"COURIER"

Project Engineering Management

Bharat Heavy Electricals Limited

(A Govt. Of India Undertaking)

Enquiry No.: 20/RTC/601/E-3631/2012 dt. 21/06/2012

DUE DATE: 06/07/2012 by 2.00 PM

Subject: Tender Enquiry for Topographical Survey and Geotechnical Investigation – Rate Contract for one Year further extendable

Dear Sirs,

We are pleased to invite your offer in two parts strictly in duplicate, in sealed covers for the under mentioned service.

Sl. No.	Description for which rate contract desired	Delivery/completion
1	Topographical Survey and Geotechnical Investigation: Refer Technical specification PE-TS-999-602-603 for detailed description	Three weeks from date of LOI/ LOA.

Your best quotation/offer for the above requirement, in line with our terms and conditions, should either be delivered in person or sent by COURIER/REGISTERED POST, to the official inviting tender(s). It shall be the responsibility of the bidder to ensure that the tender is delivered on or before the due date by 2 p.m. Part-I bids shall be opened at 3 p.m. on the due date in the presence of authorized representatives of the bidders, who may like to be present.

1. Qualifying Criteria: Qualifying criteria shall be as per enclosed annexure-1A (technical) and annexure-1B (financial).
2. Evaluation criterion shall be as per Annexure-2 (total price (item 1-13 of price format) - region wise
3. Commercial conditions shall be as per enclosed annexure-3.Security deposit as per annexure-III.
4. Price format is enclosed as per annexure-4. Vendors are requested to quote in the same price format.

The rate contract shall be valid for one year with provision of further extension by one year on mutual consent.

Please reply to:
BHEL-PEM -Power Sector
Power Project Engineering Institute,
HRD & ESI Complex,
Plot No 25, Sector-16 A, Noida-201301 (U.P.)
Phone : 0120-4368711,4213561
Fax :0120-4329026

Regd. Office :
BHEL House,
Siri Fort,
New Delhi-11049

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Enquiry No.: 20/RTC/601/E-3631/2012 dt. 21/06/2012

DUE DATE: 06/07/2012 by 2.00 PM

Instructions to bidders:

1. Enquiry No., due date etc. must be legibly super scribed on the sealed envelopes.

2. Offers should be submitted in two parts in two separate sealed covers as follows:
   Part-I: **TECHNO-COMMERCIAL BID** Part-II: **PRICE BID**.
3. Bidders shall submit their offers meeting the requirements of the following tender documents (enclosed) and other Terms and Conditions included in this Enquiry Letter.
4. Tenders shall be submitted strictly in accordance with the requirements of the above tender documents. Deviations (Technical as well as Commercial), if any, shall be listed out separately. Technical deviations and Commercial deviations shall be furnished in separate sheets under the headings "**TECHNICAL DEVIATIONS**" and "**COMMERCIAL DEVIATIONS**" respectively, along with reasons for taking such deviations.
5. Standard pre-printed terms & conditions of the Tenderers shall not be considered valid.
6. Offer (including price bid) shall remain valid for six months from part-1 opening.
7. Unsolicited fresh/revised Price Bids shall not be entertained.
8. Purchaser shall be under no obligation to accept the lowest or any other tender and shall be entitled to accept or reject any/all tender(s) in part or full without assigning any reason whatsoever.
9. Late tenders are liable to be rejected.
10. Tenders and all correspondence thereof shall be addressed to the undersigned by name & designation and sent at the following address:
    M/s Bharat Heavy Electricals Ltd.,
    Project Engineering Management,
    Power Project Engineering Institute,
    HRD & ESI Complex,
    Plot No 25, Sector-16 A, Noida-201301 (U.P.)
    Kind Attn: Sh Devendra Sharma
    Manager/CMM
    Ph 0120-4368711
    Fax 0120-4329026

    Sh Upendra Chaudhary
    Sr Engr (CMM)
    Ph 0120-4213561

In case you are not submitting an offer against this enquiry, you are requested to send a regret letter so as to reach us on or before the due date.
Yours faithfully,

For and on behalf of BHEL

Devendra 21-6-12

Devendra Sharma
Mgr. (CMM)

Encl:

a) Qualifying requirement (Annexure-1A & 1B)
b) Evaluation criterion (Annexure-2)
c) Commercial conditions of enquiry (Annexure-3)
d) Price Format- Annexure 4
e) Technical specification PE-TS-999-602-603 (Vol-IIB & Vol-III)
f) Security deposit details (Annexure-III)

Please reply to:
BHEL-PEM -Power Sector
Power Project Engineering Institute,
HRD & ESI Complex,
Plot No 25, Sector-16 A, Noida-201301 (U.P.)
Phone : 0120-4368711,4213561
Fax :0120-4329026

Regd. Office :
BHEL House,
Siri Fort,
New Delhi-11049

Annexure -1A

(2) (19)

PE-DC-999-602-004

PRE-QUALIFICATION REQUIREMENT (TECHNICAL PART ONLY)

For

PRELIMINARY TOPOGRAPHICAL SURVEY & GEOTECHNICAL INVESTIGATION

(Northern/Eastern/Western/Southern/Other Region)

[redacted]

Experience of having successfully completed "Topographical Survey and Geotechnical Investigation" works during last 7 years ending last day of month previous to the one in which applications are invited should be either of the following: -

a. Three similar completed works each costing not less than Rs. 2.25 lakhs

   Or

b. Two similar completed works each costing not less than Rs. 2.81 lakhs

   Or

c. One similar completed work costing not less than Rs. 4.49 lakhs

Annexure 1B (68)

QUALIFYING REQUIREMENT (FINANCIAL)

Bidder who wish to participate for "Topographical survey and Geotechnical investigation" should have an average annual turnover of minimum rupees ten lacs during last three years ending 31st march of the previous financial year.

Bidder should submit financial A/C for last 4 years (audited if applicable) as on tender due date to review above data.

13/6/12

Annexure-2

EVALUATION CRITERIA

Bidder shall quote for every region separately. The different regions shall consist of the following:

Sl. No.	Region	State / Union Territory for various regions
1	Northern Region	Delhi, Uttar Pradesh, Haryana, Punjab, Rajasthan, Chandigarh
2	Eastern Region	Bihar, Jharkhand, Orissa, West Bengal, Assam
3	Western Region	Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, Goa
4	Southern Region	Tamil Nadu, Andhra Pradesh, Karnataka, Kerala, Pondicherry
5	Other Region	Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Tripura, Meghalaya, Arunachal Pradesh, Sikkim, Manipur, Mizoram, Nagaland

Technical evaluation shall be done as per tender requirements considering region wise separately.

(60)

BHEL / PEM

Ref.: PW/PE/MM/RC/Civil [redacted]

Annexure-A3 (page 1/7)

Enquiry for Preliminary Topographical Survey and Geotechnical Investigation – Rate Contract for one Year

Commercial Conditions:

1) Payment terms: 100% payment on submission and approval of the report by BHEL/ PEM.
2) Completion period: Three weeks from date of LOI/ LOA/ Work Order.
3) For delayed completion of the work beyond contractual completion schedule, Liquidated Damages (LD) shall be applicable @ 1/2% of order value (without taxes/ duties) per week or part thereof, subject to maximum of 10% of order value (without taxes/ duties).
4) Security Deposit: As per enclosed Annexure-III.
5) Performance Bank Guarantee – Not applicable.
6) Guarantee clause – Not applicable.
7) Prices would remain Firm during the tenure of the Rate Contract.
8) **Vendors to ensure that applicable taxes and duties are indicated clearly in their price bids other wise these shall be considered to be included in quoted prices.**
9) Vendors to note that prices are required to be quoted in separate sealed envelopes for each Region being quoted.
10) Evaluation and ordering will be done Region-wise. Tender enquiry is as per two part bid system and price offers of technically and commercially acceptable vendors shall only be opened

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BHEL / PEM

Ref.: PW/PE/MM/RC/Civil

Dated: 21.01.2010

INCOME TAX, SERVICE TAX, WORK TAX AND SALES TAX

TDS under Income Tax, Sales Tax, VAT etc, if any, shall be deducted at prevailing rates on gross invoice value from the running bills unless Exemption Certificate from appropriate Authority / Authorities is furnished.

Price quoted shall be inclusive of all taxes. If applicable, "the service tax invoice" if require under the relevant Service Tax rule shall be submitted alongwith other compliances as per service tax rules

In VAT applicable States, "Tax Invoice" if required under the relevant State VAT law shall be submitted alongwith other compliances as per concerned VAT Act.

Contractor shall get his organization registered with concerned sales tax/VAT authorities within 15 days of award of this contract, if applicable. The delay on this account and delay in bringing the material shall be to contractor's account and no extension of time shall be allowed on this account. The sales tax/VAT registration for this contractor shall be forwarded to BHEL within 30 days from the date of LOI. In case the contractor is already registered for sales tax/VAT with Govt. Authorities he must quote his registration no, while submitting their tender.

Contractor has to make his own arrangement at his cost for completing the formalities, if required, with Sales Tax/VAT Authorities, for bringing their materials, plants, and equipment at site for the execution of the work under this contract.

FACILITIES:

All facilities including storage and office accommodation etc., required for successful & timely execution of job is to be arranged by contractor within their quoted / accepted rates including water & power.

RESOURCES: All resources including T & P, IMTEs, manpower, consumables etc. required for successful completion of job are to be arranged by the contractor within the quoted / accepted rates.

24.0 TERMINATION OF THE CONTRACT

24.1 The purchaser shall have the right to cancel the Order/Contract, wholly or in part, in case he is obliged to do so on account of any decline, diminution, curtailment or stoppage of his business and in that event, the Seller/Contractor compensation claim shall be settled mutually.

24.2 The purchaser shall also have the right to cancel the Order/Contract at the risk and cost of the Seller/Contractor in case either the Seller/Contractor himself or any of his representative or agent is found to have been a previous employee of the purchaser immediately before the retirement and has within a period of two years of such retirement accepted the employment of the Seller/Contractor either as a Seller/Contractor or as an employee without having obtained the prior permission of the purchaser.

24.3 In case of cancellation of main supply order/ contract, all other associated orders/ contracts like, mandatory spares/recommended spares/ E & C/ supervision of E & C also get cancelled.

25.0 TRANSFER, SUB-LETTING/ASSIGNMENT/SUB-CONTRACTING

25.1 The seller/contractor shall not sublet, transfer or assign this order/contract or any part thereof or interest therein or benefit or advantage thereof save with the prior consent in writing of the purchaser. In the event of seller/contractor sub-letting, transferring or assigning this order/contract or any part thereof or interest therein or benefit or advantage thereof without such permission, the purchaser shall be entitled to cancel the order/contract and to purchase the stores from elsewhere at risk and costs of the seller/contractor and the seller/contractor shall be liable for any loss or damage which the purchaser may sustain in consequence of, or arising out of such risk purchase.

25.2 If the seller/contractor is an individual or a proprietary concern and the individual or the proprietor dies or the partnership is dissolved or substantially affected, then unless the purchaser is satisfied that the legal representative of the individual seller/contractor or the proprietor of proprietary concern and in the case of partnership, surviving partners are capable of carrying out and completing the Order/Contract, the purchase shall be entitled to cancel the Order/Contract as to its incomplete and without being in any way liable to payment of any compensation to the estate of seller/contractor and/or to the surviving partners of the seller's/contractor's firm on account of the cancellation of the order/contract.

25.3 Terms and Conditions shall not get affected in case of merger/amalgamation/re-arrangement/takeover etc.

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25.4 The decision of the purchaser that the legal representatives of the deceased seller/contractor or surviving partners of the seller's/contractor's firm can not carry out and complete the order/contract shall be final and binding on the parties hereto.

26.0 **FORCE MAJEURE**

26.1 Notwithstanding anything contained in **clause 14.0**, if at any time, during the continuance of the Order/Contract the performance in whole or in part by either party, of any obligations under this Order/Contract shall be prevented or delayed by reason of any war hostilities, acts of the public enemy, restrictions by Govt. of India, civil commotion, sabotage, fires, floods, explosion, epidemics, quarantine restrictions, strike, lock-outs, or acts of God (hereinafter referred to as 'event'), then, provided notice of the happening of such event is given by either party to other within fifteen (15) days from the date of occurrence thereof, neither party shall by reason of such event be entitled to terminate this Order/Contract nor shall have any claim for damages against each other in respect of such non-performance and delay in performance. Performance under the Order/Contract shall be resumed immediately after such event has come to an end or ceased to exist and decision of the purchaser as to whether the deliveries have to be resumed or not shall be final, conclusive and binding on the parties hereto.

26.2 In the event of the parties hereto not able to agree that a force majeure event has occurred, the parties shall submit the disputes for resolution pursuant to the provisions hereunder, provided that the burden of proof as to whether a force majeure event has occurred shall be upon the party claiming such an event.

26.3 Not-withstanding the above provisions, Purchaser shall reserve the right to cancel the Order/Contract, wholly or partly, in order to meet the overall Project schedule and make alternative arrangements for completion of delivery and other schedules.

27.0 **INDEMNIFICATION**

Seller/Contractor shall fully indemnify and keep indemnified the Purchaser against all claims of whatsoever nature arising during the course and out of the execution of this Order/Contract.

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28.0 CONTRACT PERFORMANCE EVALUATION

Performance of the Seller/Contractor in the present Order/Contract shall be evaluated by the Purchaser as per Performance Evaluation System ~~detailed in Annexure – VII.~~ The Seller/Contractor may be de-listed or put under hold or retained based on the performance in the present Order/Contrad.

29.0 SETTLEMENT OF DISPUTES

29.1 Except as otherwise specifically provided in the Order/Contract, all disputes concerning questions of the facts arising under the Order/Contract, shall be decided by purchaser, subject to written appeal by the Seller/~~Co~~ntractor to the purchaser, whose decision shall be final.

29.2 Any disputes or differences shall be to the extent possible settled amicably between the parties hereto, failing which the disputed issues shall be settled through arbitration.

29.3 The Seller/Contractor shall continue to perform the Order/Contract, pending settlement of dispute(s).

30.0 ARBITRATION

30.1 In the event of any dispute or difference arising out of the execution of the Order/Contract or the respective rights and liabilities of the parties or in relation to interpretation of any provision by the Seller/Contractor in any manner touching upon the Order/Contract, such dispute or difference shall (except as to any matters, the decision of which is specifically provided for therein) be referred to the arbitration of the person appointed by the competent authority of the Purchaser.

Subject as aforesaid, the provisions of Arbitration and Conciliation Act, 1996 (India) or statutory modifications or reenactments thereof and the rules made thereunder and for the time being in force shall apply to the arbitration proceedings under this clause. The venue of arbitration shall be at New Delhi.

30.2 In case of order/contract on Public Sector Enterprises (PSE) or a Govt. Deptt., the following clause shall be applicable:-

In the event of any dispute or difference relating to the interpretation and application of the provisions of the Order/Contract, such dispute or difference shall be referred to by either party to the arbitration of one of the

arbitrators in the department of public enterprises. The award of the arbitrator shall be binding upon the parties to the dispute, Provided, however, any party aggrieved by such award may make a further reference for setting aside or revision of the award to the Law secretary, Deptt. of Legal Affairs, Ministry of Law & Justice, Government of India. Upon such reference the dispute shall be decided by the Law Secretary or the Special Secretary or Additional Secretary when so authorized by the Law Secretary, whose decision shall bind the parties hereto finally and conclusively.

30.3 The cost of the arbitration shall be borne equally by the parties.

31.0 LAWS GOVERNING THE CONTRACT

The Contract including all matters connecting with this contract shall be governed by the Indian Law both substantive and procedural, for the time being in force including modification thereto, and shall be subject to the exclusive jurisdiction of Indian courts at Delhi/ New Delhi.

32.0 JURISDICTION OF COURT

Courts at Delhi/New Delhi shall have exclusive jurisdiction to decide the dispute, if any, arising out of or in respect of the contract(s) to which these conditions are applicable.

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23.0 DEFAULT/BREACH OF CONTRACT, INSOLVENCY AND RISK PURCHASE

23.1 If the Seller/Contractor fails to deliver the goods or materials or any installment thereof within the period(s) fixed for such delivery or delivers goods or materials not of the contracted quality and failing to adhere to the contract specifications or at any time repudiates or otherwise abandons the contract before expiry of such period or refuses or is unable to supply goods or materials covered by the Order/Contract either in whole or in part or otherwise fails to perform the Order/Contract or commits any breach of the Order/Contract not herein specifically provided for or in the event of the death or insanity or if the Seller/Contractor being an individual or if a firm on a partnership thereof, shall at any time, be adjudged insolvent or shall have a receiving order for administration of his estate made against him or shall take any proceeding for composition under any Insolvency Act for the time being in force or make any assignment of the Order/Contract or enter into any arrangement or composition with his creditors or suspend payment or if the firm dissolved under the Partnership Act or if the Seller/Contractor being a company is wound up voluntarily or by order of a Court or a Receiver, Liquidator or Manager on behalf of the debenture holders and creditors is appointed or circumstances shall have arisen which entitles the Court of debenture holder and creditors to appoint a receiver, liquidator or manager, the purchaser without prejudice to his right to recover any expenses, losses or damages to which the purchaser may be put to incur or sustain by reason of the Seller/Contractor's default or breach of Order/Contract shall be entitled to cancel the Order/Contract either in whole or portion thereof without compensation to the Seller/Contractor and if the purchaser so desires, he may procure upon such terms and in such manner as he deems appropriate, stores not so delivered or others of a similar description where stores exactly complying with particulars are not, in the opinion of the purchaser, which shall be final, readily procurable, at the risk and cost of the Seller/Contractor and the Seller/Contractor shall be liable to the purchaser for any excess costs provided that the Seller/Contractor shall continue the performance of the Order/Contract to the extent not cancelled under the provisions of this clause. The Seller/Contractor shall on no account be entitled to any gain on such repurchases.

23.2 Cost of the purchases made by the Purchaser at the risk and cost of the seller/contractor shall be worked out after levying 30% overheads as departmental charges on the ex-works cost of materials purchased.

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Annexure-III

Security Deposit

Security Deposit should be collected from the successful tenderer . The rate of Security Deposit will be as below:

Upto Rs. 10 lakhs	10%
Above Rs. 10 lakhs upto Rs.50 lakhs	1 lakh + 7.5% of the amount exceeding Rs. 10 lakhs.
Above Rs. 50 lakhs	Rs 4 lakhs + 5% of the amount exceeding Rs. 50 lakhs.

The Security Deposit should be collected before start of the work by the contractor.

Security Deposit may be furnished in any one of the following forms :

i) Cash (as permissible under the Income Tax Act)

ii) Pay Order, Demand Draft in favour of BHEL

iii) Local cheques of Scheduled Banks, subject to realization

iv) Securities available from Post Offices such as National Savings Certificates, Kisan Vikas Patras etc.

(Certificates should be held in the name of Contractor furnishing the security and duly pledged in favour of BHEL and discharged on the back)

v) Bank Guarantee from Scheduled Banks / Public Financial Institutions as defined in the Companies Act subject to a maximum of 50% of the total security deposit value. The balance 50% has to be remitted either by cash or in other form of security. The Bank Guarantee format should have the approval of BHEL

vi) Fixed Deposit Receipt issued by Scheduled Banks / Public Financial Institutions as defined in the Companies Act . The FDR should be in the name of the contractor, A/c BHEL, duly discharged on the back

vii) Security Deposit can also be recovered at the rate of 10% from the running bills. However in such cases at least 50% of the Security Deposit should be collected before start of the work and the balance 50% may be recovered from the running bills

viii) EMD of the successful tenderer shall be converted and adjusted against the Security Deposit

ix) The Security Deposit shall not carry any interest

NOTE:

Acceptance of Security Deposit against Sl. No. (iv) and (vi) above will be subject to hypothecation or endorsement on the documents in favour of BHEL. However, BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith.

PRICE FORMAT FOR PRELIMINARY TOPOGRAPHICAL SURVEY & GEOTECHNICAL INVESTIGATION :: SPECIFICATION NO. PE-EST-999-602-003

SL. NO	ITEM	UNIT	QTY.	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)
				North Region		East Region		West Region		South Region		Other Region	
1	Mobilisation of necessary equipments, men and materials to the project site for carrying out topographical survey and 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	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										
3	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 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, compact disc and originals etc all complete as per specification and instructions of the engineer-in- charge.	Hectare	50										
4	Construction of bench mark pillar/reference 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	Each	1										
	b) Reference pillar	Each	2										
5	Making 150mm nominal diameter bore hole at various locations in all types of soil including ash using suitable approved method of boring including chiselling, cleaning, providing casing pipes as required or as directed; performing standard penetration tests; collection of undisturbed soil samples; 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 for depth below ground level as given below .												
	a) From ground level to 15m depth	RM	120										
	b) From 15m to 30m depth	RM	96										
6	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.	RM	24										
7	Excavating trial pit of size 3m x 3m at various locations upto 4m depth below ground level in all types of soil and in weathered rock/soft 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 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	144										
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 electrical resistivity test at various locations complete as per specification, drawings and as directed by the engineer-in-charge.	Each	5										
10	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	25										

PRICE FORMAT FOR PRELIMINARY TOPOGRAPHICAL SURVEY & GEOTECHNICAL INVESTIGATION :: SPECIFICATION NO. PE-EST-999-602-003

SL. NO	ITEM	UNIT	QTY.	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)	RATE (Rs)	AMOUNT (Rs)
				North Region		East Region		West Region		South Region		Other Region	
	b)Sieve analysis	Each	75										
	c)Hydrometer analysis	Each	10										
	d)Liquid limit and plastic limit	Each	75										
	e)Shrinkage limit	Each	10										
	f)Specific gravity	Each	15										
	g) Free swell index	Each	5										
	h) Relative density	Each	10										
	i) Unconfined compressive strength	Each	20										
	j) Direct shear test	Each	15										
	k)Unconsolidated undrained triaxial shear test	Each	20										
	l) One dimensional consolidation test	Each	15										
	m) Standard Proctor compaction test	Each	4										
	n)Chemical analysis	Each	2										
11	Conducting laboratory test on rock samples including preparation of the samples to determine the following properties etc all complete as per specification.												
	a)Moisture content, porosity & density	Each	5										
	b)Specific gravity	Each	5										
	c)Unconfined compressive strength (both at saturated and in–situ water content)	Each	10										
12	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	2										
13	Preparation and submission of draft report in 3 copies and final report in 5 hard copies and 2 soft copies on compact discs after the approval of draft report including all field records, laboratory test results, graphs, analysis of test results, photographs showing details of field tests/soil/rock samples/trial pits and recommendation etc all complete as per specification.	LS	1										
Price on which evaluation shall be done region wise---->			**Total**										
		Service Tax@											
Grand Total including service tax													

BHARAT HEAVY ELECTRICALS LTD

STANDARD SPECIFICATION FOR PRELIMINARY TOPOGRAPHICAL SURVEY AND GEOTECHNICAL INVESTIGATION

SPECIFICATION NO. PE-TS-999-602-003
VOLUME IIB

APRIL, 2012

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

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STANDARD SPECIFICATION FOR PRELIMINARY TOPOGRAPHICAL SURVEY & GEOTECHNICAL INVESTIGATION

1.0 GENERAL

This specification covers the technical requirements for carrying out the following works for locating power plant and its allied systems.

a) Part-1: Preliminary Topographical Survey
b) Part-2: Preliminary Geotechnical Investigation

2.0 SITE

The site for carrying out the work shall be anywhere in the respective Power Sector Region (Northern/Southern/Eastern/Western Region) in India and shall be identified by BHEL during execution stage.

PART-I

PRELIMINARY TOPOGRAPHICAL SURVEY

PART-1

PRELIMINARY TOPOGRAPHICAL SURVEY

1.0 GENERAL

1.1 This specification covers the technical requirements for carrying out a **"Preliminary Topographical Survey and Allied Works"** for locating 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 pillar and reference pillars in the field.

2.1.3 Spot level survey of the entire area/areas at specified interval(s) and development of contours.

2.1.4 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.

2.1.5 Furnishing all field data and drawings on compact discs apart from hard copies.

2.1.6 Furnishing survey report as described in details in the succeeding paragraphs is also included in the scope of work.

3.0 SPECIFICATION

3.1 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.

3.2 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 drawings (if any), 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.

3.3 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 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.

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

3.5 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 withheld the payments for the work done. The decision of the engineer-in-charge in this regard shall be final and binding on the contractor.

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

4.1 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.

4.2 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.

4.3 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.

4.4 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 for as possible and this route shall require the approval of the engineer-in-charge before the commencement of work.

4.5 Closing error in levelling should be limited to l2 $\sqrt{}$ L mm, where L is the length of the route in km.

4.6 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.

5.0 TOPOGRAPHICAL SURVEY AND MAPPING

5.1 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 griding 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.

5.2 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.

ii) Surveying for establishing spot levels and plotting contours.

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

5.3 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.

6.0 TRAVERSING

6.1 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.

6.2 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.

6.3 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 and 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.

6.4 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).

7.0 CONTOURING

7.1 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 1m interval after the above 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.

7.2 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.

7.3 Closing error in levelling shall not exceed the limit mentioned in clause 4.5.

8.0 CONSTRUCTION OF BENCH MARK & REFERENCE PILLAR

8.1 A bench mark pillar shall be constructed as per the sketch at **Fig-1** at location as directed by 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 along with the hemispherical ball shall be painted with anticorrosive paint. The pillar should be white washed.

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

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

9.0 PROGRESS REPORT

9.1 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.

9.2 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.

10.0 PREPARATION & SUBMISSION OF SURVEY MAPS

10.1 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 grid lines and other with grid lines, contour lines and permanent features.

10.2 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.

10.3 The contractor shall submit three copies of all the maps for review and approval of the engineer-in-charge. After approval, six prints of all the final maps along with a set of originals on polyester base film and on a compact disc 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.

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

11.0 SUBMISSION OF FIELD DATA AND REPORT

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

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

11.3 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.

11.4 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.

11.5 Final survey report shall be submitted in six copies of standard A-4 size sheets properly bound and printed using good quality paper and material.

12.0 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.

13.0 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 to 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.

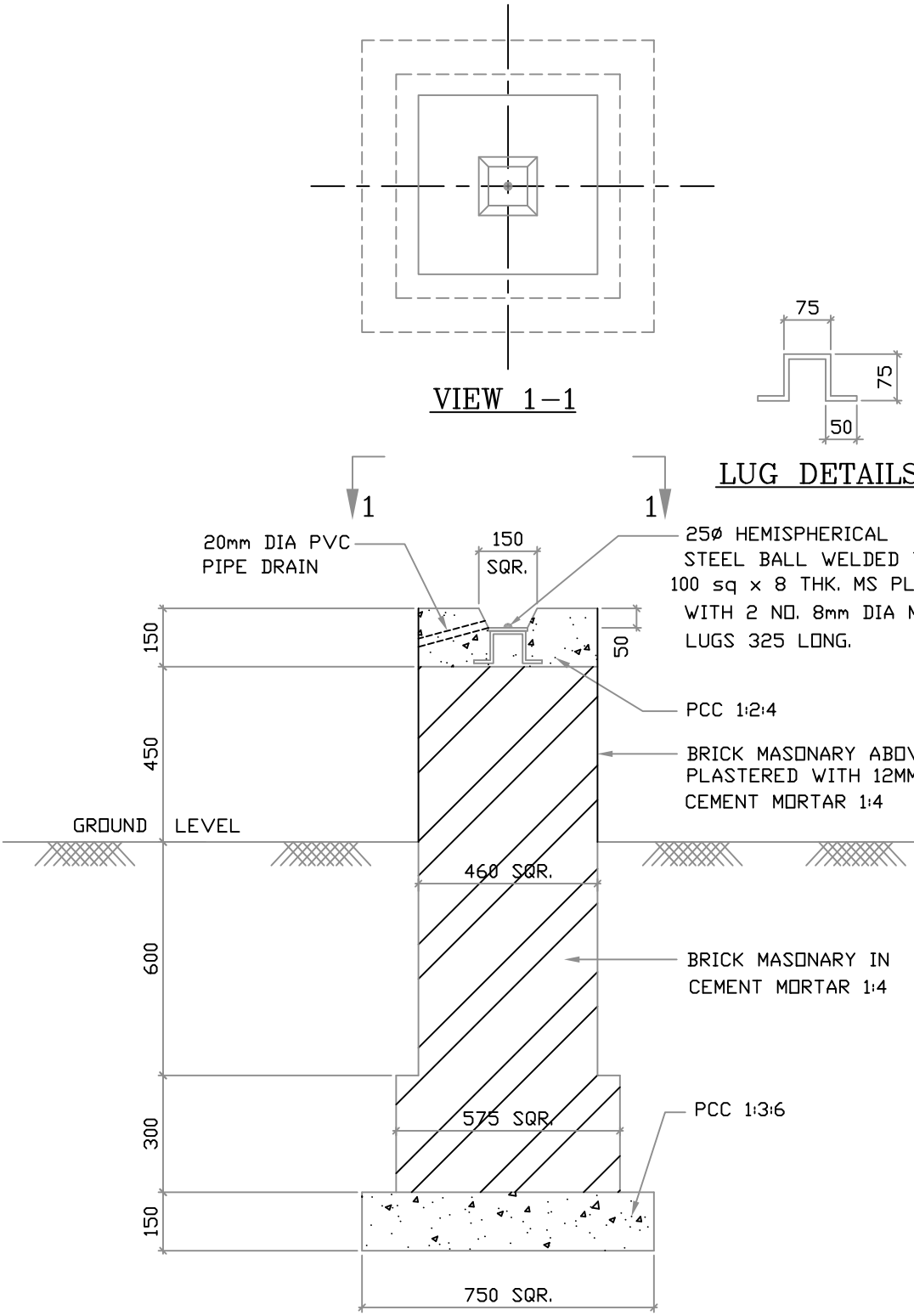
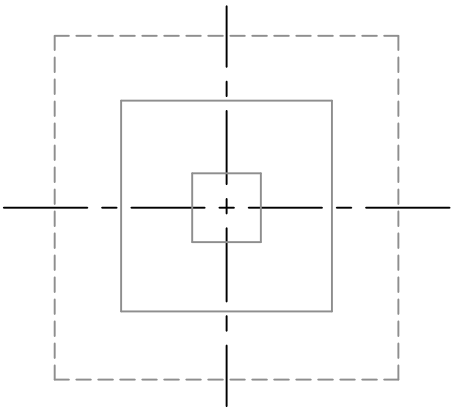


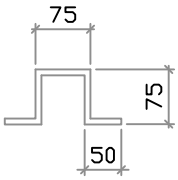
FIG. 1
BENCH MARK PILLAR

NOTES

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



VIEW 1–1



LUG DETAILS

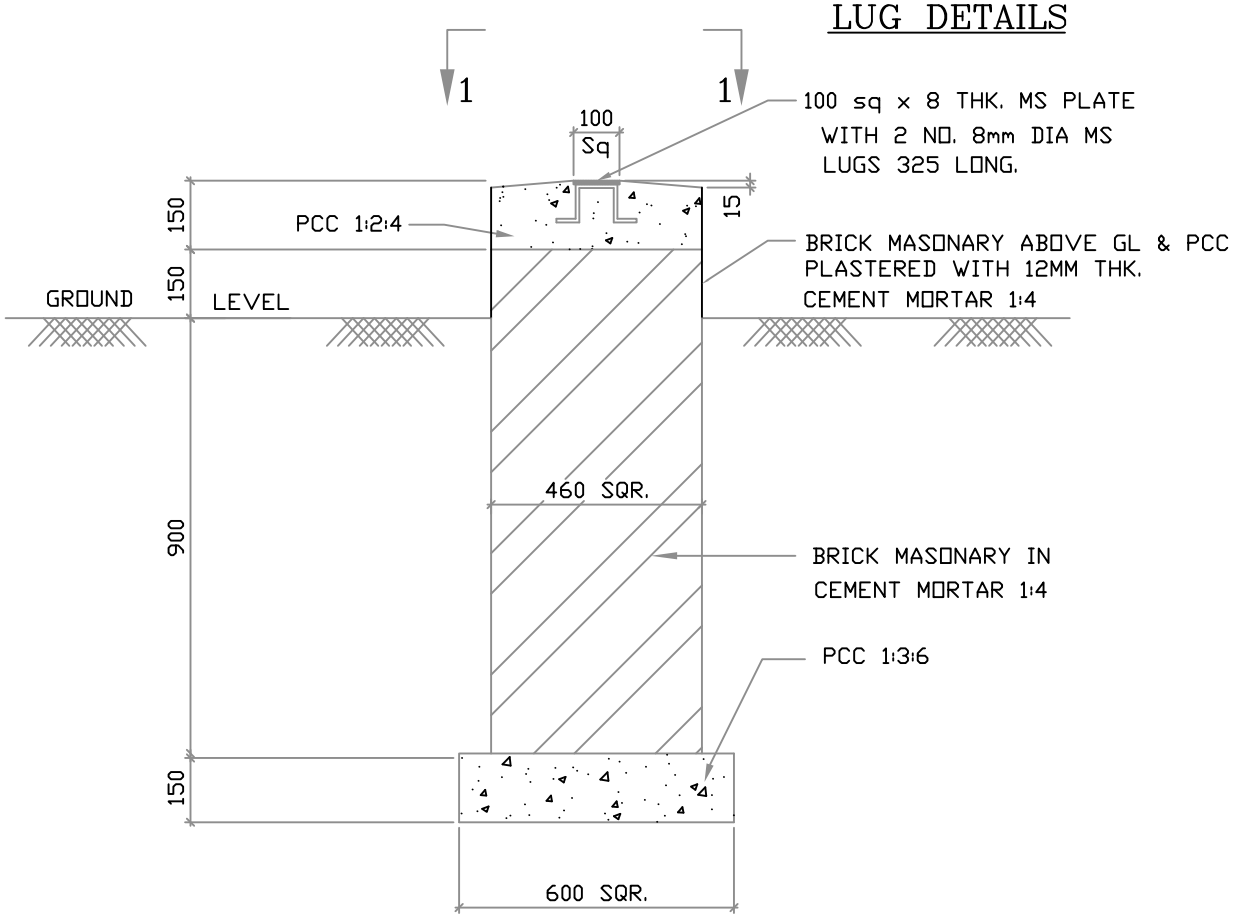


FIG. 2

REFERENCE PILLAR

NOTES

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

PART-2

PRELIMINARY GEOTECHNICAL INVESTIGATION

PART-2

PRELIMINARY GEOTECHNICAL INVESTIGATION

1.0 GENERAL

1.1 This specification covers the technical requirements for a "Preliminary Geotechnical Investigation and submission of a Geotechnical Report". The 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 600 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.

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 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 as recommended in relevant Indian Standard Codes and the field records shall be countersigned by the engineer-in-charge. The contractor shall submit two copies of the field borelogs to the engineer-in-charge soon after the completion of each bore hole. All the investigations are to be carried out by the contractor as per the priority requirements of the engineer-in-charge.

2.4 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.

2.5 All the laboratory test data shall be recorded in the proforma as 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 laboratory tests.

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

3.0 GENERAL REQUIREMENTS

3.1 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 foundation adopted and behaviour of existing structures particularly those of similar nature to the ones proposed for this project.

3.2 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/rock conditions which are likely to exist.

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

3.4 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.

3.5 The contractor shall make enquiries and verify regarding earlier use of the site which can have an 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.

3.6 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.

4.0 CODES AND STANDARDS

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

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

4.3 All work shall be carried out as per the specification and as per 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: 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: 2720 Method of test for soils (Relevant parts)

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

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

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

IS: 3025 Methods of sampling and testing (Physical and chemical) for water used in Industry

IS: 3043 Code of practice for earthing

IS: 4078 Code of practice for indexing and storage of drill cores

IS: 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 Part -II Method for subsurface sounding for soils- Dynamic method using cone and bentonite slurry

IS: 5313 Guide for core drilling observations

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

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 Part-I Code of practice for calculation of settlement of 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: 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

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

IS: 10074 Specification for compaction mould assembly for light and heavy compaction

IS: 10108 Code of practice for sampling by thin wall sampler with stationary piston

IS: 10589 Equipment for determination of subsurface sounding of soils

IS: 10837 Specifications of moulds for determination of relative density and its accessories

IS: 11229 Specifications for shear box testing of soils

IS: 11315 Part-II Description of discontinuities in rock mass - Core recovery and rock quality

IS: 12070 Code of practice for design and construction of shallow foundations on rocks

5.0 FIELD INVESTIGATION - SOIL

5.1 Boring

5.1.1 General Requirements

a) Bore holes shall be drilled at specified locations to obtain information about the sub-soil profile, its nature, strength and to collect soil samples for strata identification and conducting laboratory tests. The minimum diameter of the bore hole shall be 150 mm and boring shall be carried out in accordance with the provisions of IS: 1892 and as per this specification.

b) All bore holes shall extend up to the depths shown on the construction drawings or as directed by the engineer-in-charge. If the strata with standard penetration test (SPT) 'N' value greater than 100 with characteristics of rock is met with earlier, the bore hole shall be advanced further by chiselling. Chiselling shall be continued for a maximum depth of 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: 6.0 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 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.

5.1 .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.

5.1.3 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 5.1.2 shall apply for this type of boring also.

5.1.4 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 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.

5.1.5 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.

5.2 Standard Penetration Test (SPT)

This test shall be conducted in all type of soil deposits met within the bore hole to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. This test shall be conducted at every 1m interval alternate to collection of UDS upto 10m depth below ground level and at every at every 1.5m interval alternate to collection of UDS beyond 10m depth, at change of strata, at depths wherever undisturbed soil sample could not be collected and as per the direction of the engineer-in-charge. The starting depth of performing SPT shall be 1m 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,

accessories, procedure for conducting the test, presentation of test results and collection of disturbed soil samples etc shall conform to IS: 2131.

This test shall be carried out by driving a standard split spoon sampler in the borehole by means of a 63.5kg hammer having a free fall of 0.75m. The sampler shall be driven using the hammer for 450 mm penetration. While driving, the number of blows for every 150 mm penetration and the penetration for every 50 blows shall be recorded. The number of blows for the last 300 mm drive shall be reported as 'N' value. This test shall be discontinued when the blow count is equal to 100 and the penetration shall be recorded. Refusal shall be considered to be met with when the blow count is equal to 100. At the location where the test is discontinued, the penetration and the corresponding number of blows shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The samples shall be visually classified & recorded at site and shall be properly preserved and labelled for future identification & testing.

5.3 Sampling

5.3.1 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 for 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 vertically with the arrow directing upwards. The tube samples shall be properly trimmed at both ends and suitably sealed with molten paraffin wax at both ends immediately after extracting the samples from the bore hole/trial pit and suitably capped on both sides.

d) When the contractor fails to collect undisturbed soil sample at a specified depth, the borehole shall be advanced by 0.50m and shall be performed with a standard penetration test. The reason for not obtaining the undisturbed soil sample shall be indicated in the borelog.

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

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

5.3.2 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 25kg 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.

5.3.3 Undisturbed Samples

In each borehole undisturbed sample (UDS) shall be collected at regular interval of 1m alternate to conducting SPT upto 10m depth below ground level and at every 1.5m interval alternate to conducting SPT beyond 10m depth and as directed by the engineer-in-charge. The starting depth of collecting UDS shall be 2m below ground level 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. 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 Using Thin Walled Sampler

Undisturbed samples 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 soil 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 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 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.

5.3.4 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 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.

5.4 Ground Water

5.4.1 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.

5.4.2 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.

5.4.3 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 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.

5.5 TRIAL PIT

5.5.1 Trial pits shall be of 3m x 3m size so as to permit easy access for visual examination of walls of the pit and to facilitate sampling and in-situ testing operations. Pits shall be excavated upto a maximum depth of 4m below ground level or as directed by the engineer-in-charge. Precautions shall be taken to ensure the stability of pit walls including provision of shoring if necessary as per IS: 4453. Precautions shall be taken to prevent surface water draining into the pit. Arrangements shall be made for dewatering if the pit is extended below water table. Trial pits shall be kept dry and a ladder shall be provided for easy access to the bottom of the pit. ln-situ tests shall be conducted and undisturbed samples shall be collected immediately on reaching the specified depth so as to avoid substantial changes in moisture content of the subsoil. Arrangements shall be made for barriers, protective measures and lighting necessary for the period the pits remain open.

5.5.2 A note on the visual examination of soil strata shall be prepared. This should include the nature, colour, consistency and visual classification of the soil, thickness of soil strata, thickness of expansive soil and ground water table if any etc.

5.5.3 Undisturbed samples shall be collected at 1m, 2m, 3m depth and at the termination depth in all the pits. Undisturbed tube samples shall be obtained by means of 100mm diameter thin walled sampling tubes with a cutting edge. The sampler shall be slightly oiled or greased inside and outside to reduce friction. The sampler shall be pushed into the soil and while doing so soil around the tube shall be carefully removed. In case it is not possible to push the sampler it may be driven by light blows from a "monkey".

5.5.4 In case it is not possible to collect undisturbed samples in the pit, in-situ density of soil shall be determined by sand replacement method. The specification, equipments, accessories etc required for the test and the procedure of testing shall be in accordance with IS: 2720, Part-XXVIII. No separate payment shall be made for this test.

5.5.5 After the completion of testing, sampling and visual examination, the pit shall be suitably backfilled as directed by the engineer-in-charge. Unless otherwise specified excavated soil shall be used for this purpose.

5.6 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 65kg weight having a free fall of 0.75m. The cone shall be of 65mm diameter provided with vents for continuous flow of bentonite slurry through the cone and rods in order to avoid friction between the rods and soil. On completion of the test, the results shall be presented as a continuous record of number of blows

required for every 300mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot.

5.7 Electrical Resistivity Test

This test shall be conducted to determine the electrical resistivity of soil required for designing safety grounding system in the entire power plant area. The specification for the equipments and other accessories required for performing the test, test procedure and reporting of field observations shall conform to IS:3043. The test shall be conducted using Wenner's four electrode method as specified in IS:1892, Appendix-B2. Unless otherwise specified, at each test location the test shall be conducted along two perpendicular lines parallel to the co-ordinate axes. On each line, the electrode spacing shall be kept at 1m, 2m, 3m, 5m and 10m. Testing shall be done during the driest season prevalent in the area to the extent possible.

6.0 FIELD INVESTIGATION - ROCK

6.1 Rock Drilling

Drilling in rock shall be done at specified locations 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 5.1.1(b). The starting depth of drilling in rock as mentioned in clause 5.1.1(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.

6.1.1 Equipment

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

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

6.1.2 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 and 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 5.2.

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

6.1.3 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 depth through which an 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.

6.1.4 Core Samples

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

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

shall be recorded as specified in the continuous record of core recovery and RQD in the corelog as per IS:11315, Part-II.

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

6.2 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 for last 300mm or less penetration.

7.0 LABORATORY INVESTIGATION

7.1 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 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 engineer-in-charge/owner

progressively every week. Laboratory tests shall be carried out concurrently with field investigation since initial laboratory test results could be useful in planning the later part of field work. **A schedule of laboratory tests shall be established by the contractor and the same shall be submitted and got approved by the engineer-in-charge before starting of laboratory tests.**

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

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

7.2 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
- Standard Proctor test
- Free swell index determination

b) Test on Undisturbed Soil Samples

- Bulk density and moisture content
- Relative density (for sand)
- Unconfined compression test
- Box shear test
- Triaxial shear test (unconsolidated undrained test on undisturbed / remoulded samples)
- One dimensional consolidation test

c) Test on Rock Samples

- Visual classification
- Water absorption, porosity and density
- Specific gravity

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

d)Chemical Analysis of Sub-soil and Ground Water

7.3 Salient Test Requirements

a) Remoulded soil specimen whenever desired shall be fully reworked at field density and natural moisture content. For conducting 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 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) 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.

d) 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.

e)Chemical analysis of sub-soil shall include determination of pH value, carbonate, sulphate (both SO_3 and SO_4), chloride and nitrate contents, organic matter, salinity and any other chemicals harmful to the foundation material. The contents in soil shall be indicated as percentage.

f) Chemical analysis of sub-soil water sample shall include the determination of the properties such as colour, odour, turbidity, pH value and chemical contents such as carbonate, sulphate (both SO_3 and

SO_4), chloride, nitrate, organic matter and any other chemicals harmful to the foundation material. The contents such as sulphate etc shall be indicated as ppm by weight.

8.0 REPORT

8.1 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-strata profiles, 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 engineer-in-charge/owner's review.

b) After review of the draft report, the engineer-in-charge/owner'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 final report shall be submitted along with 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 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.

8.2 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, DCPT 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.

h) 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 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 (eo, Po) 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) Values of cohesion, angle of internal friction 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.

n)Analysis and discussion of test results.

8.3 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.

i) Net safe bearing pressure for isolated square/rectangular footings and continuous strip footings of sizes 1, 2, 3, 4 & 5m at different founding depths of 1, 2, 3, 4 & 5m below ground level considering both shear failure and settlement criteria giving reasons for the type of shear failure adopted in the calculation.

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

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

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

ii) Suitable founding strata for the pile.

iii) Estimated length of pile for 800kN (450mm dia.), 1050kN (500mm dia.), 1500kN (600mm dia.) and 4500kN (1070mm dia.) capacities. End bearing and frictional resistance shall be indicated separately. Safe lateral and tensile load carrying capacities of pile with supporting calculations.

iv) Magnitude of negative skin friction if any.

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

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

f) 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.

g) Suitability of locally available soil at site for filling and back filling purposes.

h) 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.

i) 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.

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

k) Identification of any other potential geotechnical problems and their remedial measures.

l) Description of measures required for erosion control.

m) 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 methodology, equipments to be deployed etc shall be furnished.

9.0 RATES & MEASUREMENTS

9.1 RATES

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all

the activities covered in the description of the items as well as for all necessary operations in detail described in the technical specification.

b) The rates quoted are for any site within the said Power Sector Region with 'as is where is' basis.

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 co-ordinates at location of each bore hole, trial pit, field test 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.

e) The quoted rates for trial pits shall be inclusive of dewatering and backfilling etc.

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

g)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 equipments 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.

9.2 MEASUREMENTS

a) All measurements shall be in SI Units.

b) Length shall be measured in metre(m) correct to two place of decimals. Area shall be worked out in square metre(Sqm) and volume in cubic metre(Cum) rounded off to two decimals.

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

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

e) Pits shall be measured in Cum.

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

ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

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

For type of sample

DS Disturbed soil sample
UDS Undisturbed soil sample
RMS Remoulded soil sample
WS Water sample

For strength test

UCC Unconfined compression test
Tuu Unconsolidated undrained triaxial test
(Note: Replace T by D for Direct Shear test)

For other tests

LL Liquid Limit (%)
PL Plastic Limit (%)
PI Plasticity Index (%)
SL Shrinkage limit (%)
C Cohesion (kN/Sq.m)
ϕ Angle of internal friction (degrees)
FSI Free swell index (%)
e_o Initial Void ratio
Pc Preconsolidation pressure (kN/Sq.m)
Cc Compression index

p Pressure range (kN/Sq.m)
m_v Coefficient of volume compressibility (Sq.m/kN)
Cv Coefficient of consolidation (Sq.m/hr)
MDD Maximum Dry Density (kN/Cum)
OMC Optimum moisture content (%)
CBR California Bearing Ratio (%)

ANNEXURE-B

SUMMARY OF LABORATORY TEST RESULTS ON ROCK CORE SAMPLES

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

ANNEXURE-C

MINIMUM STAFF TO BE DEPLOYED

S.No.	Description	No. of persons
1.	Geotechnical Engineer	01
2	Engineering Geologist	01
3.	Engineer/Senior Surveyor	01
4.	Supervisor	01
5.	Rig Operator	01
6.	Mechanic	01

ANNEXURE-D

LIST OF EQUIPMENTS TO BE MOBILISED TO SITE (MINIMUM)

S.No.	Description	Quantity
1	Shell and auger boring set	01
2.	Rotary core drilling unit (Hydraulic feed)	01
3.	Dynamic cone penetration test equipment	01
4.	Electrical resistivity test set up	01
5.	Total station	01
6.	Auto Level	01

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

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SHEDULE OF QUANTITIES FOR PRELIMINARY TOPOGRAPHICAL SURVEY & GEOTECHNICAL INVESTIGATION

SPECIFICATION NO. PE-TS-999-602-002
VOLUME III

APRIL, 2012

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

SCHEDULE OF QUANTITIES FOR PRELIMINARY TOPOGRAPHICAL SURVEY & GEOTECHNICAL INVESTIGATION

NOTES:

1. Details of items shall be read in conjunction with the corresponding specification, 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 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 +/- 30% (plus or minus thirty 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/her quoted price.

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 topographical survey and 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	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		
3	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 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, compact disc and originals etc all complete as per specification and instructions of the engineer-in- charge.	Hectare	50		
4	Construction of bench mark pillar/reference 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) Reference pillar	 Each Each	 1 2		

SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
5	Making 150mm nominal diameter bore hole at various locations in all types of soil including ash using suitable approved method of boring including chiselling, cleaning, providing casing pipes as required or as directed; performing standard penetration tests; collection of undisturbed soil samples; 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 for depth below ground level as given below .				
	a) From ground level to 15m depth	RM	120		
	b) From 15m to 30m depth	RM	96		
6	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.	RM	24		

SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
7	Excavating trial pit of size 3m x 3m at various locations upto 4m depth below ground level in all types of soil and in weathered rock/soft 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 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	144		
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 electrical resistivity test at various locations complete as per specification, drawings and as directed by the engineer-in-charge.	Each	5		
10	Conducting laboratory test on soil samples at an approved laboratory including preparation of soil sam ples to determ ine the following properties etc all complete as per specification.				
	a)Bulk density and moisture content	Each	25		
	b)Sieve analysis	Each	75		
	c)Hydrometer analysis	Each	10		
	d)Liquid limit and plastic limit	Each	75		
	e)Shrinkage limit	Each	10		
	f)Specific gravity	Each	15		
	g) Free swell index	Each	5		
	h) Relative density	Each	10		

SL. NO	ITEM	UNIT	QTY.	RATE (INR)	AMOUNT (INR)
	i) Unconfined compressive strength	Each	20		
	j) Direct shear test	Each	15		
	k)Unconsolidated undrained triaxial shear test	Each	20		
	l) One dimensional consolidation test	Each	15		
	m) Standard Proctor compaction test	Each	4		
	n)Chemical analysis	Each	2		
11	Conducting laboratory test on rock samples including preparation of the samples to determine the following properties etc all complete as per specification.				
	a)Moisture content, porosity & density	Each	5		
	b)Specific gravity	Each	5		
	c)Unconfined compressive strength (both at saturated and in–situ water content)	Each	10		
12	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	2		
13	Preparation and submission of draft report in 3 copies and final report in 5 hard copies and 2 soft copies on compact discs after the approval of draft report including all field records, laboratory test results, graphs, analysis of test results, photographs showing details of field tests/soil/rock samples/trail pits and recommendation etc. all complete as per specification.	LS	1		

TOTAL