SUB-SECTION-II-A11

PROJECT INFORMATION- NABINAGAR 4X250 MW

1.00.00 BACKGROUND

Details of proposed Stage / Units

Project name	:	Nabinagar TPP
No. of Units x capacity	:	4 x 250 MW
Project setting up by	:	NTPC(FOR BHARTIYA RAIL BIJLEE COMPANY LTD.)

The SG with ESP package and TG package of the subject project is being executed by M/s. BHEL.

1.01.00 LOCATION AND APPROACH

Project Location	:	(i) Place : Nabinagar
	:	(ii) District : Aurangabad
	:	(iii) State : Bihar
Latitude and Longitude of project location	:	North : 24 deg. 42' 30" (N) East : 84 deg. 05' 36" (E)
Nearest Railway station	:	Dehri-On-Sone
Distance of project location from the Railway station	:	30 KM (Approx.)
Nearest MajorTown	:	Aurangabad
Distance of the town from the Project site	:	50 KM
Nearest CommercialAirport	:	Gaya
Distance of airport from the project site	:	100 KM
Nearest Highway	:	National Highway-2
Distance from nearest highway point to the site	:	25 KM
Vicinity plan	:	Vicinity plan of the project enclosed at Annexure-I.
Any other information	:	Further to the information given in this sub-section, Bidders are advised to visit the project site and collect data on local site conditions.

1.02.00 LAND REQUIREMENT

Total area of land acquired for the project	:	1700 Acres
Any other information	:	Approximately 1700 acres of land has been identified near Dhundhua village for the Plant, Township and Ash Disposal Area. In principle commitment for the availability of land for Plant, Township and Ash Disposal Area has been obtained from Revenue Department, Govt. of Bihar vide letter dated 29.3.2003. Further, Central Coalfields Ltd., (CCL) vide their letter dated 29.05.03 have indicated that Central Mine Planning & Design Institute Ltd (CMPDI) have confirmed that plant location along with its other allied infrastructure are not coming on coal bearing area.

1.03.00 WATER

Nearest Water Source	:	The project site is located near the river Sone which is the only source of water for the project. Therefore, the make up water requirement for the project is proposed to be drawn from the pondage created by Indrapuri Barrage, which is about 3 kms from the proposed site.
Proposed water requirement for the Stage	:	60 Cusec
Proposed source / arrangement to the meet the water requirement	:	The project site is located near the river Sone which is the only source of water for the project. Therefore, the make up water requirement for the project is proposed to be drawn from the pondage created by Indrapuri Barrage, which is about 3 kms. from the proposed site. The make up water requirement for the project operating on cooling towers is about 4300 cubic m/hr with ash water recirculation system and about 5900 cubic m/hr. with once through ash water system. Water Resource Department, Govt. of Bihar, accorded in-principle clearance of 60 cusecs of consumptive water from upstream of Indrapuri Barrage vide their letter dated 06.03.03.

1.04.00 **COAL and WATER, Utility details:**

(i) Coal Quality Parameters and Fuel Oil Characteristics

Source:Pachra and Pachra south blocks in North Karanpura coalfields

Requirement: 5 MTPA

The Coal quality parameters and Fuel Oil Characteristics are enclosed at Table-1, & Table-2A & 2B of this Sub-Section.

Water data

(ii) Process water:
Process water quality based on COC in Table-3.

(iii) Clarified water:
Clarified water quality is indicated in Table-3.

(iv) DM water for Equipment cooling water system.
DM water quality is indicated in Table-4.

1.05.00 **Steam Generator and ESP data:** refer Table-5

1.06.00 Drawings are enclosed as per Table-6 for initial overview to the Bidder.

2.00.00 NOT USED

3.00.00 **RAILWAY SIDING**

For bringing the equipment and material to the power house through rail, railway siding is proposed to be constructed from nearest railway station.

4.00.00 **METEOROLOGICAL DATA**

Meteorological data of the nearest observatory Dehri station is enclosed as Annexure-II to this subsection.

5.00.00 **CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT**

All structures and equipment shall be designed for seismic forces adopting the site specific seismic information provided in this document and using the other provisions in accordance with IS:1893 (Part 1 to Part 4). Pending finalization of Part 5 of IS:1893, provisions of part 1 shall be read along with the relevant clauses of IS:1893:1984, for embankments.

A site specific seismic study has been conducted for the project site. The peak ground horizontal acceleration for the project site, the site specific acceleration spectral coefficients (in units of gravity acceleration 'g') in the horizontal direction for

the various damping values and the multiplying factor (to be used over the spectral coefficients) for evaluating the design acceleration spectra are as given at Appendix-I.

Vertical acceleration spectral values shall be taken as 2/3rd of the corresponding horizontal values.

The site specific design acceleration spectra shall be used in place of the response acceleration spectra, given at figure-2 in IS:1893 (Part 1) and Annex B of IS:1893 (Part 4). The site specific acceleration spectra along with multiplying factors specified in Appendix-I includes the effect of the seismic environment of the site, the importance factor related to the structures and the response reduction factor. Hence, the design spectra do not require any further consideration of the zone factor (Z), the importance factor (I) and response reduction factor (R) as used in the IS:1893 (Part 1 to Part 4).

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

Steel structures	2%
Reinforced Concrete structures	5%
Reinforced Concrete Stacks	3%
Steel stacks	2%

Method of Analysis

Since most structures in a power plant are irregular in shape and have irregular distribution of mass and stiffness, dynamic analysis for obtaining the design seismic forces shall be carried out using the response spectrum method. The number of vibration modes used in the analysis should be such that the sum total of modal masses of all modes considered is at least 90 percent of the total seismic mass and shall also meet requirements of IS:1893 (Part 1). Modal combination of the peak response quantities shall be performed as per Complete Quadratic Combination (CQC) method or by an acceptable alternative as per IS:1893 (Part 1).

In general, seismic analysis shall be performed for the three orthogonal (two principal horizontal and one vertical) components of earthquake motion. The seismic response from the three components shall be combined as specified in IS:1893 (Part 1).

The spectral acceleration coefficient shall get restricted to the peak spectral value if the fundamental natural period of the structure falls to the left of the peak in the spectral acceleration curve.

For buildings, if the design base shear (V_B) obtained from modal combination is less than the base shear ($\bar{V}_B$) computed using the approximate fundamental period (T_a) given in IS:1893:Part 1 and using site specific acceleration spectra with appropriate multiplying factor, the response quantities (e.g. member forces, displacements, storey forces, storey shears and base reactions) shall be enhanced in the ratio of $\bar{V}_B$/ V_B. However, no reduction is permitted if $\bar{V}_B$ is less than V_B.

For regular buildings less than 12m in height, design seismic base shear and its distribution to different floor levels along the height of the building may be carried out as specified under clause 7.5, 7.6 & 7.7 of IS:1893 (Part 1) and using site specific design acceleration spectra. The design horizontal acceleration spectrum value (Ah) shall be computed for the fundamental natural period as per clause 7.6 of IS:1893 (Part 1) using site specific spectral acceleration coefficients with appropriate multiplying factor given in Appendix-I.

Design/Detailing for Ductility for Structures

The site specific design acceleration spectra is a reduced spectra and has an in-built allowance for ductility. Structures shall be engineered and detailed in accordance with relevant Indian/International standards to achieve ductility.

APPENDIX – I

SITE SPECIFIC SEISMIC PARAMETERS FOR DESIGN OF STRUCTURES AND EQUIPMENT

The various site specific seismic parameters for the project site shall be as follows:

1) Peak ground horizontal acceleration : 0.16g

2) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') to obtain the design acceleration spectra

   a) for ordinary moment resisting steel frames designed and detailed as per IS:800 : 0.04

   b) for braced steel frames designed and detailed as per IS:800 : 0.03

   c) For special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.024

   d) for RCC chimney : 0.08
   e) for Liquid retaining tanks : 0.048
   f) for Steel chimney, Absorber tower : 0.06

   g) for design of structures not covered under 2 (a) to 2 (f) above and under 3 below : 0.04

3) Multiplying factor to be applied to the site specific horizontal acceleration spectral coefficients (in units of gravity acceleration 'g') for design of equipment and structures where inelastic action is not relevant or not permitted : 0.08

Note: g = Acceleration due to gravity

The horizontal seismic acceleration spectral coefficients are furnished in subsequent pages.

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
In units of 'g' for New Nabinagar project

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
0.000	1.000	1.000	1.000
0.030	1.000	1.000	1.000
0.050	1.750	1.607	1.443
0.100	3.737	3.060	2.374
0.104	3.904	3.174	2.443
0.123	3.904	3.401	2.753
0.150	3.904	3.401	2.753
0.200	3.904	3.401	2.753
0.250	3.904	3.401	2.753
0.300	3.904	3.401	2.753
0.350	3.904	3.401	2.753
0.400	3.904	3.401	2.753
0.450	3.904	3.401	2.753
0.500	3.904	3.401	2.753
0.516	3.904	3.401	2.753
0.550	3.662	3.401	2.753
0.600	3.357	3.142	2.753
0.607	3.320	3.105	2.753
0.670	3.006	2.813	2.493
0.700	2.877	2.693	2.386
0.750	2.685	2.513	2.227
0.800	2.518	2.356	2.088
0.850	2.369	2.218	1.965
0.900	2.238	2.094	1.856
0.950	2.120	1.984	1.758
1.000	2.014	1.885	1.670
1.050	1.918	1.795	1.590
1.100	1.831	1.714	1.518
1.150	1.751	1.639	1.452
1.200	1.678	1.571	1.392
1.250	1.611	1.508	1.336

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
In units of 'g' for New Nabinagar project

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
1.300	1.549	1.450	1.285
1.350	1.492	1.396	1.237
1.400	1.439	1.346	1.193
1.450	1.389	1.300	1.152
1.500	1.343	1.257	1.113
1.550	1.299	1.216	1.077
1.600	1.259	1.178	1.044
1.650	1.221	1.142	1.012
1.700	1.185	1.109	0.982
1.750	1.151	1.077	0.954
1.800	1.119	1.047	0.928
1.850	1.089	1.019	0.903
1.900	1.060	0.992	0.879
1.950	1.033	0.967	0.856
2.000	1.007	0.943	0.835
2.050	0.982	0.920	0.815
2.100	0.959	0.898	0.795
2.150	0.937	0.877	0.777
2.200	0.915	0.857	0.759
2.250	0.895	0.838	0.742
2.300	0.876	0.820	0.726
2.350	0.857	0.802	0.711
2.400	0.839	0.785	0.696
2.450	0.822	0.769	0.682
2.500	0.806	0.754	0.668
2.550	0.790	0.739	0.655
2.600	0.775	0.725	0.642
2.650	0.760	0.711	0.630
2.700	0.746	0.698	0.619
2.750	0.732	0.685	0.607
2.800	0.719	0.673	0.596

APPENDIX – I

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS
In units of 'g' for New Nabinagar project

Time Period	Damping Factor (as a percentage of critical damping)		
(Sec)	2%	3%	5%
2.850	0.707	0.661	0.586
2.900	0.694	0.650	0.576
2.950	0.683	0.639	0.566
3.000	0.671	0.628	0.557
3.050	0.660	0.618	0.548
3.100	0.650	0.608	0.539
3.150	0.639	0.598	0.530
3.200	0.629	0.589	0.522
3.250	0.620	0.580	0.514
3.300	0.610	0.571	0.506
3.350	0.601	0.563	0.499
3.400	0.592	0.554	0.491
3.450	0.584	0.546	0.484
3.500	0.575	0.539	0.477
3.550	0.567	0.531	0.470
3.600	0.559	0.524	0.464
3.650	0.552	0.516	0.458
3.700	0.544	0.509	0.451
3.750	0.537	0.503	0.445
3.800	0.530	0.496	0.439
3.825	0.527	0.493	0.437
3.850	0.523	0.490	0.434
3.900	0.516	0.483	0.428
3.950	0.510	0.477	0.423
4.000	0.504	0.471	0.418

6.00.00 **CRITERIA FOR WIND RESISTANT DESIGN OF STRUCTURES AND EQUIPMENT**

All structures shall be designed for wind forces in accordance with IS:875 (Part-3) and as specified in this document. See Annexure – B for site specific information.

Along wind forces shall generally be computed by the Peak (i.e. 3 second gust) Wind Speed method as defined in the standard.

Along wind forces on slender and wind sensitive structures and structural elements shall also be computed, for dynamic effects, using the Gust Factor or Gust Effectiveness Factor Method as defined in the standard. The structures shall be designed for the higher of the forces obtained from Gust Factor method and the Peak Wind Speed method.

Analysis for dynamic effects of wind must be undertaken for any structure which has a height to minimum lateral dimension ratio greater than "5" and/or if the fundamental frequency of the structure is less than 1 Hz.

Susceptibility of structures to across-wind forces, galloping, flutter, ovalling etc. should be examined and designed/detailed accordingly following the recommendations of IS:875(Part-3) and other relevant Indian standards.

It should be estimated if size and relative position of other structures are likely to enhance the wind loading on the structure under consideration. Enhancement factor, if necessary, shall suitably be estimated and applied to the wind loading to account for the interference effects.

Damping in Structures

The damping factor (as a percentage of critical damping) to be adopted shall not be more than as indicated below for:

a) Welded steel structures : 1.0%

b) Bolted steel structures : 2.0%

c) Reinforced concrete structures : 1.6%

d) Steel stacks : As per IS:6533 & CICIND Model Code whichever is more critical.

ANNEXURE-B

SITE SPECIFIC DESIGN PARAMETERS

The various design parameters, as defined in IS: 875 (Part-3), to be adopted for the project site shall be as follows:

a) The basic wind speed "V_b" at ten metres above the mean ground level : 47 metres/second

b) The risk coefficient "K_1" : 1.07

c) Category of terrain : Category-2

7.00.0 FOUNDATION SYSTEM AND GEOTECHNICAL DATA

7.00.01 Geotechnical data and foundation system for the respective project are enclosed at annexure-III. The corresponding bore logs are enclosed at annexure-IV.

7.00.02 The available soil data is of vicinity of proposed structures, therefore, bidder shall carryout his own detailed soil investigation for facilities under this package and shall be as per the scheme approved by owner**.**The scheme for geotechnical investigation shall be as given at Clause 7.07.00 and shall be approved by owner before execution.Geotechnical investigation work shall got executed by the Contractor through the agencies as mentioned in Clause No. 7.07.03. However, no time extension shall be given on account of soil investigation carried out by the Bidder. The geotechnical investigation report shall be prepared with detailed recommendations regarding type of foundation and allowable bearing pressure for various structures/ facilities and other soil parameters. The report shall be submitted for Owner's approval prior to commencement of design of foundation.

7.00.03 The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Owner and that found by the Bidder during geotechnical investigation by him or during execution of works, shall be payable.

7.00.04 Tank Foundations

a) The tanks shall rest on flexible tank pad foundation, resting on sand with concrete ring wall to retain sand. Base of the concrete ring wall shall not rest on the expansive soil, if any.

b) Entire loose/ soft soil inside the concrete ring wall shall be removed and shall be filled with sand. Sand for filling shall be clean and well graded conforming to IS 383 with grading Zone I to III.

c) Sand shall be spread in layers not exceeding 30cm compacted thickness over the area. Each layer shall be uniformly compacted by mechanical means like plate vibrators, small vibratory rollers,etc to achieve a relative density of not less than 80%.

d) Other requirements of tank foundations shall be as per IS 803 and as specified elsewhere in the specifications.

7.02.00 **Foundation System**

The requirements for the foundation system to be adopted are as given in subsequent clauses. Depending upon the depth of competent strata/stratum, type of structures, functional requirement of facility, extent of cutting / filling, suitable foundation, open or pile shall be adopted with approval of owner.

7.02.01 General Requirements

a) All structures/equipment shall be supported either on suitable open foundations (isolated, combined, raft) or pile foundations depending on type of structures/facilities, sub-strata, topography etc.

b) The roads, ground floor slabs, trenches, pipe pedestals, channels/drains and staircase foundation with foundation loading intensity less than 4 T / M2 may be supported on open / shallow foundations resting on virgin / controlled compacted filled up soil.

c) No other foundation (other than as mentioned in (b) above) shall rest on the filled up ground / soil.

d) No foundation shall rest on the black cotton soil.

e) Before execution of work the bidder shall ensure that there is no obstruction to underground/overground facilities like sewer lines, pipe lines etc. Any such damage and remedial/ rectification measures shall be at the contractors cost.

f) Bidder shall also ensure that there is no damage to existing nearby foundations and the foundations pertaining to this package are not placed at shallower depth than the nearby foundations. If required depth of foundation is deeper than the existing foundations, proper protection shall be provided to existing foundations.

g) All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian Standards.

h) The water table for design purpose shall be considered at Finished Ground Level.

i) A combination of open and pile foundations shall not be permitted under the same equipment / structure / building.

j) Foundation for equipments on ground floor

For equipments of static weight upto 1.5 T, the equipment may be supported on the ground floor slab by locally thickening the slab. Thickening of the ground floor slab shall be done upto an extent of about 0.6 m beyond the plan area of the equipment on all the sides. Further, the load intensity below the equipment shall be limited to 4T/m2. Other requirements of floor slab and compaction below the floor slab shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 1.5 T, the equipment foundation shall be taken to the founding level or shall be built up with PCC from the level as mentioned in the Table 1. The pedestal of equipment foundation or the foundation Block shall be isolated from the adjoining floor slab by providing bitumen impregnated fiber board of minimum 50 mm thick, conforming to IS: 1838 all around the equipment pedestal for the full depth of the floor slab.

7.02.02 **Open Foundations**

In case open foundations are adopted, following shall be adhered to.

a) The minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0m below Ground Level.

c) It shall be ensured that all foundations of a particular structure/ buildings/ facility shall rest on one bearing stratum.

d) Wherever the intended bearing sub-strata is virgin soil stratum but the actual stratum encountered during foundation excavation consists of filled up soil at founding level, under such cases either the foundation shall be lowered completely into the virgin stratum or the filled up soil upto the virgin layers shall be removed and built up through PCC (1:4:8) up to designed foundation level.

7.02.03 Pile Foundations –

(a.) In case piles are adopted, following shall be adhered to :

i) The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911. Pile boring shall be done using Rotary Hydraulic Rigs/conventional tripod rig. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer.

If required, temporary or permanent MS liner may be provided for piling.

ii) The minimum diameter of pile shall be 600 mm. The allowable load capacity of the pile in different modes (vertical compression, lateral and pullout) shall be as per approved geotechnical report & as enclosed in relevant annexure:

iii) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

iv) The contractor shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, pile load test arrangement, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical

Lateral Minimum of 2 Nos. in each mode.

Uplift

vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of vertical compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

viii) Load test shall be conducted at pile Cut-off Level (COL). If the water table is above the COL the test pit shall be kept dry throughout the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge with concrete blocks.

xiv) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency to be approved by Engineering department of Owner. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

xv) High Strain Dynamic Load Test may be carried out for routine load testing of working piles. However, at least two numbers of static routine vertical load tests shall be carried out on pile on which high strain dynamic load test has already been carried out for establishing the correlation between the two tests. In case of discrepancy if any between dynamic and static vertical load tests, then additional static routine vertical load tests shall be conducted as decided by the Engineer and the results of static routine vertical load shall prevail. Number of routine vertical pile load tests as per clause 7.02.03 (ix) shall be total of static routine vertical load test and high strain dynamic load tests.

The procedure to carryout the test shall be submitted to the Engineer.The test and equipment shall conform to ASTM D4945-00. The test shall be conducted by an experienced independent test agency approved by the owner.Field data shall be submitted to the site engineer and shall include force velocity curves, pile capacity, simulated static load test curve, net and total pile displacement, pile integrity. A (Case pile wave analysis) CAPWAP or equivalent software analysis shall be conducted on the field data for correct capacity estimation and to evaluate end bearing and skin friction components of the pile.

xvi) From load considerations, single pile may be used under a column/tower. In that case, pile shall be connected with tie beams at pile cut off level in both directions.

xvii) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

xviii) Reinforcement for job piles shall be designed as following:

(a) Compression + bending piles: For these piles, the allowable safe pile capacities in compression and bending shall be considered.

(b) Tension + bending piles: For these piles, the actual pile forces to be considered. However, maximum 3 types of combinations for varying percentage of tension capacity + bending case may be designed & adopted by contractor for the entire scope of work under this package.

7.03.00 Special Requirements

7.03.01 Details of treatment for foundations / underground structures required to counteract soil / water chemical environment shall be as per detailed geotechnical investigation to be carried

	out by contractor.Contractor shall carry out chemical analysis during detailed geotechnical investigation and required treatment shall be provided accordingly.
7.04.00	**Excavation, Filling and Dewatering**
7.04.01	For excavation works, comprehensive dewatering with well point or deep wells arrangement, if required, shall be adopted. Scheme for dewatering and design with all computations and back up data for dewatering shall be submitted for the owner's information. The water table shall be maintained at 0.5m below the founding depth.
7.04.02	Excavation for shallow foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil or any loose pockets are encountered at founding level during excavation the same shall be removed and compensated by PCC M7.5. The final layer of about 300 mm thickness above the founding level shall be excavated by suitable means, so as to avoid disturbance to founding stratum.
7.04.03	Backfilling around foundations, pipes, trenches, sumps, pits, plinths, etc. shall be carried out with approved material in layers not exceeding 300 mm compacted thickness (higher thickness of layers upto 500mm with heavy mechanical compacting equipment) and each layer shall be compacted to 90% of standard proctor density for cohesive soils and to 80% of relative density for non-cohesive soils Rock pieces having size less than 150 mm and interstices filled with soil may be used for backfilling around foundation, plinths etc. and shall be compacted to minimum of 85% of original stack of material after filling the interstices.
7.04.04	Founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches / channels.
7.04.05	CBR tests for pavement/road design shall be carried out by the Contractor after earth filling (if applicable) has been completed upto the formation level.
7.04.06	The contractor shall take all necessary measures during excavation to prevent the hazards of falling or sliding of material or article from any bank or side of such excavation which is more than one and a half meter above the footing by providing adequate piling, shoring, bracing etc. against such bank or sides. Adequate and suitable warning signs shall be put up at conspicuous places at the excavation work to prevent any persons or vehicles falling into the excavation trench. No worker should be allowed to work where he may be stuck or endangered by excavation machinery or collapse of excavations or trenches.
7.05.00	**EXCAVATION IN ROCK** Excavation in rock shall be carried out by mechanical means and if blasting is required for founding of some of the structures under this package, control blasting only shall be carried out.
7.05.01	Controlled blasting shall be done by a specialised agency duly approved by Engineer. All controlled blasting shall be done by using time delay detonators (i.e. excel type).
7.05.02	a) Contractor shall engage an agency expert in blasting such as, NIRM (National Institute of Rock Mechanics), CMPDIL, Central Institute of Mining and Fuel Research Dhanbad, Dept. of Mining of Govt. Institutions etc. to design detailed blasting scheme and get the same approved from Engineer before carrying out the blasting

operation. All blasting shall be done as per the approved blasting scheme & initial blasting operations shall be done under the supervision & guidance of the representative of the blasting expert.

b) All the statutory laws, (Explosives Act etc.) rules, regulations, Indian Standards, etc. pertaining to the acquisition, transport, storage, handling and use of explosives, etc. shall be strictly followed.

c) The Contractor shall obtain Licenses from Competent Authorities for undertaking blasting work as well as for procuring, transporting to site and storing the explosives as per explosives act. The Contractor shall be responsible for the safe transport, use, custody and proper accounting of the explosive Materials.

d) The Contractor shall be responsible and liable for any accident and injury / damage which may occur to any person or property of the project or public on account of any operations connected with the storage, transportation, handling or use of explosive and blasting operations.

7.06.00 Sheeting & Shoring

The contractor shall ascertain for himself the nature of materials to be excavated and difficulties, if any, likely to be encountered in excavation while executing the work. Sheet piling, sheeting and shoring, bracing and maintaining suitable slopes, drainage, etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

7.07.00 Geotechnical Investigation

The Contractor shall carry out detailed geotechnical investigation in the areas under his scope for establishing the sub-surface conditions and to decide type of foundations for the structures envisaged, construction methods, any special requirements/treatment called for remedial measures for sub-soil/ foundations etc. in view of soft sub-soils, aggressive sub-soils and water, expansive/swelling soils etc. prior to commencement of detailed design/drawings. The Contractor shall obtain the approval for the field testing scheme proposed by him from the Owner before undertaking the geotechnical investigation work.

7.07.01.00 **Scheme of geotechnical Investigation**

7.07.02.01 Field test shall include but not be limited to the following:

Boreholes, Standard Penetration Test (SPT), Dynamic Cone Penetration Test (DCPT), collection of disturbed samples (DS) and undisturbed soil samples (UDS), Trial Pits (TP), Plate Load Tests (PLT), Electrical Resistivity Test (ERT), In situ field permeability tests, collection of water samples, etc.

7.07.02.02 The diameter of borehole shall be minimum 150 mm in soil and 76 mm in rock. The diameter of UDS sampler shall be 100 mm minimum. Core drilling in rock shall be done by using hydraulically feed rotary drill & double tube core barrel with diamond bit.

7.07.02.03 The minimum tests are indicated in Clause No. 7.08.00. Adequate number of tests shall be conducted up to sufficient depth for complete determination of subsoil conditions. The depth of boreholes shall be as specified in Appendix A. SPT shall be carried out in all types of soil deposits and in all rock formations with core recovery up to 20%, met within a borehole. This test shall be conducted at every 3.0 m interval or at change of strata, up to the final depth. SPT 'N' of 100 and above shall be referred as refusal. UDS shall be collected at every 3.0 m interval or at change of strata up to depth of borehole. UDS may be replaced by additional SPT, if SPT'N' value in the strata is above 50.

7.07.02.04 Laboratory tests shall be done as per relevant IS codes. The laboratory tests, not be limited to the following shall be conducted on disturbed and undisturbed soil samples, rock samples & water samples collected during field investigations in sufficient numbers.

Laboratory Tests on Soil Samples

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for Grain Size Analysis, Hydrometer Analysis, Atterberg Limits, Triaxial Shear Tests (UU), Natural Moisture Content, Specific Gravity and Bulk Unit Weight, Consolidation Tests, Unconfined Compression Test, Free swell Index, Shrinkage Limit, Swell Pressure Test, Chemical Analysis test on soil and water samples to determine the carbonates, sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.

Laboratory Tests on Rock Samples

Moisture content, porosity & density, Specific Gravity, Hardness, Soundness, Slake durability index, Unconfined compression test (Both at saturated and in-situ water content), Point load strength index and deformability test (Both at saturated and in-situ water content) shall be carried out on rock samples.

7.07.02.05 Geotechnical investigation (field & laboratory) shall be carried out in accordance with the provisions of relevant Indian Standards.

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

Recommendations on foundation system and the net allowable bearing pressures and pile capacity shall be based on the conservative values of geotechnical investigation data.

7.07.03.00 Geotechnical investigation work shall be got executed by the Contractor through the following agencies.

1. C.E.TESTING COMPANY Pvt. Ltd, Kolkata
2. CengrsGeotechnica Pvt. Ltd, New Delhi
3. M.K. Soil Testing Laboratory, Ahemdabad
4. SECON Pvt Ltd, Bangalore
5. Soil Engineering Consultants, New Delhi
6. Orbital Infrastructure Consultancy & Research Pvt. Ltd. Cuttack
7. KCT Consultancy Services, Ahemdabad
8. ARKITECHNO Consultants (India) Pvt. Ltd. Bhubaneswar

7.08.00 Geotechnical Investigation Scheme

a) **Boreholes (Minimum)**

S.N	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	FGD	Minimum 14 Nos.	Depth of boreholes shall be 25m to 35m.	Depth of

2	Crusher House	Minimum 2 Nos.	Depth of boreholes shall be 25m to 35m.	boreholes shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 25% whichever is earlier.
3	Gypsum and Lime storage area	Minimum 10 Nos.	Depth of boreholes shall be 15m to 25m	
4	Other Structure/Facility	Minimum 2 Nos. boreholes under each area / facility	15 to 20 m	
5	Chimney	Minimum 2 Nos.	30 to 35m	

b) Other Field Tests (Minimum)

1	Cyclic Plate Load Test (CPLT)	3nos	Test Depth from 2 to 4 m	
2	Trial Pit (TP)	5 Nos.	Depth - 3 m	
3	In Situ Permeability Test In Boreholes	In minimum 3 Nos. of boreholes	Tests shall be conducted at depths of 1.0m, 3.0m, 5.0m, 8.0m and 12.0m.	
4	ERT	Minimum 10 Nos.		

- Depth and location of Boreholes and other field tests (PLT, ERT, field permeability tests etc.) shall be approved by Owner before execution of geotechnical investigation work.
- Investigation in any other building / structure / facilities / trestleswhich are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

Annexure-III

SOIL DATA AND FOUNDATION SYSTEM

Employer has carried out geotechnical investigation in the areas near to this package. Logs of representative boreholes to be used for bidder's information in the vicinity of proposed area are enclosed with this Annexure-II. The bidder is required to carry out geotechnical investigation as per the clause no. 7.07.00 and ascertain the pile capacity and bearing capacity. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. Ground water table is encountered at a depth of about 11.0 to 13.0m below natural ground level (NGL) at the time of investigation. Fluctuation may occur in ground water table due to seasonal variation. The natural ground level is varying as per enclosed contour/spot level drawing.

a) The foundation system to be adopted for different structures shall be as given in Table – i below

Table – i: Net Allowable Bearing Pressure

STRUCTURE	TYPE OF FOUNDATION TO BE ADOPTED
FGD and related structures	Open/Piles

b) During design the Allowable Bearing Pressure shall be as furnished in Table-ii. Bidder is required to carry out geotechnical investigation in this area. The allowable bearing pressure shall be adopted after approval of geotechnical investigation report by owner. However, the maximum allowable bearing pressure shall be as per the approved geotechnical report and shall be limited to the values as furnished in Table-ii.

Table – ii: Net Allowable Bearing Pressure

Structure	Founding Level in RL	Net Allowable Bearing Pressure T/m^2		
		Isolated / Strip		Rafts (width > 6m) for 75mm settlement
		width upto 6 m for 25mm settlement	Width upto 6m for 40mm settlement	
FGD and related structures	2.5 m below NGL	8.0	9.0	10.0
	3.5 m	10.0	12.0	14.0

	below NGL			
	4.5 m below NGL	12.0	15.0	17.0

The net allowable bearing pressure higher than above mentioned values shall not be permitted. At intermediate levels the bearing capacity shall be same as the net allowable bearing pressure corresponding to the immediate shallower level mentioned above.

c) Permissible Settlement of Foundations:

For open foundations, the total permissible settlement and differential settlement shall be governed by IS: 1904 and from functional requirements whichever is more stringent. However, total settlement shall be restricted to the following:

Isolated, Strip & Raft (Mill foundations/machine foundation)	25 mm
Isolated & Strip (Other than Mill foundations/machine foundation)	40 mm
Raft (widths greater than 6 m) (Other than Mill foundations/machine foundation)	75 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced after review in consultation with Engineer.

d) The diameter of pile, minimum length and maximum allowable capacity of piles shall be as given below:

Area/ Location	Pile Diameter (mm)	Minimum Length of Bored Pile Below Cut-off Level (m)	Safe Load Capacity in		
			Vertical Comp. (MT)	Pullout (MT)	Lateral (MT)
FGD and related structures	600	18.0	140.0	45.0	7.0
	760	19.0	250	75.0	12.5

- Cut off Level (COL) is assumed at 3.0 m below FGL (RL(+) 127.0m). If the COL is shallower than the assumed COL, then the length of the pile shall be increased accordingly.

e) The criteria for Pile Termination (founding level) shall be as given below:

The termination level of the pile shall be decided based on the following criterion

i) Minimum length of the pile below COL (cut off level) shall be as specified above

ii) The minimum pile length for each group of piles shall be determined based on the nearest borelog. Pile shall be socketed into yellowish weathered sand stone. A socketing length of four (4) times the diameter of the pile into rock with rock core recovery ≥ 20% shall be ensured for 600 mm & 760 mm dia piles. For pile termination, SPT 'N' values shall be used from the nearby borelog data. The boreholes are in the bidder's scope and shall be conducted as per the enclosed scheme.

iii) However, in no case the length of pile shall be less than the minimum length determined as in (i) or (ii) above whichever is longer, for that pile group.

g) Special Requirements:

i) Chemicals in ground water and subsoil, as observed during investigation are:

Chemical	SO_3	Chlorides	pH
Ground Water	18 to 30 ppm	50-82 ppm	7.26 – 7.44
Sub-soil	0.011 to 0.023 %	0.02 to 0.064 %	7.3 – 7.62

ii) In view of the above, the following shall be adopted.

Cement Type	As specified elsewhere in the specifications
Concrete Grade	As specified elsewhere in the specifications
Type of Reinforcement	As specified elsewhere in the specifications
Cover to Reinforcement	As specified elsewhere in the specifications

TABLE-1

COAL CHARACTERISTICS

Sl. No.	Description	Symbol	Design Coal	Worst Coal	Best Coal	Range of Adequacy Coal
1	2	3	4	5	6	7
A.	**PROXIMATE ANALYSIS** (As received basis)					
1.	Total Moisture	%	15.00	17.00	12.00	12.00-17.00
2.	Ash	%	43.00	47.00	38.00	36.00-49.00
3.	Volatile matter	%	20.00	18.00	22.00	25.00-15.00
4.	Fixed carbon	%	22.00	18.00	28.00	37.00-17.00
B.	**ULTIMATE ANALYSIS** (As received basis)					
1.	Carbon	C%	30.77	25.97	39.08	41.11-24.35
2.	Hydrogen	H2%	3.4	2.85	3.5	3.60-2.87
3.	Nitrogen	N2%	0.7	0.45	0.55	0.55-0.40
4.	Oxygen (By difference)	O2%	6.2	5.6	6.07	6.1-5.5
5.	Sulphur	S%	0.4	0.50	0.36	0.30-0.50
6.	Carbonates	CO3%	0.50	0.60	0.40	0.30-0.35
7.	Phosphorous	P2%	0.03	0.03	0.04	0.04-0.03
8.	Total Moisture	H2O%	15.00	17.00	12.00	12.00-17.00
9.	Ash	%	43.00	47.00	38.00	36.00-49.00
10.	Gross Calorific Value	KCal/Kg	3300	2800	4000	4200–2700
11.	Hard grove index		55	50	60	45-65
C.	**ASH ANALYSIS**					
1.	Silica	(SiO2)%	59.79	61.30	56.70	62-56
2.	Alumina	(Al2O3)%	25.36	28.00	23.50	28-23
3.	Iron Oxide	(Fe2O3)%	7.20	6.00	10.00	6-10

Sl. No.	Description	Symbol	Design Coal	Worst Coal	Best Coal	Range of Adequacy Coal
1	2	3	4	5	6	7
4.	Titania	(TiO2)%	1.2	1.00	1.50	1-1.7
5.	Phosphoric Anhydride	(P2O5)%	2.6	1.5	3	1-3
6.	Lime	(CaO)%	0.88	0.5	1.50	0.5-1.7
7.	Magnesia	(MgO)%	0.55	0.4	1	0.4-1.1
8.	Sulphuric Anhydride	(SO3)%	1.2	0.5	1.4	0.5-1.7
9.	Alkalies (By Difference)	(Na2O+K2O)%	1.22	0.8	1.4	0.6-0.8
	Note: Na2O content in the above shall not be more than 0.1%					
D.	**ASHFUSIONRANGE** (Under reducing atmosphere)					
a)	Initial Deformation Temperature (IDT)	°C	1150	1200	1100	1100-1200
b)	Hemispherical temperature	°C	1350	1450	1300	1300-1400
c)	Flow temperature	°C	1400	1400	1400	1400-1450

TABLE –2A

FUEL OIL CHARACTERISTICS

Sl. No.	Characteristics	Heavy Furnace Oil grade HV (HFO) IS-1593-1982	Low Sulphur Heavy Stock (LSHS) IS-11489-1985	Heavy Petroleum stock (HPS) IS-11489-1985
1.	Total sulphur content	4.5% Max.	1.0% Max.	4.5% Max.
2.	Gross calorific value (KCal/kg)	of the order of 10,000	of the order of 10,000	of the order of 10,000
3.	Flash Point (Min)	66 deg C	76 deg C	66 deg C
4.	Water content by volume (Max)	1.0%	1.0%	1.0%
5.	Sediment by weight (Max)	0.25%	0.25%	0.25%
6.	Asphaltene content by weight (Max.)	2.5%	2.5%	2.5%
7.	Kinematic viscosity in Centistokes	370 at 50deg C	100 at 100deg C	100 at 100deg C
8.	Ash Content by weight (Max.)	0.1%	0.1%	0.1%
9.	Acidity (inorganic)	Nil	Nil	Nil
10.	Pour Point (Max.)	57 deg C	66 deg C	72 deg C
11.	Sodium content	—	—	100 ppm
12.	Vanadium content	25 ppm	25ppm	25 ppm
13.	Specific heat below pour point (KCal/Kg °C)		0.65	

TABLE –2B

LIGHT DIESEL OIL CHARACTERISTICS

AS PER IS 1460-2000

	Characteristics	LDO
1.	Pour Point (max)	21 deg.C& 12°C for Summer and Winter respectively
2.	Kinematic viscosity in centistokes at 40 deg.C	2.5 to 15.7
3.	Sediment percent by mass (max)	0.10
4.	Total sulphur percent by mass (max)	1.8
5.	Ash percentage by mass (max)	0.02
6.	Carbon residue (Rans bottom) percent by pass (max.)	1.50
7.	Acidity in organic	Nil
8.	Flash point(Min.) - Pensky Martens	66 deg.C
9.	Copper strip corrosion for 3 hours at 100°C	Not worse than No. 2
10.	Water content, % by volume(max)	0.25
11.	GCV (Kcal/kg)	10,000

Table-3

DESIGN CLARIFIED WATER ANALYSIS

S.No	Constituent	As	mg/l (except pH & turbidity)
1.	Calcium	$CaCO_3$	131
2.	Magnesium	$CaCO_3$	52
3.	Sodium + Potassium	$CaCO_3$	65
4.	Total Cations	$CaCO_3$	248
5.	Chloride	$CaCO_3$	20
6.	Sulphate	$CaCO_3$	93
7.	Nitrate	$CaCO_3$	10
8.	Alkalinity	$CaCO_3$	125
9.	Total Anions	$CaCO_3$	248
10.	Iron(total)	Fe	0.3
11.	Total Silica	SiO_2	22
12.	pH value	---	7.0-8.2
13.	Turbidity	NTU	10

Note: Clarified water is used for CW system as make up & the CW system is expected to operate at about 5.0 – 5.5 Cycles of Concentration (COC) with suitable chemical treatment program using acid, scale & corrosion inhibitor dozing. As CW blow down water is tapped from CW system, the water quality of CW blow down shall accordingly be arrived by the bidder.

Table-4

ANALYSIS OF DM WATER

Sl.No.	Characteristics	Value
1.	Silica (Max.)	0.02 ppm as SiO2
2.	Iron as Fe	Nil
3.	Total hardness	Nil
4.	pH value	6.8 to 7.2
5.	Conductivity	Not more than 0.1 μs/cm

Table-5

STEAM GENERATOR DATA

1.	Location	Outdoor
2.	Operation	Base load
3.	Type	Pulverised coal fired
4.	Maximum Continuous Rating	810 Tons/hr.
5.	Steam pressure at SH outlet	155 Kg/cm²(a)
6.	Steam temperature at SH outlet	540°C
7.	Oil for start up and flame stabilization	Heavy Oil/LSHS/HPS/LDO
8.	Fuel oil system sizing	30% of Boiler MCR for Heavy oil/ LSHS/HPS (7.5% for LDO)
9.	Pulverised coal size and 99% thru 50 mesh	Minimum 70% through 200 Mesh
10.	Type of pulveriser	Vertical spindle mills
11.	Type of oil burners	Steam atomised, (Air atomised for LDO)
12.	No. of air heaters	Two (2) nos. of Tri-sector type
13.	No. of ID Fans	Two (Radial type, both working)

2.00.00 ESP DATA

1.	Location:	Downstream side of Air preheaters
2.	Operation:	Base load
3.	Type:	Rigid Discharge frame
4.	Rapping:	Intermittent

TABLE-6

List of Drawings enclosed in this sub-section:

Sl.No.	Drawing Description	Drawing No.
1.	General Layout Plan	Enclosed
2.	Topographical Survey	Enclosed
3.	Equipment Layout Plan	Enclosed
4.	ID system-Elevation & Plan	Enclosed
5.	Pipe Cable Trestle Layout	Not located near FGD area
6.	Pipe Cable Trestle Foundation	Not located near FGD area
7.	<u>Chimney foundation details</u>	

	Chimney shell outer diameter at ground level (m)	Chimney foundation outer diameter (m)	Type of foundation	Level of Top of foundation (m)	Level of Bottom of foundation (m)
Unit #1&2	28	42.1	Raft supported on piles	RL(+) 126.00	RL(+) 122.25
Unit #3&4	28	42.1	Raft supported on piles	RL(+) 126.00	RL(+) 122.25