at these locations with respect to a single bench mark indicated by the engineer-in-charge. Two established reference lines will be indicated to him. The contractor has to provide at the site all the required survey instruments to the satisfaction of the engineer-in-charge so that the work can be carried out accurately according to the specification and drawings.
- 2.3 All the field data shall be recorded in the proforma recommended in Indian Standard Codes and the field records shall be counter signed by the engineer-in-charge. The contractor shall submit two copies of the field borelogs to the engineer-in-charge soon after the completion of each bore hole. All the investigations are to be carried out by the contractor as per the priority requirements of the engineer-in-charge.
- 2.4 The contractor shall intimate the engineer-in-charge giving reasons if any additional specific tests he consider necessary to be carried out duly considering local sub-soil conditions before starting of such tests.
- 2.5 Whenever the contractor is unable to extract undisturbed samples he should immediately inform the engineer-in-charge. In such a case payment for boring charges shall be subject to the engineer-in-charge being satisfied that adequate effort has been made to extract undisturbed samples.
- 2.6 All the laboratory test data shall be recorded in the proforma recommended in the Indian Standard Codes and a copy of these shall be sent to the engineer-in-charge every week during the progress of laboratory testing. Whenever desired during the progress of work the owner/engineer-in-charge may be present at the laboratory where the contractor is arranging for execution of the laboratory tests.
- 2.7 The contractor shall interact with the engineer-in-charge to get acquainted with the different type of structures envisaged and in assessing the load intensities on the foundations for the various structures of the power project in order to enable him to make



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specific recommendation for the depth & type of foundation and the allowable bearing pressure. The contractor shall submit detailed geotechnical report after incorporating the comments (if any) on the draft report.

3.0 TENDER DRAWING

3.1 The enclosed General Layout (**DRG.NO. MEC/TS/11/Q6G4/14/TA-GEN/001 Rev 6**) indicate the tentative areas to be investigated for locating the project. The area(s) indicated in the drawing is subject to change that may be necessary during actual execution of the work. No claim whatsoever shall be entertained for differences between the location, extent and depth/area(s) etc of soil tests indicated on the construction drawings and those shown on the tender drawings. The work shall be carried out as per the instructions of the engineer-in-charge.

3.2 The bidder must visit the site prior to submitting his quotations to acquaint himself fully with the nature, type, scope of work and involvement therein. The rates quoted shall remain firm during the entire period of execution till completion of the work and any additional claim for lack of knowledge shall not be entertained.

4.0 GENERAL REQUIREMENTS

4.1 In areas which have already been developed, the contractor shall take advantage of existing local knowledge, record of trial pits, bore holes etc in the vicinity and the type of foundations adopted and behaviour of existing structures particularly those of similar nature to the ones proposed for this project.

4.2 The contractor shall make use of information gathered from quarries, unlined wells, cuttings from nearby areas etc. The general topography of the near by areas will often give some indication about the variation of the soil conditions which are likely to exist.

4.3 The contractor shall gather data regarding the removal of overburden by excavation, erosion or land slides in the areas which may give an



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idea of the amount of reconsolidation that the soil strata has undergone. Similarly data regarding recent fills shall also be studied to determine the characteristics of the fill as well as the original strata.

4.4 The water level in streams and water courses if any in the neighbourhood shall be noted. Reliable information regarding ground water level shall also be gathered from water level in the near by wells.

4.5 The contractor shall make enquiries and verify regarding earlier use of the site which can have important bearing on its suitability for the proposed structures. This is important particularly in areas where there have been underground works e.g. worked out ballast pits, quarries, old brick fields, mines, mineral workings etc. The possibility of damage to the structures, sewers, conduits and drainage system by subsidence shall also be investigated.

4.6 It is essential that the equipments/instruments are properly calibrated at the commencement of the work so that they represent true values and submit the test reports to the engineer-in-charge. If the engineer-in-charge so desires, the contractor shall arrange for having the instruments tested in presence of the engineer at an approved laboratory at the contractor's cost and the test reports shall be submitted to the engineer-in-charge.

4.7 When blasting with explosives is involved, agency/contractor shall arrange statutory clearances and also the portable magazine for storing/carrying the explosives.

5.0 CODES AND STANDARDS

5.1 All standards, specification and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

5.2 In case of conflict between this specification and those (IS codes and standards etc) referred to herein the former shall prevail.



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5.3 All work shall be carried out as per the specification and the following standards and codes.

IS: 1080 Code of practice for design and construction of simple spread foundations

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

IS: 1888 Method of load test on soils

IS: 1892 Code of practice for subsurface Investigation for foundation

IS: 1904 Code of practice for design and construction of foundations in soils: General requirements

IS: 2131 Method of standard penetration test for soils

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

IS: 2470 Code of practice for design and construction of septic tanks Part-I

IS: 2720 Method of test for soils (Relevant parts)

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

IS: 2810 Glossary of terms relating to soil dynamics

IS: 2911 Code of practice for design and construction of pile foundations (Relevant parts)

IS: 2950 Code of practice for design and construction of raft foundation Part- I



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- IS: 3025 Methods of sampling and testing (Physical and chemical) for water used in Industry
- IS: 3043 Code of practice for earthing
- IS: 4078 Code of practice for indexing and storage of drill cores
- IS: 4434 Code of practice for in-situ vane shear test for soils
- IS: 4453 Code of practice for exploration by pits, trenches, drifts and shafts
- IS: 4464 Code of practice for presentation of drilling information and core description in foundation investigation
- IS: 4968 Method for subsurface sounding for soils- Dynamic Part -II method using cone and bentonite slurry
- IS: 4968 Method for subsurface sounding for soils-Static cone Part-III penetration test
- IS: 5249 Method of test for determination of in-situ dynamic properties of soil
- IS: 5313 Guide for core drilling observations
- IS: 5529 Code of practice for in-situ permeability test – Test in Part-I overburden
- IS: 5529 Code of practice for in-situ permeability test - Test in bed Part-II rock
- IS: 6065 Recommendation for the preparation of geological and geotechnical maps for river valley project
- IS: 6403 Code of practice for determination of allowable bearing pressure on shallow foundation
- IS: 6926 Code of practice for diamond core drilling for site investigation of river valley projects



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- IS: 6935 Method of determination of water level in a bore hole
- IS: 6955 Code of practice of subsurface exploration for earth and rockfill dams
- IS: 7422 Symbols and abbreviations for use in geological maps, sections and subsurface exploratory logs (Relevant parts)
- IS: 8009 Code of practice for calculation of settlement of
Part-I foundation subjected to symmetrical vertical loads -
Shallow foundations
- IS: 8009 Code of practice for calculation of settlement of
Part-II foundation subjected to symmetrical vertical loads –
Deep foundations
- IS: 8763 Guide for undisturbed sampling of sands
- IS: 8764 Method for determination of point load strength index of rocks
- IS: 9143 Method for the determination of unconfined compressive strength of rock materials
- IS: 9179 Method for preparation of rock specimen for laboratory testing
- IS: 9198 Compaction rammer for soil testing
- IS: 9214 Determination of modulus of sub-grade reaction in field
- IS: 9259 Specifications for liquid limit apparatus
- IS: 9640 Specifications for split spoon sampler
- IS: 9669 Specifications for CBR mould and its accessories



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- IS: 10050 Method for determination of slake durability index of rocks
- IS: 10060 Code of practice for subsurface investigation for power house sites
- IS: 10074 Specification for compaction mould assembly for light and heavy compaction
- IS: 10108 Code of practice for sampling by thin wall sampler with stationary piston
- IS: 10589 Equipment for determination of subsurface sounding of soils
- IS: 10837 Specifications of moulds for determination of relative density and its accessories
- IS: 11229 Specifications for shear box testing of soils
- IS: 11315 Description of discontinuities in rock mass - Core Part-II recovery and rock quality
- IS: 12070 Code of practice for design and construction of shallow foundations on rocks
- IS:13372 Seismic testing of rock mass – Code of practice (Part I & II)

6.0 FIELD INVESTIGATION - SOIL

6.1 Boring

6.1.1 General Requirements

a) Bore holes shall be drilled at specified locations to obtain information about the sub-soil profile, its nature, strength and to collect soil samples for strata identification and conducting laboratory tests. The minimum diameter of the bore hole shall be 150 mm and



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boring shall be carried out in accordance with the provisions of IS: 1892 and as per this specification.

b) All bore holes shall extend up to the depths shown on the construction drawings or as directed by the engineer-in-charge. If the strata with standard penetration test (SPT) 'N' value greater than 100 with characteristics of rock is met with earlier, the bore hole shall be advanced further by chiselling. Chiselling shall be continued for a maximum depth of 20 cm or upto 2 hours whichever is earlier. During chiselling rock fragments/rock cores shall be collected. Identification of rock strata shall be on the basis of visual examination of SPT sample and rock fragments. After it is established that rock is met with, the borehole shall be advanced further by drilling in rock as specified in clause 7.0 and cores shall be collected. When the bore hole is terminated in soil strata, an additional standard penetration test shall be carried out at the termination depth.

c) Casing pipe shall be used in the borehole to support its sides when side fall is suspected to occur inside the borehole. When casing pipe is used, it shall be ensured that its bottom end is at all times 15 cm above the bottom of the bore hole. In case of cohesionless soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall be advanced by slowly turning the casing pipe and not by driving.

d) In-situ tests and collection of undisturbed samples (UDS) shall be carried out at regular intervals and at change of strata or as decided by the engineer-in-charge. Representative disturbed and undisturbed samples shall be preserved for conducting various tests in the laboratory. Water table in the borehole shall be carefully recorded and reported. No water/drilling mud shall be added while boring above ground water table. For cohesionless soil below water table, the water level in the borehole shall all times be maintained at slightly above the water table.

e) The bore hole shall be cleaned using suitable tools up to the depth of testing or sampling ensuring that there is minimum disturbance of soil at the bottom of the bore hole. The process of jetting through an



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open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.

f) On completion of the borehole, the portion drilled in soil shall be backfilled with sand unless otherwise directed by the engineer-in-charge.

g) Wash boring shall not be adopted.

6.1.2 Auger Boring

Auger boring can be adopted in soft to stiff cohesive soils above water table. Augers shall be of helical or post hole type which may be manually or power operated. While boring care shall be taken to minimise the disturbance to the deposits below the bottom of the borehole. The cuttings brought up by the auger shall be carefully examined in the field and the description of all the strata shall be duly recorded in the field borelog as per IS:1498. No water shall be used while auger boring.

6.1.3 Shell and Auger Boring

Shell and Auger boring can be used in all types of soil free from boulders. For cohesionless soil below ground water table, the water level in the bore hole shall always be maintained at or above the ground water level. The use of chisel bit shall be permitted in hard strata with SPT-N value greater than 100. Chisel bits may also be used to extend the borehole through local obstruction such as old construction, boulders, rocky formations etc. All other requirements in clause 6.1.2 shall apply for this type of boring also.

6.1.4 Percussion Drilling

This method can be adopted in soil with gravel and boulders when the boring has to be done at a faster rate. This method consists of breaking of the strata by repeated blows from a chisel or drilling bit and bailing out the debris at intervals by adding water into the bore



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hole. This method is not suitable for careful and very reliable sampling operation because of the disturbance caused during boring.

This method shall not be adopted unless otherwise specified or permitted by the engineer-in-charge.

6.1.5 Rotary Mud Circulation Drilling

This method can be used in all types of soil below water table. In this method boring shall be done by rotating the bit fixed at the bottom of the drill rod. Proper care shall be taken to keep a firm contact between the bit and the bottom of the borehole. Bentonite or mud laden fluids shall be used as the drilling fluid to serve as the protective surface inside the borehole.

6.2 Standard Penetration Test (SPT)

This test shall be conducted in all types of soil deposits met within the bore hole to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. This test shall be conducted at every 1 m intervals alternate to collection of undisturbed soil samples (UDS) upto 10m depth below ground level and at every 1.5 m interval alternate to collection of undisturbed soil samples (UDS) beyond 10m depth, at every change of strata, at depths wherever undisturbed soil samples could not be collected and as per the directions of the engineer-in-charge. The starting depth of performing SPT shall be at either 1m depth below ground level. The depth interval between the top level of standard penetration test and to that of (next) undisturbed sampling shall not be less than 1m. The specification for equipments and other accessories, procedure for conducting the test, presentation of test results and collection of disturbed soil samples etc shall conform to IS: 2131.

This test shall be carried out by driving a standard split spoon sampler in the borehole by means of a 650 N hammer having a free fall of 0.75m. The sampler shall be driven using the hammer for 450 mm penetration. While driving, the number of blows for every 150 mm penetration and the penetration for every 50 blows shall be recorded.



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The number of blows for the last 300 mm drive shall be reported as 'N' value. This test shall be discontinued when the blow count is equal to 100 and the penetration shall be recorded. Refusal shall be considered to be met with when the blow count is equal to 100. At the location where the test is discontinued, the penetration and the corresponding number of blows shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The samples shall be visually classified & recorded at the site and shall be properly preserved and labelled for future identification & testing.

6.3 Sampling

6.3.1 General

a) Sufficient number of soil samples shall be collected for reliable estimation of soil properties. The samples collected shall be either disturbed or undisturbed. Disturbed soil samples shall be collected for field identification and conducting laboratory tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate physical, strength and settlement properties of the soil.

b) All the accessories required for sampling and the method of sampling shall conform to IS:2132. All disturbed and undisturbed samples collected in the field shall be classified at site as per IS: 1498.

c) All the samples shall be identified with date, bore hole or trial pit number, depth of sampling etc. It is also essential to mark an arrow pointing towards the top surface of the undisturbed sample as the soil was in-situ. Care shall be taken to keep the undisturbed soil samples and box samples vertically with the arrow directing upwards. The tube samples shall be properly trimmed at both ends and suitably sealed with molten paraffin wax at both ends immediately after extracting the samples from the bore hole/trial pit and suitably capped on both sides.



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d) When the contractor fails to collect undisturbed soil sample at a specified depth, the borehole shall be advanced by 0.50m and shall be performed with a standard penetration test. The reason

for not obtaining the undisturbed soil sample shall be indicated in the borelog.

e) Precaution shall be taken to ensure that there shall not be any change in moisture content and disturbance of the soil samples and they shall be placed in a temporary store at the end of the day's work. All the samples shall be kept over a bed of sand, jute bags, saw dust etc and covered over the top with similar material. The bed and top cover shall be kept moist till they are properly packed in wooden boxes. The contractor shall be responsible for packing and transporting of all the samples from site to the laboratory within seven days after sampling with proper protection against loss and damage.

f) All the samples shall be suitably packed in wooden boxes using sand, saw dust etc all around the samples before transporting to the laboratory for testing.

6.3.2 Disturbed Samples

a) Disturbed soil samples shall be collected from cuttings and from split spoon sampler in boreholes at regular intervals to provide complete description of soil profile and its variation. The samples shall be immediately stored in airtight jars or polythene bags and labelled with borehole/trial pit number and depth.

b) In elevated areas, if superficial material is available in plenty, then bulk samples from a depth of about 0.5m below ground level shall be collected to establish all required properties to use it as a fill material. Disturbed samples weighing about 250N shall be collected at shallow depths and immediately stored in polythene bags as per IS: 1892. The bags shall be sealed properly and shall be kept in wooden boxes.

6.3.3 Undisturbed Samples



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In each borehole undisturbed sample (UDS) shall be collected at regular intervals of 1m alternate to conducting standard penetration test (SPT) up to 10m depth below ground level and at every 1.5m

Interval alternate to conducting standard penetration test (SPT) beyond 10m depth and as directed by the engineer-in-charge. The starting depth of collecting UDS shall be 2m depth below ground level and as directed by the engineer-in-charge. Undisturbed samples shall be of 100mm diameter and 450mm length. Samples shall be collected in such a manner that the structure of soil and its moisture content do not get altered. The specification for the accessories required for sampling and the sampling procedure shall conform to IS:1892 and IS:2132. Undisturbed sampling in sand shall be done using compressed air technique as mentioned in IS:8763. Thin walled sampler shall be used to collect undisturbed samples by pushing the tube into the soil. The sampling tube shall have a smooth finish on both surfaces and minimum effective length of 450mm. The area ratio of sampling tubes shall be less than 12.5%. However in case of very stiff soils, area ratio upto 20% shall be permitted.

a) Undisturbed Sampling in Cohesive Soil

Undisturbed samples in soft to stiff cohesive soils shall be obtained using a thin walled sampler. In order to reduce wall friction, suitable precautions such as oiling the surfaces shall be taken. The bore hole shall be cleaned and the depth of sampling below ground level shall be noted. The sampler shall then be attached to the bottom of boring rods and lowered into the borehole. The sampler shall be pushed into the clay layer by hand or by jacking and soil sample of specified length shall be collected without disturbing the soil. The distance by which the sampler penetrates into the soil strata shall be checked. Care shall be taken to ensure that the sampler is not driven too far as this will compress the soil. The sampler shall be rotated to break the core at bottom of the sampler and then steadily drawn up.

b) Undisturbed Sampling Using Piston Sampler

Undisturbed samples in very loose saturated sandy & silty soils and very soft clays shall be obtained by using a piston sampler consisting



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of a sampling cylinder and piston system. In soft clays and silty clays with water standing in the casing pipe, piston sampler shall be used to collect undisturbed samples. During this method of sampling expert supervision is called for. The interior surface of the sampler shall be smooth, clean and corrosion resistant. Its cutting edge and the ring seals shall be inspected for wear and rejected if worn. Check shall be done to ensure that the moving parts of the sampler function freely before the sampler is lowered into the borehole. While pushing the system into the soil and till the beginning of the sampling operations, the bottom of the piston shall be flushed with the cutting edge of the sampler. At the depth of sampling, the piston should be fixed relative to the ground and the sampler cylinder shall be independently pressed down smoothly and continuously into the ground. If an obstruction is met, the sampler shall be withdrawn and another sample be taken after the obstruction is removed.

Accurate measurements of the depth of sampling, height of sampler, stroke and length of sample recovery shall be noted and recorded. After the sampler is pushed to the required depth, both the sampler cylinder and the piston system shall be drawn up together ensuring that there shall not be any disturbance to the sample which shall then be protected from changes in moisture content.

c) Undisturbed Sampling in Cohesionless Soils

Undisturbed samples in cohesionless soils shall be obtained as per the procedure given in IS:8763. Compressed air sampler shall be used to take the samples of cohesionless soil below water table. Precautions shall be taken to clean the borehole before sampling. Thin walled tube samplers of 60mm internal diameter shall be used. The height and other dimensions of the sampler shall be recorded before use. Proper care shall be taken to maintain the water level in the bore hole slightly above the ground water table before and during sampling operations. Immediately after the sample is obtained, the ends of the sample shall be waxed and capped to avoid moisture content changes.



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6.3.4 Relaxation During Sampling

a) The sampler shall be pushed into the soil and driving of sampler shall be resorted to only when it cannot be pushed into the soil. This

shall be done only with the permission of the engineer-in-charge and all the details about the same shall be recorded in the bore logs.

b) In clays when 'N' value is greater than 50, the undisturbed sampling may be replaced by standard penetration test.

6.4 Ground Water

6.4.1 One of the following methods shall be adopted for determining the ground water table in bore holes as per IS:6935 and as per the instructions of the engineer-in-charge.

a) In permeable soils, the water level in borehole shall be allowed to stabilize after lowering it adequately by bailing. When water level inside the borehole is found to be stable, the depth of water level below ground level shall be measured. Stability of sides and bottom of the borehole shall be ensured at all times.

b) For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observation on the rise or fall of water level shall be made at each depth. The level at which neither a fall nor a rise is observed shall be considered as the water table elevation. This shall be established by three successive readings of water level taken at an interval of two hours.

6.4.2 In case any variation in the ground water level is observed in any specific boreholes then the water level in these bore holes shall be recorded daily during the course of field investigation. Levels in nearby wells, streams etc if any shall also be noted whenever these readings are taken. If so called for, observation wells shall be drilled for the purpose of long term studies on the fluctuation in ground water levels and pressure. Either stand pipe or piezometer shall be



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installed at the specified depths in the selected previously drilled bore holes or specially drilled bore holes for this purpose as per the specification and instructions of the engineer-in-charge. Daily water level readings shall be recorded immediately following the installation upto the time of leaving the site. At the end of field work, these installations shall be handed over in satisfactory working condition to the engineer-in-charge without disturbing their position so that the owner can continue further observations.

6.4.3

Stand pipes and piezometers shall consist of 19mm internal diameter rigid unplasticised (UPVC) tubing. All the joints in the tubing shall be made of coupling sleeves. The top of UPVC tubing shall be enclosed in a 75mm diameter galvanised steel pipe of 1.5m length having a galvanised steel screw cap with well greased threads and the caps shall be tightened such that it would be impossible to loosen by hand. The lower end of the pipe shall have four legs of 6mm thick and 100mm long and welded to have projection of 25mm. The pipe shall be sealed into the ground with cement grout so that it does not rotate. The top end of the pipe shall project about 300mm above ground level unless otherwise specified by the engineer-in-charge. The perforated tubing for the porous element shall be surrounded by a response zone of well graded sand from 500mm below to 150mm above the lower end of the stand pipe or piezometer and the bore hole above the response zone shall be back filled with natural soil or well graded sand.

a) Stand pipe

Stand pipes shall be installed to measure the water level in soils with high permeability such as sand and gravel. The stand pipe shall consist of a perforated tubing attached to the bottom of the UPVC tubing. The perforated tube shall be 150mm long having perforations of diameter not greater than 1mm.

b) Piezometers

Piezometers shall be installed to measure the pore pressures in soil with medium to low permeability. Piezometer shall consist of a



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porous filter attached to the bottom of the UPVC tubing. The filter shall be 300mm in length and shall be placed in the bore hole and sealed at top and bottom by grouting. Hydraulic piezometers with double line are to be used to remove the air trapped in the system.

6.4.4 Sub-Soil Water Samples

a) Sub-soil water samples shall be collected for carrying out chemical analysis. Representative samples of ground water shall be collected when it is first encountered in boreholes before the addition of water

to aid boring or drilling. Water samples shall not be collected when bentonite slurry or mud has been used for drilling operations. If water has been added for drilling purposes or if ground water has been diluted by surface rain water then the bore hole shall be dewatered and water be allowed to rise from which the sample may be taken.

b) The sampling apparatus shall be such that the water at the desired depth can be collected directly without any disturbance and any change in concentration of constituents like dissolved gases etc. Undue agitation shall be avoided. An ordinary suction pump with its suction end inserted upto the required depth in the borehole shall be used for this purpose.

c) The sample shall be collected in a clean vessel and allowed to settle so that the supernatural liquid can be poured into a clean well rinsed glass or polythene bottle. Sufficient quantity and number of samples shall be collected to carry out the chemical analysis and sent to a laboratory in airtight bottles with proper labelling. Chemical analysis of water samples shall include determination of pH value, turbidity, sulphate, carbonate, nitrate & chloride contents, presence of organic matter and suspended solids etc.

d) In some cases constituents may be mixed and analysed later as specified in the specific test methods. Chemical preservatives may be added to the sample for cases as specified in the test method/IS codes. This shall only be done if analysis cannot be conducted within an hour of collection and shall have the prior written permission and approval of the engineer-in-charge.



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6.5 In-situ Permeability Test

6.5.2 Pump-in-Test

6.7 Vane Shear Test

6.8 Static Cone Penetration Test

Static cone penetration test shall be conducted to know the soil stratification and to estimate the various physical and engineering properties of soil. The cone penetrometer shall be advanced by pushing and the static force required for unit penetration shall be determined. The test shall be conducted using a 200kN capacity mechanically operated equipment upto the specified depth or refusal whichever is earlier. For this test, 'refusal' means meeting a very hard strata which cannot be penetrated at the rate of at least 0.3cm/sec even when the equipment is loaded to its full capacity. The specification for the equipment and accessories required for performing the test, test procedure, field observation and reporting of results shall conform to IS : 4968, Part-III. At the ground level, preboring upto 0.5m depth shall be permitted if the overlying strata is very hard. No extra payment shall be made on account of this preboring. Continuous record of the penetration resistance shall be maintained.

6.9 Dynamic Cone Penetration Test

Dynamic cone penetration test shall be conducted using bentonite slurry by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or refusal whichever is earlier. Refusal shall be considered when the blow count exceeds 150 for 300mm penetration. The specification for the equipment and accessories required for performing the test, test procedure, field observations and reporting of results shall conform to IS:4968, Part-II. The driving system shall comprise of a 650N weight having a free fall of 0.75m. The cone



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shall be of 65mm diameter provided with vents for continuous flow of bentonite slurry through the cone and rods in order to avoid friction between the rods and soil. On completion of the test, the results shall be presented as a continuous record of number of blows required for every 300mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot.

6.10 Plate Load Test

6.10.1 Plate load test shall be conducted to determine the bearing capacity and load/settlement characteristics of soil at shallow depth by

loading a plane and levelled steel plate kept at the desired depth and measuring the settlement under different loads until a desired settlement takes place or failure occurs. The specification for equipment and accessories required for conducting the test, the test procedure, field observations and reporting of results etc shall conform to IS: 1888. The location and depth of the test shall be as given in the drawing or as indicated by the engineer-in-charge. Undisturbed tube samples as specified in clause 6.6.3 (b) shall be collected at 1m and 2.5m depths from the ground level for carrying out laboratory tests.

6.10.2 The size of pit shall not be less than five times the plate size and the depth shall be as specified. All provisions regarding excavation and visual examination of pit under clause 6.6.1 and 6.6.2 shall apply here also.

6.10.3 If the ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. Dewatering shall be at the cost of the contractor.

6.10.4 Unless otherwise specified the reaction method of loading shall be adopted. Settlement shall be recorded from dial gauges placed at four diametrically opposite ends of the test plate. The test plate shall be of 600mm x 600mm size and atleast 25mm thick. The bottom of the pit shall be levelled before placing the plate in position for conducting the test.



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- 6.10.5 A seating load of 7kN/sqm shall be applied and after the dial gauge readings are stabilized, the load shall be released and the initial readings of the dial gauges be recorded after they indicate constant reading. The load shall be increased in stages. These stages shall be 20, 40, 70, 100, 150, 200, 250, 300, 400, 500, 600 and 800kN per sqm or as directed by the engineer-in-charge. Under each loading stage, record of 'time vs settlement' shall be kept as specified in IS:1888.
- 6.10.6 In case of cohesive soils, each load increment shall be maintained until the settlement is less than 0.02mm/minute or 6 hours whichever is later. Dial gauge readings for settlement shall generally be taken at 1, 2.25, 4, 6.25, 9, 16, 25, 60, 90 and 120 minutes from the start of each stage of loading. Thereafter the readings shall be taken at hourly interval upto a further 4 hours and at two hours interval thereafter for another 6 hours.
- 6.10.7 Other than cohesive soils, each stage loading shall be maintained for a minimum duration of one hour or till the settlement rate reduces to 0.02mm/minute whichever is later. No extrapolation of settlement rate from periods less than one hour shall be permitted. The final loading shall be maintained for 24 hours. During unloading, reading of dial gauge shall be recorded for each stage of unloading.
- 6.10.8 Loading shall be carried out in stages as specified above till one of the following conditions occur.
- a) Failure of soil under the plate i.e. the settlement of the plate at constant load becomes progressive and reaches a value of 40 mm or more.
- b) Load intensity of 800 kN/sqm is reached without failure of the soil.
- 6.10.9 Backfilling of the pit shall be carried out as per the directions of the engineer-in-charge. Unless otherwise specified the excavated soil shall be used for this purpose.



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6.11 Cyclic Plate Load Test

This test shall be carried out to determine the dynamic soil properties required for the analysis of foundation subjected to dynamic loads. This test shall be conducted on similar lines as the ordinary plate load test with an addition that unloading shall also be done before each stage of loading. Test set up, load increment and maximum load intensity etc shall be as per clause 6.10.

- 6.11.1 After each stage of loading, the load shall be removed in a minimum of two stages and as directed by the engineer-in-charge. After each stage of reduction of load, dial gauge readings and settlements shall be taken for atleast one hour until the readings stabilize. Thereafter the next loading stage shall commence. Recording and analysis of test data shall be as per IS: 5249.

6.12 Field California Bearing Ratio Test

This test shall be carried out to obtain the properties of soil required for the design of roads. The equipments and accessories required for carrying out the test, test procedure, recording of observations and presentation of results shall conform to IS: 2720 part XXXI. The test locations and depth shall be as specified in the drawings or as directed by the engineer-in-charge.

6.13 Electrical Resistivity Test

This test shall be conducted to determine the electrical resistivity of soil required for designing safety grounding system for the entire power plant area. The specification for the equipments and other accessories required for performing the test, test procedure and reporting of field observations shall conform to IS:3043. The test shall be conducted using Wenner's four electrode method as specified in IS:1892, Appendix-B2. Unless otherwise specified, at each test location the test shall be conducted along two perpendicular lines parallel to the co-ordinate axes. On each line a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.5m upto a distance of 10m.



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6.14 Seismic Refraction Test

- 6.14.1 This test shall be carried out to establish the rock and soil profiles of varying density. The dynamic shear modulus of the soil shall also be obtained from the results of this test. The specification for the equipments and other accessories, procedure for carrying out the test, recording and analysis of results and their presentation shall conform to IS: 1892.
- 6.14.2 This test shall be carried out by inducing shock waves into the soil by striking a plate placed on the ground surface with a hammer. The shock waves shall be picked up through geophones placed on the ground surface at regular intervals in line with the plate along a straight line. The time elapsed before the waves reach the geophones shall be recorded to an accuracy of one millisecond or better.
- 6.14.3 The distance between the shock point and the geophones shall be increased to cover a wider area. Alternatively, multiple geophones shall be used simultaneously using multiple channel seismograph to record the arrival time and intensity of waves reaching the geophones. The spacing of geophones shall be 5m. As the distance between geophones and the shock producing point are increased, the time lapse for the waves passing through different underlying strata and reaching the geophone shall be recorded. The wave forms shall be recorded for each test using multiple channel seismograph.
- 6.14.4 The test shall be conducted along traverses in two orthogonal directions as specified in the drawing or as directed by the engineer-in-charge. During testing, proper care shall be taken to avoid disturbance caused due to the movement of vehicles or other working operations around the test location. The type of wave (compression or shear) shall be analysed properly using the data recorded during the test.



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6.15 Cross Hole Shear Test

This test shall be generally carried out in accordance with IS: 13372 to establish the dynamic elastic properties of soil and rock. In this test, the seismic waves are to be picked up in two adjacent receiver boreholes. The spacing of boreholes shall be determined so as to obtain good results. The boreholes shall be uncased in the portion carrying the geophones. However it should be kept filled with water or drilling mud in order to ensure perfect contact between the borehole wall and the geophone. In case of cased hole preferably a low velocity material such as a high impact PVC should be used for casing and it is essential that it should be well grouted behind in order to make an intimate contact with the soil. The charge shall be installed within the depth as specified and the waves shall be picked up from the geophones installed at required depths in receiver boreholes. Knowing the travel time from shot hole to receiver hole

and corresponding distance, the velocity of the waves is determined which enables to estimate dynamic elastic modulus, shear modulus and Poisson's ratio. In each receiver borehole multiple geophones shall be provided at 2m interval (with starting depth as 3m below ground level) to cover the depth and various strata as specified. Intensity of the waves shall be recorded by multiple channel seismograph.

6.16 Pressuremeter Test

6.16.1 This test shall be conducted in bore holes at desired depth to obtain the in-situ stress-strain characteristics and strength parameters of soil/rock layer by measuring the deformation of the probe at different pressures of the volume meter. The location and depth of the test shall be as given in the drawing or as per the directions of the engineer-in-charge.

6.16.2 All precautions shall be taken to ensure a smooth bore hole of required diameter with minimum disturbance to the surrounding soil. In soft, loose and sensitive soils, the bore hole shall be predrilled deeper than the testing depth for enough so that the cuttings settling at the bottom of the bore hole shall not interfere with the test.



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- 6.16.3 The equipment shall be calibrated for pressure losses (membrane correction/air calibration) and volume or radius changes (line calibration/thick wall rigid steel cylinder test) before starting of test and at regular intervals as per the manufacturer's specification.
- 6.16.4 Maximum value of pressure correction shall not be more than 50% of limit pressure. The total volume losses in the system shall not exceed 0.5% of the static probe volume per 100kPa. Volume correction may be neglected in soil if it is less than 0.1% of probe volume per 100 kPa.
- 6.16.5 The test shall be performed by expanding a cylindrical probe to obtain a pressure vs volume or pressure vs radius curve as specified in IS:1892. The probe may be of Ax, Bx or Nx size. However the size of the borehole shall be compatible to the size of pressuremeter probe. Hose pipe connecting the probe with the surface unit shall be of flexible tubing of single or coaxial type. The equipment should be able to reach a maximum pressure of 5000kPa for testing in soil and 8000kPa for testing in rock. The accuracy of measuring device shall be such that a change of 0.2% of static probe volume or 0.1% of probe radius is measurable as specified in IS:1892.
- 6.16.6 The probe shall be lowered down to the required depth as soon as the boring is completed so as to limit the expansion of soil due to release of stresses. The probe shall be held by a clamping device ensuring that it is not located at the interface of two different soil/rock layers.
- 6.16.7 The pressure shall be increased in at least 20 equal stages as directed by the engineer-in-charge. At each stage the pressure shall be maintained for a period of at least 60 seconds and volume reading shall be taken for 7 to 14 minutes. The volume of water sent into the probe during this period shall be measured upto an accuracy of 0.01cum. In case the water level in the volumemeter drops rapidly, it is necessary to close the volumemeter valve quickly so that the reservoir does not empty and allow air or gas into the tubing.



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6.16.8 The test shall be carried out in stages till one of the following conditions occur.

- a) The volume of the probe is doubled
- b) Ultimate failure of soil/rock occurs
- c) Load intensity of 5000kPa for soil and 8000kPa for rock is reached without failure.

6.16.9 If the shape of uncorrected pressure vs volume curve drastically varies from the ideal test curve, the test shall be repeated at no extra cost to the owner at a different depth as decided by the engineer-in-charge.

6.16.9 On completion of the test, all results mentioned in clause 9.2 shall be reported.

6.16.10

7.0 FIELD INVESTIGATION - ROCK

7.1 Rock Drilling

Drilling in rock shall be done at specified locations or as per the directions of the engineer-in-charge. Before commencing drilling, it shall be proved that characteristics of rock has been met with as mentioned in clause 6.1.1(b). The starting depth of drilling in rock as mentioned in clause 6.1.1(b) shall be certified by the engineer-in-charge. The portion drilled in rock shall be backfilled with 1part of cement : 3 part of sand (1:3) grout unless otherwise directed by the engineer-in-charge.

7.1.1 Equipment

- a) Core drilling shall be done by rotary motion using diamond bit. The feed or thrust to the drilling bit shall be actuated by hydraulic system. The rotary core drilling equipment and procedure for drilling shall conform to IS: 6926. The equipment shall be provided with necessary facilities to regulate the spindle speed, bit pressure and



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water pressure during core drilling to get a good core recovery.

b) Drilling shall be carried out with Nx size diamond tipped drill bits or impregnated diamond bits depending on the type of rock encountered. Double tube swivel core barrel of Type B conforming to IS: 6926 shall be used to ensure a good core recovery and to pick up cores from all layers of rock. Suitable core catchers shall be used to ensure continuous and good core recovery.

7.1.2 Procedure

a) The drilling fluid shall be clean water. Circulation of drilling fluid shall be started before the core barrel reaches the bottom of the hole to prevent cuttings or sludge from entering the core barrel at the start of coring. Drilling fluid shall be circulated continuously down the hollow rods and the sludge conveying the rock cuttings to the surface shall be collected.

b) When drilling through soft/weathered/fractured rock, water circulation must be reduced so as to avoid shattering/breaking of core.

c) The rotational speed of the bit (spindle speed), the amount of downward pressure applied on the bit (bit pressure) and water pressure shall be suitably adjusted and properly monitored so that the core is collected with least disturbance and to avoid shearing of the core from its base. Bit speed, bit pressure, water pressure for the type of bit for various rock types shall be as per Appendix A of IS:6926.

d) No drill run shall exceed 0.75m in length. This can be increased to 1.5m provided the core recovery observed is more than 80% in two successive 0.75m drill runs and on approval from the engineer-in-charge. If the core recovery is less than 20% then SPT shall be performed before commencing the next drill run as explained in clause 6.2.



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e) If at any time blocking of the bit or grinding of the core is observed, the core barrel shall be immediately withdrawn from the borehole regardless of the length of drill run completed.

7.1.3 Observations

a) The colour of return water at regular intervals, the depth at which any change of colour of return water is observed, the depth of occurrence and amount of flow of hot water if encountered shall be recorded.

b) The depths through which a uniform rate of penetration was maintained, the depth at which a marked change in rate of penetration or sudden fall of drill rod occurs, the depth at which any blockage of drill bit causing core loss if any etc shall be recorded.

c) Any heavy vibration or torque noticed during drilling should be recorded together with the depth of occurrence.

d) Special conditions like the depth at which grouting was done during drilling, presence of artesian conditions, loss of drilling fluid, observation of gas discharge with return water etc shall also be observed and recorded.

e) During drilling operation, observation on return water, rate of penetration etc shall be recorded in a proforma as given in IS: 5313, Appendix-A.

7.1.4 Core Samples

a) Core samples shall be extracted by the application of a continuous pressure at one end of the core with the barrel held horizontally without vibration. Friable cores shall be extracted from the barrel directly into a suitable sized half round plastic channel section. Care shall be taken to maintain the direction of extrusion of sample same as that while coring to avoid stress reversal.



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b) Immediately after withdrawal from the core barrel, the cores shall be placed in a tray and transferred into boxes specially prepared for the purpose. The boxes shall be made from seasoned timber or any other durable material and shall be indexed on top of the lid as per IS:4078. The cores shall be numbered serially and arranged in the boxes in a sequential order. The description of the core samples shall be recorded as per IS: 4464. Where no core is recovered, it shall be recorded as specified in the continuous record of core recovery and RQD in the corelog as per IS:11315, Part-II.

c) The basic information for the description of rocks shall cover
i) degree of weathering ii) discontinuity spacing iii) strength iv) colour v) grain size vi) structural condition, the mineralogy of the grains and cementing material vii) rock name, special features like major joint planes, features/laminations, faults etc.

7.2 Standard Penetration Test

The relevant hardness of rocks shall be tested in boreholes after every drill run of 0.75m in rock if core recovery observed is less than 20% or as directed by the engineer-in-charge. The testing

equipment and arrangement shall be conforming to IS: 2131. The number of blows for each 75mm penetration to a total penetration of 450mm shall be recorded. Penetration for every 50 blows shall be recorded and the test shall be stopped at a total of 100 blows.

7.3 Plate Load Test

The test shall be conducted as described under clause 6.10 for soil subject to the following changes.

The test plate shall be of size 45cm x 45cm and at least 25mm thick. The maximum load shall be 2500 kN/sqm to be applied in stages of 25, 50, 100,150,200, 300, 400, 600, 800, 1000, 1500, 2000 and 2500 kN per sqm. Under each load the time Vs settlement shall be recorded and plotted.

7.4 Pressuremeter Test



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This test shall be conducted as described under clause 6.16 for soil subject to the following changes. The test shall be carried out till one of the following condition occurs.

- a) The volume of the probe is doubled
- b) Ultimate failure of rock
- c) Load intensity of 8000 kN/sqm is reached without failure.

7.5 Cross Hole Shear Test

This test shall be conducted as described under clause 6.15 for soil.

7.6 Permeability Test

Permeability test shall be conducted in bed rock inside the bore hole by pumping in water under pressure to determine the percolation capacity of the rock strata. This test shall be conducted in uncased and ungrouted sections of the drill hole. Clear and clean water shall be used for the purpose of both drilling and testing. The specification for the equipments and other accessories, test procedure etc shall conform to IS: 5529, part-II. The length of the test section shall be either 1.5m or 3m as per field conditions and as

per the directions of the engineer-in-charge. The level of water table (if any) in the bore hole shall be recorded and the drill hole shall be cleaned before the start of the test. Depending upon the depth of the test section, single or double packer method shall be adopted. Care shall be taken to maintain water tightness of all the joints and connections during testing.

a) Single Packer method

This method shall be adopted when the bottom elevation of the test section is the same as the bottom of the drill hole. The packer shall be fixed at the top level of test section such that only the test section lies below the packer. Water shall then be pumped through a pipe into the test section under a required pressure and maintaining it till a constant quantity of water intake is observed. The amount of water percolating through the hole shall be recorded at every 5 minute interval. The test shall be repeated by increasing the pressure at



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regular intervals upto a pressure limit as specified in IS: 5529, part-II. The details and observations shall be recorded in a proforma as recommended in IS: 5529, part-II, Appendix-B.

b) Double Packer method

This method shall be adopted when the permeability of an isolated section inside a drill hole is to be determined. Packers shall be fixed both at the top and bottom of the test section such that their spacing is exactly equal to the length of the test section. The test shall then be conducted as specified in clause 7.6(a).

8.0 LABORATORY INVESTIGATION

8.1 Essential Requirements

a) All laboratory tests shall be conducted in an approved laboratory using approved apparatus complying with the requirements and specifications of Indian standards or other approved standards for this class of work. It shall be checked that the apparatus are in good working condition before starting the laboratory tests. Calibration of

all the instruments and their accessories shall be done carefully and precisely.

b) Depending on the type of sub strata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by a qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, rock and water samples as per relevant IS codes. One copy of all the laboratory test data records shall be submitted to the owner progressively every week. Laboratory tests shall be carried out concurrently with field investigation since initial laboratory test results could be useful in planning the later part of field work. **A schedule of laboratory tests shall be established by the contractor and the same shall be**



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submitted and got approved by the engineer-in-charge before starting of laboratory tests.

c) All samples whether undisturbed or disturbed shall be extracted, prepared and examined by a competent personnel properly trained and experienced in soil sampling, examination, testing and in using the apparatus as per the specified standards.

d) Undisturbed soil samples retained in liners or seamless tube samplers shall be taken out without causing any disturbance to the samples using suitably designed extruder just prior to actual testing. If the extruder is horizontal, proper support shall be provided to prevent the sample from breaking. For screw type extruders the pushing head shall be free from the screw shaft so that no torque is applied to the soil sample in contact with the pushing head. For soft clay samples, the sample tube shall be cut by means of a high speed hacksaw to specified test length and placed over the mould before pushing the sample into it with a suitable piston.

e) While extracting a sample from a liner or tube care shall be taken to see that its direction of movement is the same as that during sampling to avoid stress reversal.

f) On all undisturbed soil samples tested for bulk density, water content, grain size distribution, liquid limit and plastic limit tests shall also be performed.

g) On all rock samples tested for unconfined compression test, bulk density and water content tests shall also be performed.

h) After completion of all tests, a summary of test results for each soil and rock sample shall be presented in a proforma as enclosed in **Annexure-A & B** respectively. Chemical test results on soil and water samples shall be furnished in a tabular form separately.



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8.2

Tests

Tests as indicated in this specification and as called for by the engineer-in-charge shall be conducted. The tests shall include the following.

a) Tests on Undisturbed and Disturbed Soil Samples

- Visual and engineering classification
- Sieve analysis and hydrometer analysis
- Liquid, plastic and shrinkage limits
- Specific gravity
- Chemical analysis
- Swell pressure and free swell index determination
- Proctor compaction
- California bearing ratio

b) Test on Undisturbed Soil Samples

- Bulk density and moisture content
- Relative density (for sand)
- Unconfined compression test
- Box shear test
- Triaxial shear tests (depending on the type of soil and field conditions on undisturbed or remoulded samples)
 - i) Unconsolidated undrained
 - ii) Consolidated undrained test with the measurement of pore water pressure



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iii) Consolidated drained

- One dimensional consolidation test

c) Test on Rock Samples

- Visual classification

- Water absorption, porosity and density

- Specific gravity

- Hardness

- Slake durability

- Unconfined compression test (both at saturated and at in-situ water content)

- Point load strength index

- Deformability test (both on saturated and dry samples)

c) Chemical Analysis of Sub-soil and Ground Water

8.3 Salient Test Requirements

a) Remoulded soil specimen whenever desired shall be fully reworked at field density and natural moisture content. For conducting CBR test and triaxial test for dyke/road material the sample shall be remoulded to 95% of standard proctor density.

b) Triaxial shear test shall be conducted on undisturbed soil samples saturated by the application of backpressure. Only if the water table is at sufficient depth such that chances of its rising to the base of the



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footing are meagre or nil, the triaxial tests shall be performed on the specimens at natural moisture content. Each test shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300kN/sqm or as required depending on the soil conditions.

c) Effective stress triaxial shear test shall be consolidated undrained with pore water pressure measurement. The test shall be conducted at cell pressures of 100, 200 and 300kN/sqm ensuring complete consolidation at each stage.

d) Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300 kN/sqm or as required depending on the soil conditions.

e) Consolidation test shall have loading stages of 10, 25, 50, 75, 100, 200, 400 and 800 kN/sqm. Rebound curve shall be recorded for all the samples by unloading the specimen at the in-situ stress of the specimen. Additional rebound curves shall also be recorded whenever desired by the engineer-in-charge.

f) Chemical analysis of sub-soil shall include determination of pH value, carbonate, sulphate (both S03 and S04), chloride and nitrate contents, organic matter, salinity and any other chemicals harmful to the foundation material. The contents in soil shall be indicated as percentage.

g) Chemical analysis of sub-soil water sample shall include the determination of the properties such as colour, odour, turbidity, pH value and chemical contents such as carbonate, sulphate (both S03 and S04), chloride, nitrate, organic matter and any other chemicals harmful to the foundation material. The contents such as sulphate etc shall be indicated as ppm by weight.

h) The laboratory CBR test shall be performed on undisturbed or on remoulded sample as per the drawing or as directed by the engineer-in-charge in soaked and unsoaked conditions.



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9.0 REPORT

9.1 General

a) On completion of all the field and laboratory works, the contractor shall submit a draft report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include detailed borelogs, sub-soil sections, field test results, laboratory observations and test results in both tabular as well as graphical forms, practical and theoretical considerations for the interpretation of test results, the supporting calculations for the conclusions drawn etc. Initially, the contractor shall submit three copies of the report in draft form for the owner's review.

b) After review of the draft report, the employer's comments will be intimated to the contractor. The contractor shall incorporate the comments and after getting the amended draft report approved, five copies of the detailed final report shall be submitted alongwith one set of reproducible of the graphs, tables etc. Any expenditure on account of redrafting, finalising the report etc shall be deemed to have been included in the quoted rates.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical

considerations for foundation of different type of structures envisaged in the area under investigation. The contractor shall acquaint himself about the type of structures, foundation loads and other information required from the engineer-in-charge.



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9.2 Data to be Furnished

The report shall also include but not be limited to the following.

- a) A plot plan showing the location and reduced levels of all field tests e.g. bore holes, trial pits, plate load tests etc properly drawn to scale and dimensioned with reference to the established grid lines.
- b) Geological information of the area such as geomorphology, geological structure, lithology, stratigraphy and tectonic faults, seismicity of the region and site, core recovery and rock quality designation etc.
- c) Past observations and historical data if available for the area or for other areas with similar soil profile for similar structures in the surrounding areas.
- d) A true cross section of all individual boreholes and trial pits with reduced levels and co-ordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum if met with.
- e) A set of longitudinal and transverse soil/rock profiles connecting various bore holes in order to give a clear picture of the variation of the subsoil strata as per IS: 6065.
- f) Water level contours and rock level contours
- g) Plot of standard penetration test 'N' values (both uncorrected and corrected) with depth for identified areas.
- i) Results of all field tests in tabular as well as in graphical forms.
- i) Results of all laboratory tests summarised (i) for each sample as well as (ii) a consolidated table giving the layer-wise soil and rock properties . All the relevant charts, tables, graphs, figures, supporting



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calculations, conclusions and photographs of representative rock cores and trial pits shall be furnished.

j) For all triaxial shear tests, stress vs strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elasticity 'E' shall be furnished for all tests along with relevant calculations.

k) For all consolidation tests the following curves shall be furnished.

e vs log P

e vs P and

Compression vs log t or square root of t (depending upon shape of the plot for proper determination of coefficient of consolidation)

The point showing initial condition (e_0 , P_0) of the soil shall be marked on the curves.

l) Values of compression index, coefficient of volume compressibility etc shall be furnished. The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlement if significant shall also be calculated.

m) For pressuremeter tests, the following shall be furnished.

Calibration record including description of membrane and sheath on probes, dimensions of thick walled cylinder, length of flexible tubing, calibration curves and temperature etc.

Drilling record including borehole number, method of making borehole, log with soil type and condition, depth of water table in the borehole, weather and temperature etc.

Test record including type of test, date and time, depth of centre point of probe, volume readings at 30 and 60 second elapsed time and



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corresponding pressure readings and notes on any deviation from standard test procedure etc.

Field pressuremeter, creep and air calibration curves indicating P_o , P_f and P_l . Corrected pressuremeter and creep curves indicating P_o , P_f , P_l along with calculation for the corrections.

n) Values of cohesion, angle of internal friction, pressuremeter modulus, shear modulus and co-efficient of sub-grade reaction along with sample calculations. Calculation for allowable bearing pressures and corresponding total settlements for shallow foundations and load carrying capacity calculation of piles in various modes etc.

o) Analysis and discussion of test results.

9.3 Recommendations

Recommendations shall be given areawise duly considering the type of soil/rock, structure, foundation type and ground water table etc in the area. The recommendations shall include but not be limited to the following.

- a) Type of foundation to be adopted for various structures duly considering the sub strata characteristics, water table, total settlement permissible for the structures and equipments, minimum depth and width of foundation etc.
- b) For shallow foundations the following shall be indicated with comprehensive supporting calculations.
- j) Net safe bearing pressure for isolated square/rectangular footings and continuous strip footings of sizes 1, 2, 3, 4 & 5m at different founding depths of 1, 2, 3, 4 & 5m below ground level considering both shear failure and settlement criteria giving reasons for the type of shear failure adopted in the calculation.



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ii) Net safe bearing pressure for raft foundation of widths greater than 6m at 2 , 3, 4 & 5m below ground level considering both shear failure and settlement criteria.

iii) Modulus of sub-grade reaction and modulus of elasticity from plate load test results along with time-settlement curves and load-settlement curves in both natural and log-log graph.

c) If piling is envisaged the following shall be furnished with comprehensive supporting calculations.

i) Type of pile and reasons for recommending the same duly considering the sub strata characteristics.

ii) Suitable founding strata for the pile.

iii) Estimated length of pile for 500 kN (400mm dia.), 750kN (450mm dia.), 1000kN (500mm dia.) and 4500kN (1070mm dia.) capacities. End bearing and frictional resistance shall be indicated separately. Safe lateral and tensile load carrying capacities of pile with supporting calculations.

iv) Magnitude of negative skin friction if any.

d) Coefficient of permeability of various sub-soil and rock strata based on in-situ permeability tests.

e) Cone resistance, frictional resistance, total resistance and settlement analysis for different size of foundations.

f) Electrical resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curves.

g) Dynamic soil properties such as dynamic shear modulus and Poisson's ratio etc from cross-hole shear and seismic refraction tests and coefficient of elastic uniform compression from cyclic plate load tests.



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h) Suitability of the soil for construction of roads and embankments, their stable slopes for shallow and deep excavations, active and passive earth pressures, earth pressure at rest and modulus of elasticity as a function of depths for the design of underground structures etc.

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

j) If expansive soil is met with, then recommendation on removal or retainment of the same under the structures/roads etc shall be given. In the latter case, detailed specifications of any special treatment required including specification for materials to be used, construction method, equipments to be deployed etc shall be furnished.

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

l) Susceptibility of sub soil strata to liquefaction in the event of earthquake. If so, recommendation for remedial measures.

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

n) Description of measures required for erosion control.

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



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10.0 RATES & MEASUREMENTS

10.1 RATES

a) The item of work in the schedule of quantities describes the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rates shall include all the activities covered in the description of the items as well as for all necessary operations in details described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way (e.g. location and depth of tests, number of tests etc) from those shown on the tender drawings.

c) The unit rates quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidders quoted rates shall be inclusive of providing all equipments, men, materials, skilled and unskilled labours, making observations, establishing the ground level and coordinates at location of each bore hole, test pit etc by carrying levels from one established bench mark and distances from one set of grid lines furnished by the engineer-in-charge. Also no extra payments shall be made for conducting the standard penetration tests, collection, packing and transportation of all the samples and cores, recording of all results and submitting them in approved formats etc.

d) The quoted rates for trial pits/plate load tests/ cyclic plate load tests shall be inclusive of dewatering and backfilling etc.



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e) The quoted rates for drilling in rock shall satisfy the requirements as furnished in specification.

f) The rates quoted for conducting pump out test shall be inclusive of boring a well of 400mm diameter, providing and installation of perforated GI/MS pipes and observation pipes etc .

g)The rates quoted for conducting cross hole shear test shall be inclusive of necessary boring, providing PVC pipes, grouting, geo-phones, backfilling the holes after completion of testing etc.

h)The rates quoted for laboratory tests shall include preparation of samples, performing tests, recording, analysis and submission of data etc.

i) The bidder shall submit a scheme showing the arrangement and equipment proposed to be used for conducting the site work along with rates. However the minimum number of staff and equipments to be deployed/mobilised for site works shall be as per **Annexure-C & D** respectively.

10.2 MEASUREMENTS

a) All measurements shall be in SI Units.

b) Length shall be measured in metres (m) correct to two places of decimals. Areas shall be worked out in square meters(Sqm) and volume in cubic meters(Cum) rounded off to two decimals.

c) Certain tests have to be conducted in the bore holes and trial pits etc. Such bore holes and trails pits etc shall be measured once only and not again just because the tests are conducted therein.

d) The depth of penetration due to SPT at the bottom of bore hole shall not be considered for the measurement of bore hole depth.

e) Pits shall be measured in Cum.



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f) Coring in rock with diamond bit shall be measured in length(metre) correct to two places of decimal for the actual cored length satisfying the criteria of specification.



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ANNEXURE-A

SUMMARY OF LABORATORY TEST RESULTS
ON SOIL SAMPLES

IN EXCEL SHEET



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ANNEXURE-B

SUMMARY OF LABORATORY TEST RESULTS
ON ROCK CORE SAMPLES

BORE HOLE NO.	
DEPTH	
CORE PIECE NO.	
MOISTURE CONTENT	
SPECIFIC GRAVITY	
HARDNESS	
POROSITY	
DRY DENSITY	
SLAKE DURABILITY	
POINT LOAD STRENGTH INDEX	
DEFORMABILITY (DRY /SATURATED)	
UNCONFINED COMPRESSIVE STRENGTH (INSITU/SATURATED)	
CORE DESCRIPTION	
REMARKS	



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ANNEXURE-C

MINIMUM STAFF TO BE DEPLOYED

<u>S.No.</u>	<u>Description</u>	<u>No. of persons</u>
1.	Geotechnical Engineer	
2.	Engineering Geologist	
3.	Supervisor	
4.	Qualified Surveyor	
5.	Rig Operators	
6.	Mechanic	



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ANNEXURE-D

LIST OF EQUIPMENTS TO BE MOBILISED TO SITE (MINIMUM)

<u>S.No.</u>	<u>Description</u>	<u>Quantity</u>
1	Shell and auger boring set	
2.	Rotary core drilling unit (Hydraulic feed)	
3.	Dynamic cone penetration test equipment	
4.	Plate load test set up	
5.	Field permeability test set up	
6.	Menard pressuremeter or equivalent set up with limit pressure of 80kg/sq.cm.	
7.	Seismic refraction test set up	
8.	Electrical resistivity test set up	

Note:

Additional equipments shall be mobilized if required as per the directions of the engineer-in-charge to match the work schedule.



**STANDARD SPECIFICATION
FOR
GEOTECHNICAL INVESTIGATION OF
2 x 500 MW TUTICORIN THERMAL POWER STATION**

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ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

BORE HOLE/ TRIAL PIT NO.	DEPTH (m)	TYPE OF SAMPLE	DENSITY (kN/Cum)		PARTICLE SIZE (%)				ATTERBERG'S LIMITS				SOIL			STRENGTH TEST			CONSOLIDATION TEST					SWELL TEST		COMPACTION TEST			REMARKS					
			BULK	DRY	(%)	GRAVEL	SAND	SILT	CLAY	LL	PL	PI	SL	IS CLASSIFICATION	DESCRIPTION	SPECIFIC GRAVITY	TYPE	C	ϕ	e_o	P_c	C_c	p	m_v	C_v	S.Pr	FSI	MDD		OMC	CBR	RELATIVE DENSITY	PERMEABILITY (m/hr)	

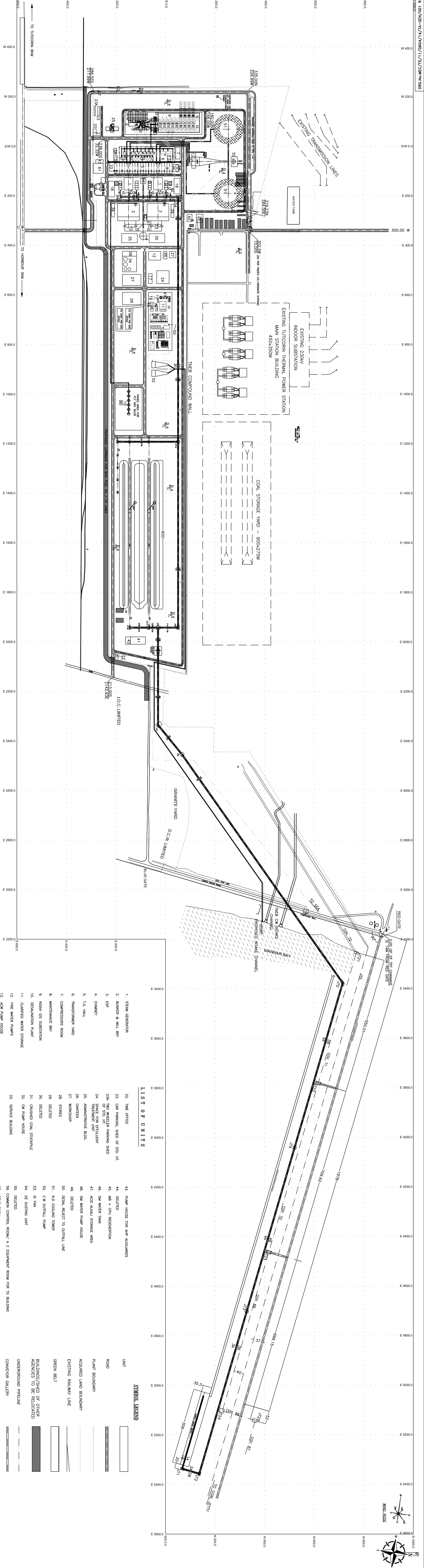
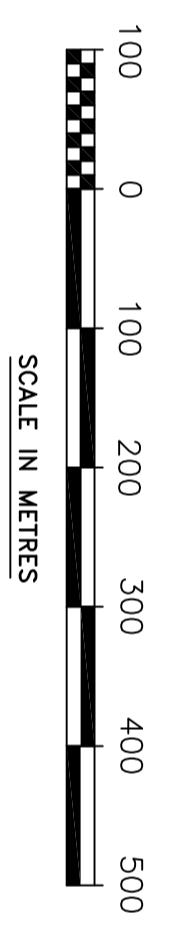
<p><u>For type of sample</u></p> <p>DS Disturbed soil sample UDS Undisturbed soil sample RMS Remoulded soil sample WS Water sample</p> <p><u>For strength test</u></p> <p>UCC Unconfined compression test VST Vane shear test Tuu Unconsolidated undrained triaxial test Tcu Consolidated Undrained Triaxial test with pore pressure Tcd Consolidated drained triaxial test (Note: Replace T by D for Direct Shear test)</p>	<p><u>For others tests</u></p> <p>LL Liquid Limit (%) PL Plastic Limit (%) PI Plasticity Index (%) SL Shrinkage limit (%) C Cohesion (kN/Sq.m) ϕ Angle of internal friction (degrees) S.Pr Swelling pressure (kN/Sq.m) FSI Free swell index (%) e_o Initial Void ratio P_c Preconsolidation pressure (kN/Sq.m) C_c Compression index</p>	<p>p Pressure range (kN/Sq.m) m_v Coefficient of volume compressibility (Sq.m/kN) C_v Coefficient of consolidation (Sq.m/hr) MDD Maximum Dry Density (kN/Cum) OMC Optimum moisture content (%) CBR California Bearing Ratio (%)</p>
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NOTES

1. THE COMPLETION OF THIS CONCEPT DESIGN WITH RESPECT TO THE EXISTING INFRASTRUCTURE IS ESTABLISHED AS FOLLOWS:
2. THE CONCEPT DESIGN IS BASED ON THE DATA PROVIDED BY THE CLIENT.
3. ALSO REFER TO THE ATTACHED DOCUMENTS FOR THE DETAILED DESIGN OF THE PLANT.
4. DESIGN SHALL BE IN ACCORDANCE WITH THE APPLICABLE STANDARDS AND REGULATIONS.
5. PROVISION OF ALL NECESSARY SERVICES AND UTILITIES SHALL BE THE RESPONSIBILITY OF THE CLIENT.

AS ON 01.11.2008

FOR TENDER PURPOSE ONLY



LIST OF UNITS

- | | |
|-------------------------------------|-------------------------------|
| 1. STEAM GENERATOR | 22. FINE OFFICE |
| 2. BOILER & MILL BAY | 23. OIL ROOM, SHED OF SH. HT. |
| 3. ESP | 24. OIL WASTE TREATMENT |
| 4. CONDENSER | 25. FRESH WATER TREATMENT |
| 5. T.C. HALL | 26. ADMINISTRATION BLDG. |
| 6. TRANSFORMER BAY | 27. CONTROL |
| 7. COMPRESSOR ROOM | 28. STORES |
| 8. MAINTENANCE BAY | 29. DELETED |
| 9. COOLING WATER SUBSTATION | 30. DELETED |
| 10. DECONTAMINATION PLANT | 31. CHILLED COAL STORAGE |
| 11. CHILLED WATER STORAGE | 32. CW PUMP HOUSE |
| 12. FRESH WATER PUMPS | 33. SERVICE BUILDING |
| 13. ACP PUMP HOUSE | 34. FUEL OIL TANK |
| 14. WB UNIT FILL PUMP & TANK | 35. F.S.O. (FUELING) |
| 15. WB UNIT | 36. F.O. PUMP HOUSE |
| 16. INTERMEDIATION HT | 37. 1/2 CONDENSATION PLANT |
| 17. GUARD FENCE | 38. CC ROOM |
| 18. COMPRESSOR FOR SHY AIR HANDLING | 39. ESP CONTROL ROOM |
| 19. ASH SLIPS-RTV & BOTTOMS | 40. FIRE STATION |
| 20. DELETED | 41. COAL HANDLING PLANT |
| 21. SECURITY OFFICE | 42. OMP MCC ROOM |

NO.	DESCRIPTION	REVISION	DATE	BY	CHKD
1	23500 MW THERMAL POWER PLANT GENERAL LAYOUT				
2					
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41					
42					

SECTION	CLIENT	NO. OF SHEETS	TOTAL SHEETS
DESIGNED	K.GOPALAN	1	1
CHECKED	K.GOPALAN	1	1
APPROVED	K.GOPALAN	1	1

MECON LIMITED

NICTAMILL NADU POWER LIMITED

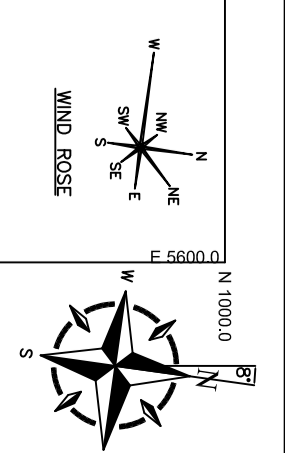
23500 MW THERMAL POWER PLANT AT TUTHOZH

GENERAL LAYOUT

SCALE: AS SHOWN

DRAWN: MECHS/10064/11/AC/SHW/1

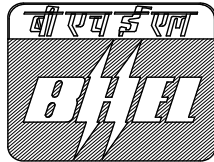
SHEET REV 1 OF 1



BHARAT HEAVY ELECTRICALS LTD

**STANDARD SPECIFICATION
FOR
TOPO GRAPHICAL SURVEY OF
2 x 500 MW TUTICORIN THERMAL POWER STATION**

SPECIFICATION NO. PE-TS-G47-603-002



JANUARY, 2009

**PROJECT ENGINEERING MANAGEMENT
POWER SECTOR, PPEI BUILDING
PLOT NO. 25, SECTOR-16A, NOIDA (U.P.)-201301**



**STANDARD SPECIFICATION FOR
TOPOGRAPHICAL SURVEY OF
2 x 500 MW TUTICORIN THERMAL
POWER STATION**

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**STANDARD SPECIFICATION
FOR
TOPOGRAPHICAL SURVEY**

1.0 GENERAL

1.1 This specification covers the technical requirements for carrying out “**Topographical Survey and Allied Works**” for the entire area/areas indicated for locating the power plant and its other systems. The work shall be executed in accordance with the specification and good standard of practice necessary to fulfil the objectives of the survey work strictly in accordance with the instruction and satisfaction of the engineer-in-charge.

2.0 SCOPE

2.1 The scope of work includes the following.

2.1.1 Carrying out topographical survey and preparation of plans (maps) and report of the entire area/areas indicated for locating the power plant and its other systems.

2.1.2 Carrying out bench mark (GTS / any other reference bench mark approved by the engineer-in-charge) to site/sites under survey by parallel levelling, establishing and constructing bench mark, grid and reference pillars in the field.

2.1.3 Spot level survey of the entire area/areas at specified intervals and development of contours.

2.1.4 Carrying out cross-section of canal/nallah as specified in the schedule of quantities by taking spot levels at 5m interval or less depending upon the site conditions and instructions of the engineer-in-charge.

2.1.5 Providing survey instruments, construction equipments, tools & plants, materials, labours, qualified surveyors, clearance of jungles, cutting of trees, earth work, scaffoldings, transport, supervision by competent engineers/surveyors, testing of materials, full insurance and all other incidental items as may be necessary for successful completion of the surveying , mapping and construction works etc.



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- 2.1.6 Furnishing all field data and drawings on floppies apart from hard copies.
- 2.1.7 Furnishing survey report as described in details in the succeeding paragraphs is also included in the scope of work.

3.0 TENDER DRAWING

- 3.1 The enclosed vicinity General Layout (**Drg. No. MEC/TS/11/Q6G4/14/TA-GEN/001 Rev 6**) indicate the tentative location of the area/areas to be surveyed for locating the project. The location/area(s) indicated in the drawing is subject to change that may be necessary during actual execution of the work. The work shall be carried out as per the instructions of the engineer-in-charge.
- 3.2 The bidder must visit the site prior to submitting his quotations to acquaint himself fully with the nature, type, scope of work and involvement therein. The rates quoted shall remain firm during the entire period of execution till completion of the work and any additional claim for lack of knowledge shall not be entertained.

4.0 SPECIFICATION

- 4.1 The work shall be executed according to the specification and good standard of practice necessary to fulfil the objectives of the survey work strictly in accordance with the instruction and satisfaction of the engineer-in-charge.
- 4.2 The specification shall be read in conjunction with the description of items in the schedule of quantities. The bidder shall refer to the employer for any discrepancy which may exist between the drawings, specification and corresponding items of the schedule for clarification before submission of quotation and the employer's decision as to the clarity of the point raised shall be final and binding on the bidder.
- 4.3 The work at site shall be carried out under the full time supervision by a qualified engineer or a senior surveyor. The engineer or senior surveyor shall be responsible for and capable of co-ordinating the work of the surveying teams, setting out the work accurately, identifying immediately and positively the type of instruments to be deployed and the



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methodology of surveying to achieve speed and accuracy in the work and shall be fully conversant with the theory and techniques of traversing, triangulation, spot levelling survey work etc covered by this contract.

4.4 The contractor shall be responsible for the proper execution of the work to such lines and grades as specified in the specification, drawings or as directed by the engineer-in-charge from time to time.

4.5 After arrival of the instruments to site, these shall not be moved out of the site by the contractor without the prior written permission and approval of the engineer-in-charge. In case the instruments are moved out of the site without the prior written permission and approval, the engineer-in-charge/owner reserves the right to deduct from the contractor's bill(s) the amount as considered reasonable and or to withhold the payments for the work done. The decision of the engineer-in-charge in this regard shall be final and binding on the contractor.

5.0 CARRYING OUT AND SETTING UP OF BENCH MARK & REFERENCE PILLARS

5.1 The contractor shall carry out bench mark by fly-levelling from the nearest GTS bench mark or available source as approved by the engineer-in-charge and establish the same on a permanent bench mark to be constructed as per **Fig.1** at a convenient location(s) at site as per the instructions of the engineer-in-charge. All subsequent transfer of levels shall be carried out with respect to this bench mark.

5.2 The work shall also include constructing permanent reference pillars as per **Fig.2** at suitable locations as approved by the engineer-in-charge. These reference pillars shall be labelled permanently with their respective co-ordinates and reduced levels for future use. The bench mark and reference pillars shall be shown on the survey drawings.

5.3 The fly levelling should be carried out using two good quality levels simultaneously. The levelling instruments should always be kept free of collimation error which should be checked and adjusted before start of the work every day. A record of adjustments should be kept in the field book.



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5.4 While carrying bench mark to the project site, levels shall be established on the permanent objects like culverts etc at least on one object in every 500m along the route with adequate description about the objects and levels to be mentioned in the level book/survey report to facilitate locating these objects later on. The route for transferring levels shall follow the existing roads as far as possible and this route shall require the approval of the engineer-in-charge before the commencement of work.

5.5 Closing error in levelling should be limited to $12 \sqrt{L}$ mm, where L is the length of the route in km.

5.6 Payment shall be made on the basis of shortest length of the said route measured between the original reference bench mark and the bench mark to be established at site.

6.0 TOPOGRAPHICAL SURVEY AND MAPPING

6.1 Positions both in plan and elevation of all natural and artificial features of the area like waterways, railway tracks, trees, cultivation, houses/any structure, fences, pucca and kutcha roads including culverts and crossings, foot tracks, other permanent objects like telephone posts and transmission towers etc are to be established and subsequently be shown on survey maps by means of conventional symbols (preferably symbols of Survey of India maps). All earth deposits, depressions, hills and valleys within the area/areas are to be surveyed and plotted on maps by contours. Necessary levelling work of the entire area/ areas are to be surveyed and plotted on maps by establishing horizontal location so that location and sketching of contours for the area/ areas can be done at specified intervals and in specified scales on maps. In case of steep slopes and dense jungle etc where gridding is not possible, the method of survey, contour intervals etc shall be decided by the engineer-in-charge at site. Any unusual condition or formations on the ground, location of rock outcrops and springs/falls etc shall also be noted and plotted on the maps.

6.2 The field work shall be done with total station equipment in the following steps.

- i) Establishing horizontal and vertical controls and locating reference grids and bench mark in the area.



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ii) Surveying for establishing spot levels and plotting contours.

iii) Surveying for locating natural and man made details as described earlier.

6.3 The grids for the survey work shall be established in N-S & E-W direction corresponding to magnetic north or the plant north as directed by the engineer-in-charge.

7.0 TRAVERSING

7.1 Triangulation or traversing or a combination of both shall be adopted for the purpose of establishing horizontal control and in order to determine the exact relationship between various existing points on the ground so that surveys required under the present scope of work and in future may be co-related and tied together.

7.2 Total intelligent station instruments should be deployed to achieve the specified accuracy of the work. Proper precautions for avoiding graduation errors, instrumental and personal errors should be scrupulously observed.

7.3 From main traverse/triangulation station, subsidiary stations shall be established at suitable interval to cover the entire area. Level of these stations shall be based on the bench mark established in the survey area. Occupying the main & subsidiary stations, all major details shall be surveyed by total station equipment. Further classification of details if necessary shall be carried out by plane table method.

7.4 The closing error in traverse shall not exceed one in twenty five thousand (1 in 25000) in terms of length or $L\sqrt{N}$ seconds (total in angular measurement) whichever is less (where L is the least count of the instrument and N is the number of stations).

8.0 CONTOURING

8.1 Contractor shall carry out spot level surveying at an interval of 25m for contouring the area/areas. Levels shall also be taken on all traverse stations and on salient points located at random over the area (ground points). Contours are to be interpolated at 0.5m intervals after the above



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points are plotted. The contours shall not be just interpolated but properly surveyed on the ground so that features falling between the two successive levels are also picked up. Sufficient points properly distributed over the entire area shall be located and levels taken so that accurate contouring can be done. At places of sharp curvature or abrupt change in direction and elevation, points selected shall be close to each other. Salient points on ridge lines and valley lines shall also be measured.

8.2 Cross-section of canal/nallah if any shall be prepared by taking spot levels at 5m interval or less depending upon the site conditions and instructions of the engineer-in-charge. For contouring within reservoirs /ponds sounding technique shall be adopted.

8.3 Levelling operation shall always start from main/subsidiary stations whose levels are based on the bench mark established in the survey area and end on the same.

8.4 Closing error in levelling shall not exceed the limit mentioned in clause 5.5.

9.0 CONSTRUCTION OF BENCH MARK, REFERENCE & GRID PILLARS

9.1 Bench marks shall be constructed as per the sketch at **Fig - 1** for each isolated area as per the directions of the engineer-in-charge. The reduced level of the top of hemispherical ball and co-ordinates with respect to survey grid shall be engraved clearly on the top of the bench mark pillar. The top surface of MS plate alongwith the hemispherical ball shall be painted with anticorrosive paint.

9.2 There shall be one reference pillar constructed within one meter of each bench mark pillar as per the sketch at **Fig - 2**. The relation of these pillars with respect to the bench mark pillar and survey grids should be established and indicated in the drawings. The reduced levels and co-ordinates should be transferred & punched on the top of the steel plate of reference pillars. The top surface of MS plate shall be painted with anticorrosive paint.



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9.3 Grid pillars as per the enclosed sketch at **Fig - 2** shall be constructed at the intersection of the 200m grid lines which should be established at site in N-S and E-W direction corresponding to magnetic north or plant north or as directed by the engineer-in-charge and their co-ordinates with reference to the survey grids shall be engraved on the top of the pillars. The top surface of MS plate shall be painted with anticorrosive paint. The pillars should be white washed.

9.4 The payment shall be made on the number of bench mark and reference/grid pillars actually constructed at site as per the directions of the engineer-in-charge.

10.0 PROGRESS REPORT

10.1 The contractor shall prepare and submit progress report in three copies every week to the engineer-in-charge without fail indicating status of setting out of the grids, total area surveyed, grid pillars constructed, methodology adopted for surveying and instruments deployed including staff working on the site and difficulties encountered during execution of the work etc.

10.2 The submission of such reports and review thereof by the engineer-in-charge shall not be deemed to absolve the contractor of his responsibility of timely completion of the assignment as per the time schedule indicated.

11.0 PREPARATION & SUBMISSION OF SURVEY MAPS

11.1 The contractor shall submit survey maps of the site in 1:1000 scale indicating grid lines and contour lines, demarcating all permanent features like roads, railways, waterways, buildings, power lines, natural streams, trees etc. Project area should have two originals, one showing spot levels and contours (with contour line interval of 0.5m) with grid lines and other with grid lines, contour lines and permanent features.

11.2 All the maps should be prepared in digitised forms using Inkjet/Pen plotter and standard computer software like Autocad - 12/13/14 or auto civil on standard A-0 size polyester base film. The block of name plate of all the drawings should be as per BHEL standard.



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11.3 The contractor shall submit three copies of all the maps for review and approval of the engineer-in-charge. After approval, 6(six) prints of all the final maps alongwith a set of the originals on polyester base film and a floppy shall be submitted. Copies of the maps shall be submitted in proper flappers and original polyester base drawings should be handed over in proper card board covers indicating index of drawings.

11.4 Payment shall be made on the area actually surveyed as covered by the plan.

12.0 SUBMISSION OF FIELD DATA AND REPORT

12.1 Contractor shall submit all data pertaining to the survey in original to the engineer-in-charge.

12.2 All field data shall be submitted to the engineer-in-charge from time to time as per progress of the work.

12.3 Three copies of draft report shall be submitted on the completion of the field work for review and approval of the engineer-in-charge. The report should give the introduction of the site, methodology adopted for surveying the areas, calculation of errors, transfer of bench mark and any other calculation required for surveying and preparation of the survey maps.

12.4 Details of trees with their name, numbers and girths shall also form part of the survey report.

12.5 The survey report should also cover the following.

- General site observation such as location of access roads, river and nallah courses, irrigation canals etc.
- Presence of any well and /or tube well in the site and water level in them shall also be indicated.
- Whether there is any rock outcrops in the site.
- Existing drainage pattern of the site, possibility of water logging and high flood level of the area.

12.6 Final survey report shall be submitted in 6 copies of standard A4 size sheets properly bound and printed using good quality paper and material.



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13.0 CLEARANCE OF JUNGLES AND CUTTING OF TREES

Clearance of jungles and cutting of trees as required to facilitate the survey work also form part of the contract. Necessary permission of concerned public bodies shall be secured by the owner. The contractor shall ensure that minimum amount of jungles are cleared and trees are properly cut under the direction of public bodies. The trees and jungles as cleared shall be stacked and handed over to the engineer-in-charge/owner. No extra payment is admissible under this account.

14.0 INSPECTION

The contractor shall make all arrangements of men, material, instruments, surveyors, necessary records and field data etc at the work site for checking of the work to the satisfaction of the engineer-in-charge or his authorised representative during the progress and on successful completion of the work. The contractor shall intimate well in advance before final decamping from work site so that the final work can be inspected by the engineer-in-charge. This will form a part of acceptance of the work for release of payments.



STANDARD SPECIFICATION
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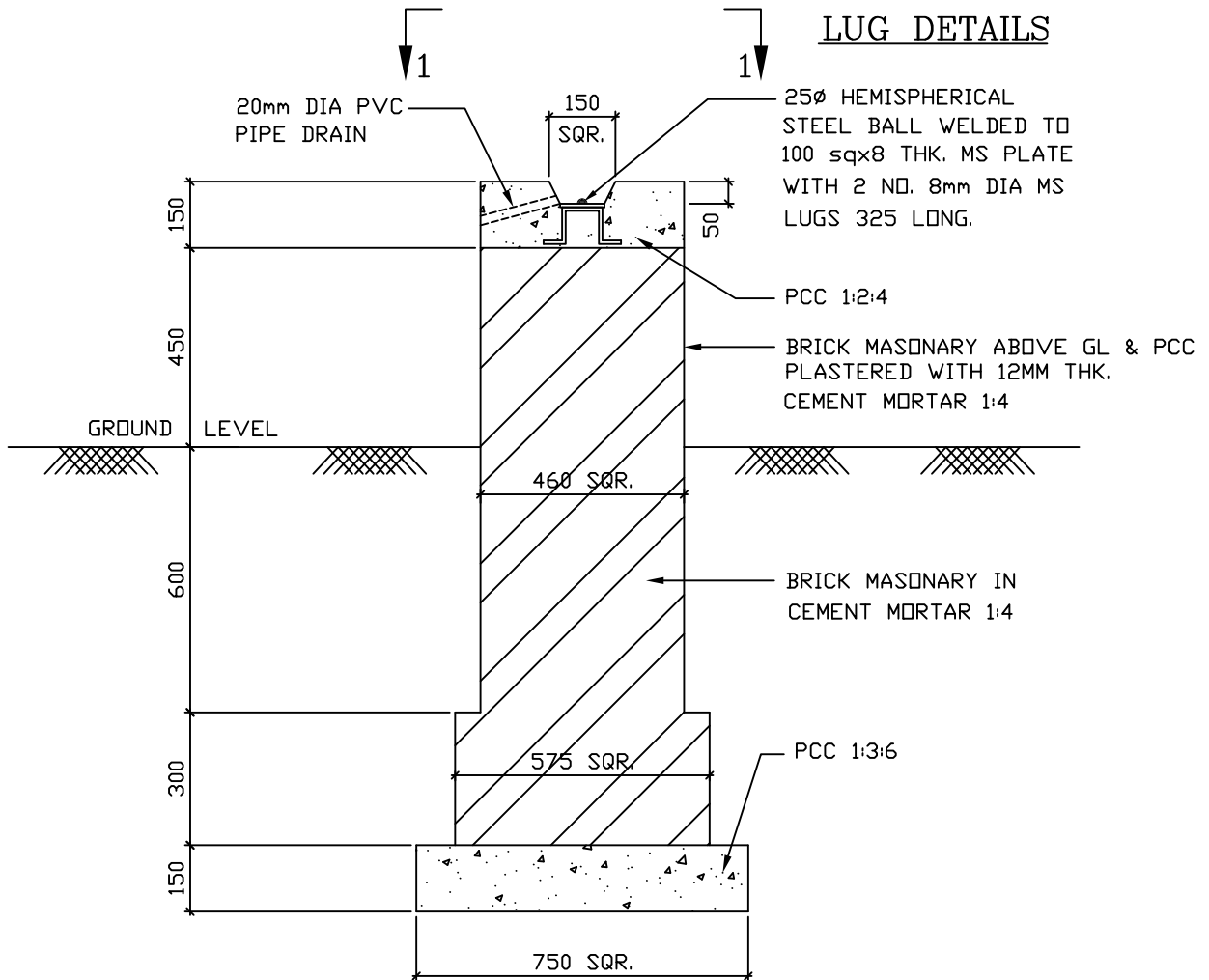
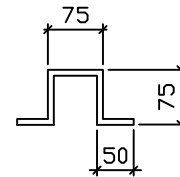
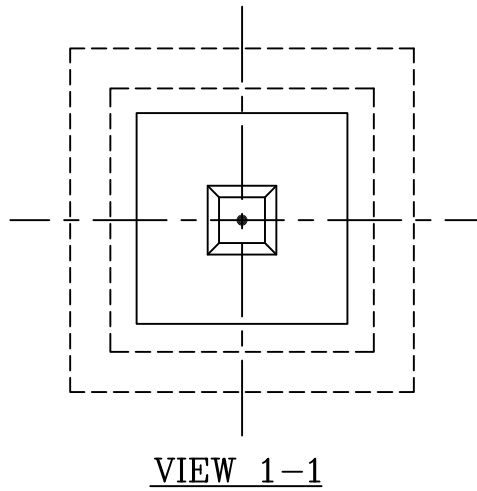


FIG. 1
BENCH MARK PILLAR

NOTES

1. ALL DIMENSIONS ARE IN MM
2. ALL MATERIALS AND WORKMANSHIP SHALL BE AS PER SPECIFICATION & RELEVANT IS CODES

DATE 17.01.2009

PREPARED BY: AKV

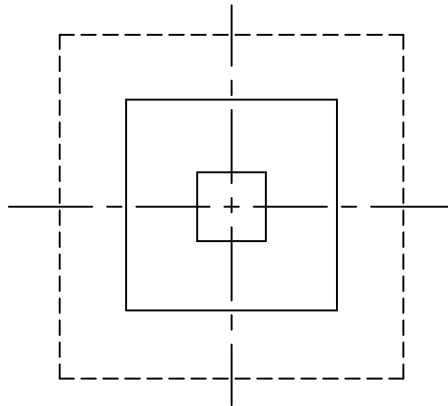
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APPROVED BY: KD

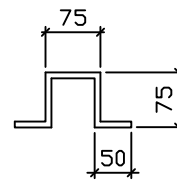


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VIEW 1-1



LUG DETAILS

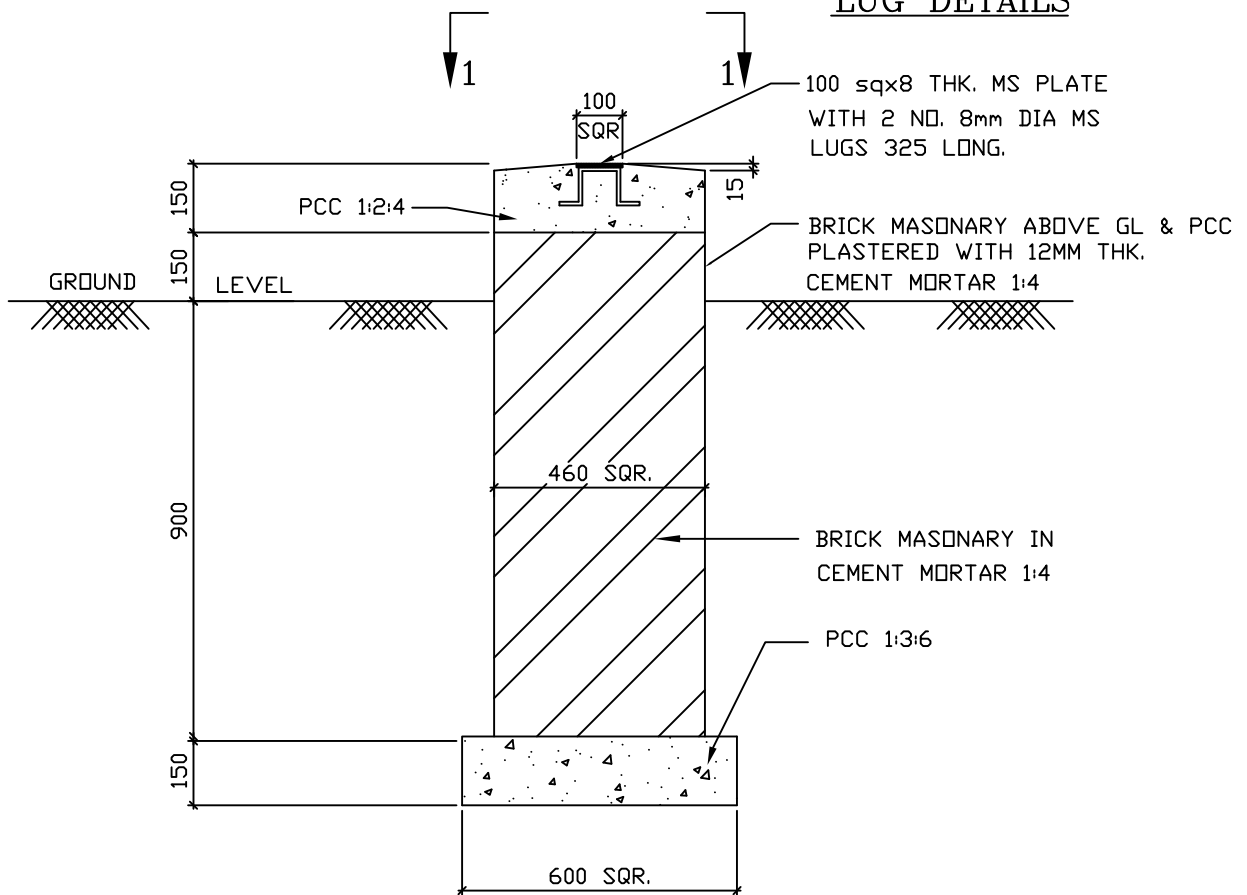


FIG. 2

GRID PILLAR/REFERENCE PILLAR

NOTES

1. ALL DIMENSIONS ARE IN MM
2. ALL MATERIALS AND WORKMANSHIP SHALL BE AS PER SPECIFICATION & RELEVANT IS CODES

DATE 17.01.2009

PREPARED BY: AKV

CHECKED BY: CPK

APPROVED BY: KD

SECTION VII

APPENDIX – I

DECLARATION SHEET

I, _____ hereby certify that, all the information and data furnished by me with regard to this Tender Specification No.BHEL:PSSR:SCT:1338 are true and complete to the best of my knowledge. I have gone through the specifications, conditions, stipulations in detail and agree to comply with the requirements and intent specifications.

I further certify that I am duly authorized representative of the under mentioned tenderer and a valid power of Attorney to this effect is also enclosed.

TENDERER'S NAME & ADDRESS

**AUTHORISED REPRESENTATIVE'S
SIGNATURE WITH NAME & ADDRESS**

SECTION VII

APPENDIX –II

TENDER SPECIFICATION NO BHEL:PSSR:SCT:1338

**CERTIFICATE OF DECLARATION FOR CONFIRMING
KNOWLEDGE ON SITE CONDITIONS**

We,

hereby declare and confirm that we have visited the project site under subject, namely and acquired full knowledge and information about the site conditions. We further confirm that the above information is true and correct and we will not raise any claim of any nature due to lack of knowledge of site conditions.

TENDERER'S NAME AND ADDRESS

Place:

Date :

**SIGNATURE OF AUTHORISED
REPRESENTATIVE WITH NAME &
ADDRESS:**

OFFICE SEAL

5. Whether the following details are furnished : YES/NO
- a) Previous Experience : YES/NO
 - b) Present assignments : YES/NO
 - c) organization chart of the company : YES/NO
 - d) Company financial statue : YES/NO
 - e) Incase of company, proof of Registration of the company : YES/NO
 - f) Memorandum & Articles of Association of company/copy of Partnership deed : YES/NO
 - g) Profit & Loss account for the Last 3 years : YES/NO
 - h) Audited Balance sheet for the Last 3 years : YES/NO
 - i) Income Tax clearance certificate (latest) : YES/NO
 - j) Solvency Certificate from a Nationalised Bank : YES/NO
 - k) Power of Attorney of the person Signing the tender duly attested By a Notary Public : YES/NO
 - l) Manpower organization chart With deployment plan at site For posting of Engineers/super Visitors and workers/labourers For satisfactory completion of Work under this specification : YES/NO

SIGNATURE OF THE TENDERER

6. Whether the Tenderer is conversant with local labour laws & conditions : YES/NO
7. Whether the tenderer is aware of all safety rules and codes : YES/NO
8. Whether the Declaration sheet (as per appendix enclosed) : YES/NO
9. Time required for mobilization of site organization and start of work : YES/NO
10. Whether list of tools and Plants available with the contractor and proposed to be deployed for this work enclosed : YES/NO
11. Whether all the Pages are read understood and signed. : YES/NO
12. Deviations, if any Pointed out :
13. Whether PF exemption No. is allotted by RPFCL of your area if so, indicate number : YES/NO

SIGNATURE OF THE TENDERER

NOTE : The Tenderers are requested to peruse the Tender Specification terms and conditions carefully and furnish the above information also in detail as required.

TENDER SPECIFICATION

BHEL:PSSR:SCT: 1338

FOR

**CIVIL WORK –
TOPOGRAPHICAL SURVEY
AND GEO TECHNICAL
INVESTIGATION FOR 2 X 500
UNIT 1 & 2**

AT

**TUTICORIN THERMAL POWER STATION
TUTICORIN , TAMILNADU**

PART – III PRICE BID

BOOK NO :



BHARAT HEAVY ELECTRICALS LIMITED

(A Government of India Undertaking)

Power Sector – Southern Region

690, Anna Salai, Nandanam, Chennai – 600 035.

BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India Undertaking)
Power Sector, Southern Region
690, Anna Salai, Nandanam, Chennai – 35

TENDER SPECIFICATION NO:BHEL:PSSR:SCT:1338

NAME OF WORK

**Topographical Survey and
geotechnical investigation for Unit 1
& 2 of 2 x 500 MW at Tuticorin
Thermal Power Station, Tamilnadu**

(PRICE BID)

PART III

Issued to
M/s.

For and on behalf of
BHARAT HEAVY ELECTRICALS LIMITED

Additional General Manager/Contracts

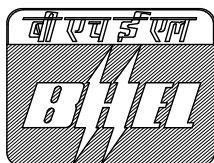
(This tender document is not transferable)

Place: Chennai-600 035.
Date:

BHARAT HEAVY ELECTRICALS LTD

**SCHEDULE OF QUANTITIES
FOR
TOPOGRAPHICAL SURVEY OF
2 x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-001



JANUARY, 2009

**PROJECT ENGINEERING MANAGEMENT
POWER SECTOR, PPEI BUILDING
PLOT NO. 25, SECTOR-16A, NOIDA (U.P.)-201301**



**SCHEDULE OF QUANTITIES FOR
TOPOGRAPHICAL SURVEY OF
x 500 MW TUTICORIN THERMAL
POWER STATION**

2

SPECIFICATION NO. PE-TS-G47-602-001

VOLUME III

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REV.NO. 0 DATE-17/01/2009

SHEET 1 OF 3

**SCHEDULE OF QUANTITIES
FOR
TOPOGRAPHICAL SURVEY**

NOTES:

1. The item of work in the schedule of quantities describes the work very briefly. Details of items shall be read in conjunction with the corresponding specification, drawings and other tender terms. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail described in the technical specification.
2. The bidder shall quote for finished items of work and shall provide all necessary power, water, instruments, fuel, tools and plants, tackles, materials, transport, labour, supervision and maintenance till handing over, repairs, rectifications, safety and security of their workmen and equipments including insurance etc.
3. The unit rates quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.
4. Quantities of the various items mentioned in the schedule of quantities are approximate and may vary upto any extent or be deleted altogether and new items may be added. The contractor shall carry out all the works upto a variation of $\pm 25\%$ (plus or minus twenty five percent) on the tendered value of the contract and all tendered rates shall remain firm within this limit.
5. Rates shall be quoted in both figures and words in clear legible writing. No overwriting is allowed. All scoring and cancellations should be countersigned by the bidder. In case of illegibility, the interpretation of the engineer-in-charge shall be the final and binding on the contractor.
6. Engineer-in-charge's decision regarding clarification of items in the schedule with respect to other sections of the contract shall be final and binding on the contractor.



**SCHEDULE OF QUANTITIES FOR
TOPOGRAPHICAL SURVEY OF
x 500 MW TUTICORIN THERMAL
POWER STATION**

2

SPECIFICATION NO. PE-TS-G47-602-001

VOLUME III

SECTION

REV.NO. 0 DATE-17/01/2009

SHEET 2 OF 3

7. The bidder shall submit a scheme showing the arrangement and equipment proposed to be used for conducting the work alongwith the rates.
8. Contractor shall make his own arrangement for water, electricity, accommodation, access to site and the cost of all such works shall be considered to be included in his quoted price.



**SCHEDULE OF QUANTITIES FOR
TOPOGRAPHICAL SURVEY OF
x 500 MW TUTICORIN THERMAL
POWER STATION**

2

SPECIFICATION NO. PE-TS-G47-602-001

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SCHEDULE OF QUANTITIES

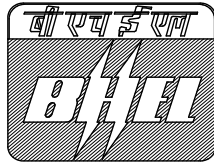
SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
1	Carrying out bench mark from the nearest GTS bench mark or any other available source as approved by the engineer-in-charge to different locations in the project area including clearing of jungles and/or cutting trees and any other works required for completion of the said item etc all complete as per specification and instructions of the engineer-in-charge. (Construction of bench mark pillar to be paid separately)	km	4		
2	Carrying out topographical survey of plant and allied areas showing all permanent & general features and detailed contour survey by taking spot levels at 25m interval, carrying out cross section of canal/nallah by taking spot levels at 5m interval or less including clearance of jungles and cutting of trees etc which are interfering with the survey works and any other field works necessary for the completion of the said item, preparation and submission of all plans (maps), reports, floppy and originals etc all complete as per specification and instructions of the engineer-in-charge.	Hectare	20		
3	Construction of bench mark pillar/reference pillar/grid pillar at different locations including clearing of jungles, excavation, supply of materials, pillar marking, backfilling, white washing, painting on MS plate etc all complete as per specification, drawings and instructions of the engineer-in-charge. a) Bench mark pillar b) Grid/reference pillar	Each Each	2 25		

TOTAL

BHARAT HEAVY ELECTRICALS LTD

**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF 2 x 500 MW
TUTICORIN THERMAL POWER STATION**

SPECIFICATION NO. PE-TS-G47-603-002



JANUARY, 2009

**PROJECT ENGINEERING MANAGEMENT
POWER SECTOR, PPEI BUILDING
PLOT NO. 25, SECTOR-16A, NOIDA (U.P.)-201301**



**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF
2x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-C002

VOLUME III

SECTION

REV.NO. 0 DATE-17/01/2009

SHEET 1 OF 7

**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION**

NOTES:

1. Detail of items shall be read in conjunction with the corresponding specifications, drawings and other tender terms.
2. The bidder shall quote for finished items of work and shall provide all necessary power, water, instruments, fuel, tools and plants, tackles, materials, transport, labour, supervision and maintenance till handing over, repairs, rectifications, safety and security of their workmen and equipments including insurance etc.
3. Quantities of the various items mentioned in the schedule of quantities are approximate and may vary up to any extent or be deleted altogether and new items may be added. The contractor shall carry out all the works up to a variation of $\pm 25\%$ (plus or minus twenty five percent) on the tendered value of the contract and all tendered rates shall remain firm within this limit.
4. Rates shall be quoted in both figures and words in clear legible writing. No overwriting is allowed. All scoring and cancellations should be countersigned by the bidder. In case of illegibility, the interpretation of the engineer-in-charge shall be the final and binding on the contractor.
5. Engineer-in-charge's decision regarding clarification of items in the schedule with respect to other sections of the contract shall be final and binding on the contractor.
6. The bidder shall submit a scheme showing the arrangement and equipment proposed to be used for conducting the work along with the rates.
7. Contractor shall make his own arrangement for water, electricity, accommodation, access to site and the cost of all such work shall be considered to be included in his quoted price.



**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF
2x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-C002

VOLUME III

SECTION

REV.NO. 0

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SCHEDULE OF QUANTITIES

SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
1	Mobilisation of necessary equipments, men and materials to the project site for carrying out the geotechnical investigation and demobilisation of the same after completion of all the field works etc all complete as per specification, drawings and as directed by the engineer-in-charge.	LS	1		
2	Making 150 mm nominal diameter bore hole at various locations in all types of soil including laterite using suitable approved method of boring including chiselling, cleaning, providing casing pipes as required or as directed; performing standard penetration test (SPT) at every 1 m interval alternate to collection of undisturbed soil samples (UDS) up to 10 m depth below ground level and at every 1.5 m interval alternate to collection of undisturbed soil sample (UDS) beyond 10 m depth up to a maximum depth of 20 m below ground level, at change of strata and at depths wherever undisturbed soil samples could not be collected; collection of undisturbed soil samples at every 1 m interval alternate to conducting standard penetration test (SPT) up to 10 m depth below ground level and at every 1.5 m interval alternate to conducting standard penetration test (SPT) beyond 10 m depth alternate to conducting SPT test; collection of disturbed soil samples and water samples, sealing and packing of samples, observation such as ground water table etc; transportation of all the collected samples to the laboratory and back filling of boreholes with sand on completion of the same etc all complete as per specification and as directed by the engineer-in-charge.	M	245		



**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF
2x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-C902

VOLUME III

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SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
3	Core drilling (Nx size) in rock using hydraulic feed rotary drill and double tube core barrel with diamond bit including collection of core samples, performing SPT at locations where core recovery is less than 20%, maintaining continuous record of core recovery and RQD, keeping the cores in wooden core boxes, transporting the cores to laboratory, back filling the holes with 1 part of cement : 3 part of sand grout on completion of the same etc all complete as per specification, drawings and as directed by the engineer-in-charge.	M	310		
4	Excavating trial pit of size 3m x 3m at various locations upto a maximum depth of 3m depth below ground level in all types of soil and weathered rock which can be excavated with pick axe/crow bar etc including sheeting or shoring the sides for the purpose of stability, dewatering and maintaining the pit dry at all times, collecting disturbed/undisturbed samples at 1m interval and at final depth and transporting all the collected samples to the laboratory; backfilling of the pit with excavated material etc all complete as per specification and as directed by the engineer-in-charge.	CuM	120		
5	Conducting plate load test in various locations at specified depth complete as per specification, drawings and as directed by the engineer-in-charge. Payment for making the pit of suitable size, maintaining it dry and backfilling etc shall be paid separately as per item no.4.	Each	4		
6	Conducting cyclic plate load test in various locations at specified depth complete as per specification, drawings and as directed by the engineer-in-charge. Payment for making the pit of suitable size, maintaining it dry and backfilling etc shall be paid separately as per item no. 4.	Each	2		



**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF
2x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-C002

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SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
7	Conducting electrical resistivity test at various locations complete as per specification, drawings and as directed by the engineer-in-charge.	Each	15		
8	Performing dynamic cone penetration test at various locations using 65mm cone with circulation of bentonite slurry etc all complete as per specification, drawings and as directed by the engineer-in-charge.	Each	10		
9	Conducting pressure meter test in various bore holes at all depth such as 2m, 4m, 6m, 8m, 10m, 12m, 15m, 18m & 20m depth below ground level in all types of strata including preparation of bore hole of required size etc all complete as per specification, drawings and as directed by the engineer-in-charge.	Each	3		
10	Conducting cross hole shear wave test in bore hole in all types of strata at all depths such as 2m, 4m, 6m, 8m, 10m, 12m, 15m, 18m & 20m depth below ground level including preparation of boreholes, providing PVC liner, grouting and backfilling with sand after completion of the test etc all complete as per specification, drawings and as directed by the engineer-in-charge.	Each	4		
11	Conducting pump in type field permeability test by constant head or falling head method (suitability of type of test shall be as per site conditions) in various boreholes at specified depth including providing packers as required etc all complete as per specification, drawings and as directed by the engineer-in-charge. Cost of the borehole and backfilling etc shall be paid separately as per item no.2.	Each	5		
12	Conducting laboratory test on soil samples at an approved laboratory including preparation of soil samples to determine the following properties etc all complete as per specification.				
	a) Bulk density and moisture content	Each	35		
	b) Sieve analysis	Each	130		



**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF
2x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-C902

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SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
	c) Hydrometer analysis	Each	25		
	d) Liquid limit and plastic limit	Each	75		
	e) Shrinkage limit	Each	10		
	f) Specific gravity	Each	25		
	g) Swell pressure	Each	10		
	h) Free swell index	Each	10		
	i) Relative density	Each	20		
	j) Unconfined compressive strength	Each	15		
	k) Direct shear test	Each	20		
	l) Triaxial shear test				
	i)unconsolidated undrained test	Each	15		
	m) One dimensional consolidation test	Each	20		
	n) Standard Proctor compaction test	Each	5		
	o) CBR test	Each	5		
	p) Chemical analysis	Each	7		
13	Conducting laboratory test on rock samples including preparation of the samples to determine the following properties etc all complete as per specification.	Each			
	a) Moisture content, porosity & density	Each	30		
	b) Specific gravity	Each	30		
	c) Slake durability index		25		
	d) Unconfined compressive strength (both at saturated and in-situ water content)	Each	60		
	e) Point load strength	Each	25		



**SCHEDULE OF QUANTITIES
FOR
GEOTECHNICAL INVESTIGATION OF
2x 500 MW TUTICORIN THERMAL
POWER STATION**

SPECIFICATION NO. PE-TS-G47-602-C002

VOLUME III

SECTION

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SHEET 6 OF 7

SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
14	Conducting chemical test on water samples to determine the carbonate, sulphate, chloride and nitrate contents, pH value, turbidity, organic matter and any other chemicals harmful to foundation material etc all complete as per specification.	Each	7		
15	Preparation and submission of draft report in 3 copies and final report in 5 hard copies and 2 soft copies on CDs after the approval of draft report including all field records, laboratory test results, graphs, analysis of test results and recommendation etc all complete as per specification.	LS	1		