(3X200 MW+3X500 MW) RAMAGUNDAM STAGE-I & II FGD

OF
NTPC Limited
(A Government of India Enterprise)

TECHNICAL SPECIFICATION
FOR
MISCELLANEOUS FGD TANKS

SPECIFICATION NO.: PE-TS-467-167-A101

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

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SECTION-I,
SUB-SECTION-A

INTENT OF SPECIFICATION

1.0 **SCOPE OF ENQUIRY/ INTENT OF SPECIFICATION**

1.1 This specification includes, but not limited to Supply part, Services part comprising of design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles(as applicable) along with spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, Rubber lining/Glass flake lining final painting at site, minor civil work and carrying out Performance guarantee / Functional / Demonstration tests at site (as applicable) and handover in flawless condition of Miscellaneous FGD Tanks turnkey package specified above for **(3X200 MW+3x500 MW) RAMAGUNDAM STAGE-I & II FGD Project** complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order.

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve them of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **Miscellaneous FGD Tanks** within quoted price.

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment / system shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system for its safe, efficient, reliable and trouble free operation and maintenance shall also be in supplier's scope unless specifically excluded and notwithstanding that they may have been omitted in drawings / specifications or schedules.

1.5 Items though not specifically mentioned but needed to make the system complete as stipulated under these specifications are also to be furnished unless otherwise specifically excluded.

1.6 The general terms and conditions, instructions to tenderer and other attachment referred to elsewhere are hereby made part of the tender specifications. The equipment / material and works covered by this specification is subject to compliance to all the attachments referred in the specification. The tenderer shall be responsible for adherence to all requirements stipulated herein.

1.7 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on

specification requirement in the format enclosed under Sec.-III of the specification within 10 days of receipt of tender documents. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.8 Deviations, if any, should be very clearly brought out clause by clause in the enclosed schedule otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.

1.9 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.10 Unless specified otherwise, all through the specification, the word contractor shall have same meaning as successful bidder/vendor and Customer/Purchaser/Employer will mean BHEL and/or Customer as interpreted by BHEL in the relevant context. Please refer GCC/SCC for better clarity.

1.11 The equipment covered under this specification shall not be dispatched unless the same have been finally inspected, accepted and dispatch release issued by BHEL/Customer.

1.12 BHEL's Customer's representative shall be given full access to the shop in which the equipment's are being manufactured or tested and all test records shall be made available to him.

1.13 Various codes and standards to be used shall be as indicated in various parts of the specification. In case bidder uses any standard other than those indicated in the specification, the onus of establishing equivalence of the same with the specified standards will rest with the bidder and acceptance of the same shall be sole prerogative of customer. The bidder will also arrange for BHEL a copy of the standards in ENGLISH language. The cost of such service will be deemed to have been included by the bidder in the total cost of the package. BHEL will not entertain any additional cost on account of the same.

1.14 All text/ numeric in the document / drawings to be generated by the successful bidder will be in English language only.

1.15 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

Note:

Bidder to note that BHEL reserves the right for drawing/document submission through web based Document Management System. Bidder would be provided access to the DMS for drawing/document approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.

- Internet explorer version – Minimum Internet Explorer 7.
- Internet speed – 2 mbps (Minimum preferred).
- Pop ups from our external DMS IP (124.124.36.198) should not be blocked.
- Vendor's internal proxy setting should not block DMS application's link (http://dmsserver.bhelpem.com/Wrench%20Web%20Access/Login.aspx.).

SECTION-I,
SUB-SECTION-B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

CLAUSE NO.	PROJECT INFORMATION
1.00.00	**Background** Ramagundam stage- I (3x200 MW) steam generators were designed for coals with GCV of 4300 kcal/kg while presently the units are fired with coal having GCV in the range of 3500-3800 kcal/kg.
1.01.00	**Location and Approach** NTPC Ramagundam (RSTPS) is a pit-head thermal power station based on the coal supplied from the nearby Singareni Mines of M/s. SCCL and water from Pochampad Dam. The station is located in the Peddapalli district of the Indian state of Telangana. about 60 kms from Karimnagar town and 100 kms from Warangal. Ramagundam Railway station is on the Delhi - Chennai main line. Ramagundam is well connected to Hyderabad by Rajiv Rahadari state highway. The aerial distance from Ramagundam to Hyderabad is 178 km while the road distance between Ramagundam to Hyderabad is 209 km and by train it is 224 Km. Nearest commercial airport is Rajiv Gandhi International Airport, Hyderabad at about 250 km. Vicinity plan of the proposed project is placed at **Annexure –I.**
1.02.00	Not Used
1.03.00	**Unit Capacity** The units are originally designed for 200 MW which is being uprated for unit TMCR (Turbine through separate R&M package) rating of 210 MW. This applies to all the three units. The BMCR shall remain the same and is considered adequate for the uprated steam turbine.
1.04.00	**Equipment cooling water** The cooling water system for equipment/systems is taken from existing equipment cooling water (ECW) sources. Any requirement for equipment cooling shall be from the existing ECW system only. Water for ash disposal requirements, if any, shall also be taken from existing nearby ash water lines.
1.05.00	**Coal Quality Parameters / Fuel Oil Characteristics** Coal Quality Parameters / Fuel Oil Characteristics & Plant Water details: (i) The Coal quality parameters and Fuel Oil characteristics are indicated in Table-1 & Table-2 respectively below. (ii) **Process water:** Process water quality is CW Blowdown based on the COC indicated in Table-4. (iii) **Clarified water:**

Clarified water quality is indicated in Table-4.

(iv) **DM water for Equipment cooling water system.**
DM water quality is indicated in Table-5.

1.06.00 Steam Generator and ESP data: refer Table-6.

1.07.00 **Drawings are enclosed as per Table-**7 for initial overview to the Bidder.

2.00.00 NOT USED

3.00.00 Capacity

Stage-I 3 x 200 MW

Stage-II 3 x 500 MW

4.00.00 Metrological Data

The metrological data from nearest observatory is placed at **Annexure-II.**

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:

a)	Steel structures	:	2%
b)	**Reinforced Concrete structures**	:	5%
c)	Reinforced Concrete Stacks	:	3%
d)	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.

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 (MCE) : 0.28 g

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 special moment resisting steel frames designed and detailed as per IS:800 : 0.082

b) For special concentrically braced steel frames designed and detailed as per IS:800 : 0.062

c) for special moment resisting RC frames designed and detailed as per IS:456 and IS:13920 : 0.049

d) for RCC chimney, RCC Natural Draft Cooling Tower : 0.163

e) For Liquid retaining tanks : 0.098

f) for Steel chimney, Absorber tower, Vessels : 0.123

g) for design of structures not covered under 2 (a) to 2 (f) above and under 3 below, in general (excluding special structure/ configuration/materials) : 0.082

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 : 0.163

Note: g = Acceleration due to gravity

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

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ANNEXURE-A

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS (In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0	1.000	1.000	1.000
0.03	1.000	1.842	1.450
0.04	1.355	2.032	1.600
0.05	1.716	2.223	1.750
0.06	2.081	2.413	1.900
0.07	2.449	2.604	2.050
0.08	2.820	2.794	2.200
0.09	3.194	2.985	2.350
0.10	3.570	3.175	2.500
0.105	3.759	3.175	2.500
0.106	3.760	3.175	2.500
0.11	3.760	3.175	2.500
0.115	3.760	3.175	2.500
0.12	3.760	3.175	2.500
0.125	3.760	3.175	2.500
0.13	3.760	3.175	2.500
0.135	3.760	3.175	2.500
0.14	3.760	3.175	2.500
0.145	3.760	3.175	2.500
0.15	3.760	3.175	2.500
0.20	3.760	3.175	2.500
0.25	3.760	3.175	2.500
0.27	3.760	3.175	2.500
0.30	3.760	3.175	2.500
0.32	3.760	3.175	2.500
0.35	3.760	3.175	2.500
0.372	3.760	3.175	2.500
0.40	3.500	3.175	2.500
0.402	3.483	3.159	2.488
0.405	3.457	3.136	2.469
0.41	3.415	3.098	2.439
0.425	3.294	2.988	2.353
0.45	3.111	2.822	2.222
0.50	2.800	2.540	2.000

ANNEXURE-A

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS (In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
0.55	2.545	2.309	1.818
0.60	2.333	2.117	1.667
0.65	2.154	1.954	1.538
0.70	2.000	1.814	1.429
0.75	1.867	1.693	1.333
0.80	1.750	1.588	1.250
0.85	1.647	1.494	1.176
0.9	1.556	1.411	1.111
0.95	1.474	1.337	1.053
1.0	1.400	1.270	1.000
1.05	1.333	1.210	0.952
1.10	1.273	1.155	0.909
1.15	1.217	1.104	0.870
1.20	1.167	1.058	0.833
1.25	1.120	1.016	0.800
1.30	1.077	0.977	0.769
1.35	1.037	0.941	0.741
1.40	1.000	0.907	0.714
1.45	0.966	0.876	0.690
1.50	0.933	0.847	0.667
1.55	0.903	0.819	0.645
1.60	0.875	0.794	0.625
1.65	0.848	0.770	0.606
1.70	0.824	0.747	0.588
1.75	0.800	0.726	0.571
1.80	0.778	0.706	0.556
1.85	0.757	0.686	0.541
1.90	0.737	0.668	0.526
1.95	0.718	0.651	0.513
2.0	0.700	0.635	0.500
2.05	0.683	0.620	0.488
2.10	0.667	0.605	0.476
2.15	0.651	0.591	0.465
2.20	0.636	0.577	0.455
2.25	0.622	0.564	0.444

ANNEXURE-A

HORIZONTAL SEISMIC ACCELERATION SPECTRAL COEFFICIENTS (In units of 'g')

Time Period (Sec)	Damping Factor (as a percentage of critical damping)		
	2%	3%	5%
2.30	0.609	0.552	0.435
2.35	0.596	0.540	0.426
2.40	0.583	0.529	0.417
2.45	0.571	0.518	0.408
2.50	0.560	0.508	0.400
2.55	0.549	0.498	0.392
2.60	0.538	0.488	0.385
2.65	0.528	0.479	0.377
2.70	0.519	0.470	0.370
2.74	0.511	0.464	0.365
2.80	0.500	0.454	0.357
2.85	0.491	0.446	0.351
2.88	0.486	0.441	0.347
2.90	0.483	0.438	0.345
2.95	0.475	0.431	0.339
3.0	0.467	0.423	0.333
3.05	0.459	0.416	0.328
3.10	0.452	0.410	0.323
3.15	0.444	0.403	0.317
3.20	0.438	0.397	0.313
3.25	0.431	0.391	0.308
3.30	0.424	0.385	0.303
3.35	0.418	0.379	0.299
3.40	0.412	0.374	0.294
3.45	0.406	0.368	0.290
3.50	0.400	0.363	0.286

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/RCC structures	:	2.0%
c) Prestressed 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 : 44 meters/second

b) The risk coefficient "K_1" : 1.07

c) Category of terrain : Category-2

7.00.00 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 furnished borelog details are specific to the co-ordinates where the boreholes have been carried out and are provided for bidder's information only. Soil profile in the proposed area may vary with respect to the borelogs enclosed for bidder's information. Bidder has to consider all such variations in his estimation, over the extent of the work to be carried out. 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's of static weight between 1.5 T and 20 T, the equipment may be supported on compacted sand filling with the load intensity below the equipment limited to 4T/m2. The minimum depth of foundation is 1.0m below FFL. Other requirements of sand compaction below the foundation shall be adhered, as specified elsewhere in the specifications.

For equipment of static weight more than 20 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 2. 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 –

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. However, conventional tripod rig may be allowed in inaccessible areas subject to site specific conditions. 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 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 carry out 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. Cengrs Geotechnica Pvt. Ltd, New Delhi
3. KCT Consultancy Services, Ahemdabad
4. M.K. Soil Testing Laboratory, Ahemdabad

7.08.00 Geotechnical Investigation Scheme

a) **Boreholes (Minimum)**

S.No	Structure	Spacing/Number of borehole	Depth of borehole	Remarks
1	FGD	Minimum 14 Nos.	Depth of boreholes shall be 25m to 35m.	Depth of boreholes

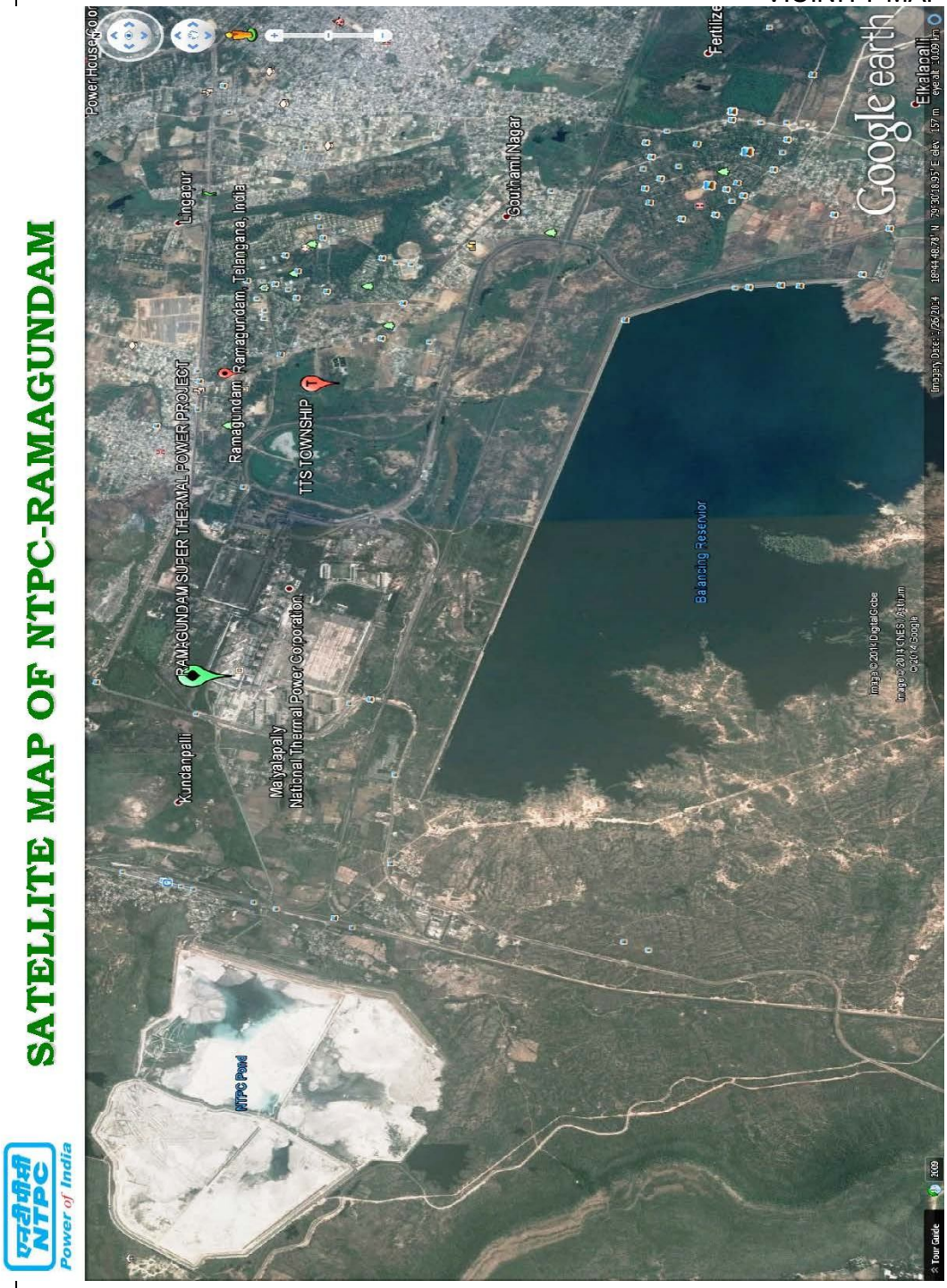
2	Crusher House	Minimum 2 Nos.	Depth of boreholes shall be 25m to 35m.	shall be as mentioned in column "Depth of Borehole" or 5m continuous in rock with RQD > 25% whichever is earlier.
3	Gypsum and Lime storage area	Minimum 10 Nos.	Depth of boreholes shall be 15m to 25m	
4	Other Structure/Facility	Minimum 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)	3 nos	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 / trestles which are not mentioned above shall also be carried out, if required, by the bidder for the facilities under his scope.

ANNEXURE-I
VICINITY MAP



जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : रामगुंडम
STATION : Ramgundam

अक्षांश LAT. 18°46' देशांतर LONG. 79°26'

समुद्री तल माध्य से ऊंचाई HEIGHT ABOVE M.S.L. 156 मीटर METRES

प्रेक्षणों पर आधारित BASED ON OBSERVATIONS 1971-2000

माह / MONTH		स्टेशन का सतह दाब / STATION LEVEL PRESSURE (एच.पी.ए / hPa)	वायु तापमान / AIR TEMPERATURE — माध्य / MEAN: शुष्क बल्ब / DRY BULB (डि. सें / °C)	नम बल्ब / WET BULB (डि. सें / °C)	दैनिक अधिक तम / DAILY MAX (डि. सें / °C)	दैनिक न्यून तम / DAILY MIN (डि. सें / °C)	माह मे उच्चतम / HIGHEST IN THE MONTH (डि. में / °C)	माह मे निम्नतम / LOWEST IN THE MONTH (डि. सें / °C)	चरम / EXTREMES: उच्चतम / HIGHEST (डि. सें / °C)	दिनांक और वर्ष / DATE AND YEAR	निम्नतम / LOWEST (डि. सें / °C)	दिनांक और वर्ष / DATE AND YEAR	आर्द्रता / HUMIDITY: सापेक्ष आर्द्रता / RELATIVE HUMIDITY (प्रतिशत / %)	वाष्प दाब / VAPOUR PRESSURE (एच.पी.ए / hPa)	मेघ की मात्रा / CLOUD AMOUNTS (आकाश के अष्टमाश / Oktas of sky): समस्त मेघ / ALL CLOUDS	निम्न मेघ / LOW CLOUDS	मासिक योग / MONTHLY TOTAL (मि.मि. / mm)	वर्षा के दिनोकी संख्या / NO. OF RAINY DAYS	वर्षा / RAINFALL: वर्षसहित सबसे नम महीने का योग / TOTAL IN WETTEST MONTH WITH YEAR (मि.मि. / mm)	वर्षसहित शुष्कतम महीने का योग / TOTAL IN DRIEST MONTH WITH YEAR (मि.मि. / mm)	24 घंटोकी सबसे भारी वर्षा / HEAVIEST FALL IN 24 HOURS (मि.मि. / mm)	दिनांक और वर्ष / DATE AND YEAR	माध्य पवन गति / MEAN WIND SPEED (कि.मी. प्र. घं. / Kmph)
जनवरी JAN	I	998.3	19.9	17.0	30.7	15.6	33.4	10.5	35.3	28 1974	8.0	4 1991	74	17.4	1.6	0.7	11.5	0.7	53.0 1966	0.0	47.6	20 1979	2.6
	II	994.4	28.2	20.2									45	17.2	1.5	0.6							
फरवरी FEB	I	996.3	22.9	18.8	33.5	18.5	36.5	13.3	39.4	29 1980	8.4	22 1993	65	18.6	1.8	0.9	9.7	0.7	77.2 1998	0.0	56.8	6 1998	3.3
	II	992.1	31.4	21.3									38	17.2	1.3	0.7							
मार्च MAR	I	994.5	26.9	21.0	37.5	21.8	40.7	16.5	43.0	29 1996	13.0	11 1979	57	20.2	1.3	0.5	9.2	0.7	71.6 1951	0.0	40.4	12 1987	3.5
	II	989.6	35.3	22.7									30	17.4	1.5	0.7							
अप्रैल APR	I	991.6	30.5	23.7	40.5	25.7	43.7	21.2	45.6	30 2000	15.4	20 1971	55	23.8	1.8	0.5	13.7	1.1	97.7 1997	0.0	62.0	24 1961	4.6
	II	986.2	38.2	24.1									29	18.8	2.7	1.3							
मई MAY	I	988.2	32.8	24.4	42.1	28.3	45.3	23.4	47.3	24 1984	20.4	1 1977	49	23.9	2.5	0.7	34.7	2.4	142.2 1977	0.0	111.2	1 1977	4.5
	II	983.1	39.7	25.2									29	20.4	3.3	1.6							
जून JUN	I	985.5	29.8	24.5	37.4	26.8	43.8	22.6	47.2	8 1953	19.4	3 1973	65	26.6	5.2	1.8	180.1	8.7	373.3 1989	0.0	158.8	15 1998	4.9
	II	981.4	34.9	25.8									49	25.9	5.6	2.4							
जुलाई JUL	I	985.9	27.2	24.5	32.6	24.8	36.6	22.2	41.0	6 1966	18.8	14 1973	79	28.5	6.3	2.4	328.2	14.5	727.2 1988	104.3 1970	131.6	17 1986	3.6
	II	982.7	30.5	25.7									68	29.2	6.5	2.7							
अगस्त AUG	I	986.7	26.7	24.4	31.4	24.5	34.8	22.6	37.9	4 1990	19.8	31 1965	82	28.7	6.3	2.6	285.8	13.1	638.9 1986	46.4 1984	161.9	13 1986	2.9
	II	983.6	29.5	25.5									72	29.4	6.6	2.8							
सितम्बर SEP	I	989.8	27.3	24.7	33.1	24.3	35.7	22.1	38.6	28 1987	17.8	30 1972	80	29.2	4.9	1.9	166.9	8.2	430.4 1998	13.1 1985	145.3	20 1998	2.0
	II	986.2	30.2	25.6									69	29.3	5.7	2.5							
अक्तूबर OCT	I	993.5	26.2	23.1	33.3	22.1	35.8	17.7	38.4	11 1957	15.0	30 1992	76	26.0	3.0	1.1	102.5	4.7	539.6 1973	0.0	135.8	24 1973	1.6
	II	989.9	29.9	24.1									61	25.5	3.8	1.7							
नवम्बर NOV	I	996.7	23.1	19.7	31.5	18.0	34.1	13.4	36.6	6 1977	9.0	30 1970	71	20.4	2.0	0.6	24.0	1.7	118.0 1962	0.0	70.2	5 1961	1.5
	II	993.2	27.8	21.3									54	20.3	2.6	0.9							
दिसम्बर DEC	I	999.1	19.6	16.6	30.0	14.4	32.4	10.4	35.5	14 1984	7.5	24 1994	72	16.8	1.5	0.3	6.5	0.6	109.4 1962	0.0	101.2	2 1966	1.7
	II	995.3	26.6	19.5									49	17.2	1.9	0.5							
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	I	992.2	26.0	21.8	34.5	22.1	45.6	9.4	47.3	24	7.5	24	69	23.3	3.2	1.2	1172.8	57.0	1747.1	565.2	161.9	13	3.0
	II	988.2	31.8	23.4					5	1984	12	1994	49	22.3	3.6	1.5			1983	1952	8	1986	
वर्षोंकी सं NUMBER OF YEARS	I																						
	II	30	30	30	30	30	30	30	53		53		30	30	30	30	30	30	50	50	50		24

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जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : रामगुंडम
STAION : Ramgundam

		मौसम परिघटना						पवन														मेघ												दृश्यता				
		के साथ दिनों की संख्या						पवन की गती के साथ दिनों की संख्या (कि. मी. प्र. घं.)				पवन की दिशा के दिनों की संख्या का प्रतिशत										मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश					निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश						दृश्यता सहित दिनों की संख्या				
माह		वर्षण 0.3 मि.मि.या अधिक	ओले	गर्जन	कुहरा	धूल भरी आँधी	चंड वात	62 या अधिक	20-61	1-19	0	उ	उपू	पू	दपू	द	दप	प	उप	शांत		0	ले-2	3-5	6-7	8	0	ले-2	3-5	6-7	8	कुहरा 8	1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक
		WEATHER PHENOMENA						WIND														CLOUD											VISIBILITY				
		No. OF DAYS WITH						No. OF DAYS WITH WIND SPEED (Km. p. h.)				PERCENTAGE No. OF DAYS WIND FROM										No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) OKTAS					No. OF DAYS WITH LOW CLOUD AMOUNT OKTAS						No. OF DAYS WITH VISIBILITY				
MONTH		PPT 0.3 mm Or more	HAIL	THUNDER	FOG	DUST STORM	SQUALL	62 Or more	20-61	1-19	0	N	NE	E	SE	S	SW	W	NW	CALM		0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	FOG 8	UP TO 1 Km	1-4 Kms	4-10 Kms	10-20 Kms	OVER 20 Kms
जनवरी	I	1.0	0.0	0.5	0.4	0.0	0.0	0	0	11	20	3	5	3	6	11	4	0	1	67		18	5	4	3	1	22	5	3	1	0	0	0.1	1.5	8.1	17.6	3.6
JAN	II							0	0	13	18	1	10	7	8	8	3	2	1	60		15	8	5	2	1	20	9	2	0	0	0	0.0	0.0	2.6	23.0	5.4
फरवरी	I	1.1	0.0	0.8	0.0	0.0	0.0	0	0	14	14	4	8	2	11	15	6	1	2	51		15	4	4	4	1	18	5	4	1	0	0	0.0	0.7	7.0	16.1	4.2
FEB	II							0	0	14	14	2	8	4	7	14	7	4	2	52		15	8	4	1	0	17	9	2	0	0	0	0.0	0.1	1.9	19.9	6.2
मार्च	I	1.2	0.0	1.3	0.0	0.0	0.0	0	0	18	13	2	4	3	14	22	7	1	2	45		19	6	4	2	0	23	6	2	0	0	0	0.0	0.4	6.0	19.1	5.5
MAR	II							0	0	16	15	2	4	1	5	16	12	6	3	51		15	8	6	2	0	19	10	2	0	0	0	0.0	0.0	2.1	21.8	7.2
अप्रैल	I	2.0	0.0	3.0	0.0	0.1	0.0	0	0	21	9	2	2	3	14	26	15	3	3	32		13	8	6	2	1	22	6	2	0	0	0	0.0	0.0	4.4	19.2	6.4
APR	II							0	0	18	12	3	6	2	6	14	13	7	6	43		6	10	9	4	1	10	15	5	0	0	0	0.0	0.1	1.6	21.1	7.2
मई	I	3.8	0.0	4.7	0.0	0.0	0.1	0	0	24	7	3	2	2	9	16	16	10	18	24		10	8	8	4	1	19	9	3	0	0	0	0.0	0.0	3.0	20.9	7.1
MAY	II							0	0	19	12	4	5	3	6	9	8	10	12	43		4	8	12	6	1	7	17	7	0	0	0	0.0	0.1	1.4	21.5	8.1
जून	I	12.9	0.0	7.6	0.0	0.0	0.0	0	0	23	7	2	1	1	2	3	16	27	24	24		2	4	7	8	9	10	10	8	1	1	0	0.0	0.0	4.8	19.0	6.2
JUN	II							0	0	21	9	5	3	1	2	4	14	25	14	32		1	3	9	11	6	3	14	11	1	1	0	0.0	0.1	4.0	19.4	6.5
जुलाई	I	19.2	0.0	7.0	0.0	0.0	0.0	0	0	20	11	2	0	0	1	2	15	25	16	39		1	1	6	9	14	6	10	13	1	1	0	0.0	0.5	6.6	20.0	3.9
JUL	II							0	0	17	14	3	1	0	0	3	12	19	14	48		0	1	6	12	12	2	12	15	1	1	0	0.0	0.4	5.5	20.4	4.7
अगस्त	I	19.0	0.0	5.6	0.0	0.0	0.0	0	0	18	13	2	0	0	0	2	9	26	19	42		1	2	5	9	14	4	11	14	1	1	0	0.0	0.2	7.6	19.7	3.4
AUG	II							0	0	17	14	1	1	0	1	1	7	26	16	47		0	1	5	12	13	2	12	15	1	1	0	0.0	0.3	6.5	19.8	4.4
सितम्बर	I	12.4	0.0	6.8	0.0	0.0	0.0	0	0	15	15	2	1	1	1	2	6	16	19	52		2	5	8	9	6	8	11	10	1	0	0	0.0	0.0	5.8	20.5	3.7
SEP	II							0	0	14	16	3	5	2	2	1	4	15	11	57		0	2	8	14	6	2	14	13	1	0	0	0.1	0.3	4.4	20.8	4.4
अक्तूबर	I	6.7	0.0	4.3	0.0	0.0	0.0	0	0	12	19	5	9	2	4	3	2	3	9	63		9	6	7	6	3	18	8	5	0	0	0	0.0	0.6	6.7	17.6	6.1
OCT	II							0	0	13	18	4	15	8	3	1	2	3	4	60		5	7	9	7	3	9	13	8	1	0	0	0.0	0.5	3.8	20.6	6.1
नवम्बर	I	2.5	0.0	0.5	0.0	0.0	0.0	0	0	11	19	6	14	2	2	1	2	1	5	67		14	6	5	3	2	23	5	2	0	0	0	0.0	0.5	7.9	16.6	5.1
NOV	II							0	0	12	18	4	18	8	2	1	1	4	2	60		10	7	7	5	1	17	9	4	0	0	0	0.0	0.1	3.9	21.1	4.9
दिसम्बर	I	0.9	0.0	0.1	0.2	0.0	0.0	0	0	7	24	4	7	2	3	4	1	0	2	77		17	6	4	3	1	24	5	2	0	0	0	0.0	1.5	8.1	16.9	4.5
DEC	II							0	0	11	20	1	18	8	2	2	1	1	1	66		13	8	6	3	1	21	8	2	0	0	0	0.0	0.1	3.3	22.9	4.7
वार्षिक योग या माध्य	I	82.6	0.0	42.1	0.7	0.1	0.1	0	1	195	169	3	4	2	6	9	8	9	10	49		123	61	67	63	51	198	90	67	6	4	0	0.1	5.8	76.2	223.2	59.8
ANNUAL TOTAL OR MEAN	II							0	1	185	179	3	8	4	4	6	7	10	7	51		82	71	88	79	45	130	141	85	6	3	0	0.1	2.0	41.0	252.2	69.7
वर्षों की सं NUMBER OF YEARS	I II	30						30				30										30					30						30				

ANNEXURE-III

SOIL DATA AND FOUNDATION SYSTEM (Ramagundam-I&II)

Employer has carried out geotechnical investigation in vicinity to the proposed area. Logs of available boreholes solely for bidder's information in the vicinity of proposed area are enclosed with this Annexure.

The bidder is required to carry out geotechnical investigation as per Clause No 7.07.00 & 7.08.00 and ascertain the bearing capacity. The onus of correct assessment / interpretation and understanding of the existing subsoil condition / data is on the Bidder. The existing 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 – 1 below

Table – 1: Net Allowable Bearing Pressure

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

b) Bidder is required to carry out geotechnical investigation in this area. During detailed engineering, the Allowable Bearing Pressure shall be adopted after approval of geotechnical investigation report. However, the maximum allowable bearing pressure shall be lower of the two values i.e. as per approved geotechnical report and as per the values furnished in Table-2.

Table – 2: Net Allowable Bearing Pressure

Founding Depth/ Stratum	Net Allowable Bearing PressureT/m2		
	Isolated and combined footings including raft for 25mm permissible settlement in case of soil and 12mm in case of rocky strata	Isolated and combined footings for 40mm permissible settlement in case of soil and 12mm in case of rocky strata	Rafts (width > 6m) for 75mm permissible settlement in case of soil and 12mm in case of rocky strata
	Width upto 6.0m		
In case of Soil			
2.0m below NGL	8	10	12

3.0m below NGL	10	12	15
4.0m below NGL	14	16	18
In case of rocky strata			
1.0m Embedment in SDR (soft disintegrated rock)	30	30	30
0.6m Embedment in fractured sandstone rock.	40	40	40
1.0m Embedment in fractured sandstone rock.	45	45	45

- For NGL, topographical survey drawing along with borehole details carried out by bidder shall be referred.

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 (machine foundation)	25 mm
Isolated & Strip (Other than machine foundation)	40 mm
Raft (widths greater than 6 m) (Other than machine foundation)	75 mm
Foundations in rock	12 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.

ANNEXURE-IV (BORE LOG DATA REFERE ANNEXURE)

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION

AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM

LOCATION STAGE IV MAIN PLANT AREA

BEARING OF HOLE

COLLAR ELEVATION : 30 cms

STARTED :19-07-2011

BORE HOLE NO. : 111

CO - ORDINATES : 18A+39,11B+66

ANGLE WITH HORIZANTAL NIL

GROUND ELEVATION : 151.514 mtr

COMPLETED : 31-07-2011

SHEET NO. : 01

FEATURE : Plain area

TOTAL DEPTH : 20.00 mtr

TYPE(S) OF CORE BARREL: NX

DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY											WATER LOSS		PERMEABILITY			
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
0.00	1.00	Filling Soil	{{{{{{{{ {{{{{{{{													Diamond Core Bit			NX	3.00 mtr	5.00 mtr						D/S
1.00	1.50	Filling Soil	{{{{{{{{ {{{{{{{{																								SPT 4-6+8=14
1.50	3.00	SDR	//////// ////////																								SPT 5-7+8=15
3.00	4.50		//////// ////////																								SPT 7-8+10=18
4.50	5.00		//////// ////////																								D/S
5.00	6.00		//////// ////////																								SPT Refusal 3-50
6.00	7.00		//////// ////////																								D/S
7.00	8.00	Fractured ferrogenous sand stone rock	>>>> >>>>		20 20	30 40 40 50						20%					-	over 15									
8.00	9.00		>>>> >>>>			60 50 50	90					25%					-	over 15									
9.00	10.00		>>>> >>>>		30 30 40	50 30 50 60 50 50						39%					-	over 15									

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
BORE HOLE NO. : 111
SHEET NO. : 02
LOCATION STAGE IV MAIN PLANT AREA
CO - ORDINATES : 18A+39,11B+66
FEATURE : Plain area
BEARING OF HOLE
ANGLE WITH HORIZANTAL NIL
TOTAL DEPTH : 20.00 mtr
COLLAR ELEVATION : 30 cms
GROUND ELEVATION : 151.514 mtr
TYPE(S) OF CORE BARREL: NX
STARTED :19-07-2011
COMPLETED : 21-07-2011
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY											WATER LOSS		PERMEABILITY			
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
10.00	11.00	Fractured ferrogenous sand stone rock	>>>> >>>>			60 60	130 120 80						45%			Diamond Core Bit	25%	over 15	NX	3.00 mtr	5.00 mtr						
11.00	12.00		>>>> >>>>			50	90 100 120	160					52%				38%	15 to 8									
12.00	13.00		>>>> >>>>		20	70 30 30 60 40	150 100						50%				25%	over 15									
13.00	14.00		>>>> >>>>			30 60 60 60 60	150						42%				15%	over 15									
14.00	15.00		>>>> >>>>			40 30 60 60		290					48%				29%	15 to 8									
15.00	16.00	Ferrogenous sand stone rock	^^^^^^^^ ^^^^^^^^			60 60 30 40 40 60	130 90 90						60%				13%	over 15									
16.00	17.00		^^^^^^^^ ^^^^^^^^			40 50	90 80 150	190					60%				34%	15 to 8									
17.00	18.00		^^^^^^^^ ^^^^^^^^			40 70 60 50 60 60	120	490					95%				61%	5 to 3									
18.00	19.00		^^^^^^^^ ^^^^^^^^			30 50 60		170 200					51%				37%	15 to 8									
19.00	20.00		^^^^^^^^ ^^^^^^^^		10 10	40 50 30 50 60 70	90	160 160						73%			32%	15 to 8									

Total Depth of Bore Hole : 20.00 m

. APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
BORE HOLE NO. : 112
SHEET NO. : 01
LOCATION STAGE IV MAIN PLANT AREA
CO - ORDINATES : 19A+1,11B+66
FEATURE : Plain area
BEARING OF HOLE
ANGLE WITH HORIZANTAL NIL
TOTAL DEPTH : 20.00 mtr
COLLAR ELEVATION : 30 cms
GROUND ELEVATION : 151.924 mtr
TYPE(S) OF CORE BARREL: NX
STARTED :22-07-2011
COMPLETED : 24-07-2011
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY											WATER LOSS		PERMEABILITY			
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
0.00	1.00	Silty Clay	******** ********													Diamond Core Bit			NX	3.00 mtr	5.30 mtr						D/S
1.00	1.50	SDR	////////// //////////																								SPT>50
1.50	3.00	SDR	////////// //////////																								SPT 15-17+19=36
3.00	4.50	Silty Clay	******** ********																								SPT>50
4.50	5.00	Silty Clay	******** ********																								SPT>50
5.00	6.00	SDR	////////// //////////																								D/S
6.00	7.00	SDR	////////// //////////																								
7.00	8.00	Fractured ferrogenous sand stone rock	>>>> >>>>			50 50 70	80					25%					-	over 15									
8.00	9.00		>>>> >>>>			40 60 70 70 70 60	110						48%				11%	over 15									
9.00	10.00		>>>> >>>>			60 70 50		280					46%				28%	15 to 8									

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
LOCATION STAGE IV MAIN PLANT AREA
BEARING OF HOLE
COLLAR ELEVATION : 30 cms
STARTED :22-07-2011

BORE HOLE NO. : 112
CO - ORDINATES : 19A+1,11B+66
ANGLE WITH HORIZANTAL NIL
GROUND ELEVATION : 151.924 mtr
COMPLETED : 24-07-2011

SHEET NO. : 02
FEATURE : Plain area
TOTAL DEPTH : 20.00 mtr
TYPE(S) OF CORE BARREL: NX
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY											WATER LOSS		PERMEABILITY			
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
10.00	11.00	Fractured ferrogenous sand stone rock	>>>> >>>>				150	360					51%			Diamond Core Bit	51%		NX	3.00 mtr	5.30 mtr						
11.00	12.00		>>>> >>>>		20	30 70 50 60	90 110						43%				11%										
12.00	13.00		>>>> >>>>			60 60 40 50	80 140 80 90 80							68%			14%										
13.00	14.00		>>>> >>>>		20	70 50 60 50 60	80 80						47%				-										
14.00	15.00		>>>> >>>>			60 40 50 60	80 130 100 80 80							68%			23%										
15.00	16.00	Ferrogenous sand stone rock	^^^^^^^^ ^^^^^^^^			70	130 80 110	200					59%				44%										
16.00	17.00		^^^^^^^^ ^^^^^^^^			80	140 80 140 80 110						55%				39%										
17.00	18.00		^^^^^^^^ ^^^^^^^^			60 70 60 70 60 70 70 50 60 60 60	90							78%			-	over 15									
18.00	19.00		^^^^^^^^ ^^^^^^^^			60 60 70 70 60 60 70	150 80	160							84%		31%	over 15									
19.00	20.00		^^^^^^^^ ^^^^^^^^			60 70 50 70 60 70	80 110	180 170							92%		46%	8 to 5									

Total Depth of Bore Hole : 20.00 m

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
LOCATION STAGE IV MAIN PLANT AREA
BEARING OF HOLE
COLLAR ELEVATION : 37 cms
STARTED :25-07-2011

BORE HOLE NO. : 113
CO - ORDINATES : 18A+1,11B+31
ANGLE WITH HORIZANTAL NIL
GROUND ELEVATION : 151.426 mtr
COMPLETED : 27-07-2011

SHEET NO. : 01
FEATURE : Plain area
TOTAL DEPTH : 20.00 mtr
TYPE(S) OF CORE BARREL: NX
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV. IN M		LITHOLOGY DESCRIPTION	LITHOLOGY LOG	SIZE OF CORE PIECES <10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	STRUCTURAL CONDITIONS DESCRIPTION	LOG	% CORE RECOVERY 0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	WATER LOSS PARTIAL	COMPLETE	PERMEABILITY TEST SECTION	MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
0.00	1.00	Silty Clay	******** ********													Diamond Core Bit			NX	4.00 mtr	5.00 mtr						D/S
1.00	1.50	SDR	////////// //////////																								SPT 13-15+17=32
1.50	3.00		////////// //////////																								SPT 5-17+20=37
3.00	4.50		////////// //////////																								SPT>50
4.50	6.00		////////// //////////																								SPT>50
6.00	7.00	Fractured ferrogenous sand stone rock	>>>> >>>>			40 40 30 30 30 30 40 50						29%					-									
7.00	8.00		>>>> >>>>		20	50 50 60 60 60	100					40%					10%	over 15									
8.00	9.00		>>>> >>>>			70 60 70 70 70 60	90						49%				-	over 15									
9.00	10.00		>>>> >>>>			50 60 60	110 120	160					56%				39%	15 to 8									
10.00	11.00		>>>> >>>>			70 70 60 60	130 100						49%				23%	over 15									

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
LOCATION STAGE IV MAIN PLANT AREA
BEARING OF HOLE
COLLAR ELEVATION : 37 cms
STARTED :25-07-2011

BORE HOLE NO. : 113
CO - ORDINATES : 18A+1,11B+31
ANGLE WITH HORIZANTAL NIL
GROUND ELEVATION : 151.426 mtr
COMPLETED : 27-07-2011

SHEET NO. : 02
FEATURE : Plain area
TOTAL DEPTH : 20.00 mtr
TYPE(S) OF CORE BARREL: NX
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY											WATER LOSS		PERMEABILITY			
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
11.00	12.00	Fractured ferrogenous sand stone rock	>>>> >>>>		20 20 20	40 40 40 50 50 50	100						43%			Diamond Core Bit	10%	over 15	NX	4.00 mtr	5.00 mtr						
12.00	13.00		>>>> >>>>			60 60 60	80 90 100						45%				10%	over 15									
13.00	14.00		>>>> >>>>				130 80 110	210					53%				45%	15 to 8									
14.00	15.00		>>>> >>>>			70	140 80 140 80						51%				28%	15 to 8									
15.00	16.00	Ferrogenous sand stone rock	^^^^^^^^ ^^^^^^^^		70	60 70 60 60 60	120						50%				12%	over 15									
16.00	17.00		^^^^^^^^ ^^^^^^^^			70 70 70 70 50 60	100						49%				10%	over 15									
17.00	18.00		^^^^^^^^ ^^^^^^^^			60 60 70 70 70	120 80 90	160						78%			28%	over 15									
18.00	19.00		^^^^^^^^ ^^^^^^^^			60 70 40 60 60 70 70		170					60%				17%	15 to 8									
19.00	20.00		^^^^^^^^ ^^^^^^^^			60	110	170 190 200						73%			67%	5 to 3									

Total Depth of Bore Hole : 20.00 m

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
BORE HOLE NO. : 114
SHEET NO. : 01

LOCATION STAGE IV MAIN PLANT AREA
CO - ORDINATES : 18A+29,10B+95
FEATURE : Plain area

BEARING OF HOLE
ANGLE WITH HORIZANTAL NIL
TOTAL DEPTH : 20.00 mtr

COLLAR ELEVATION :
GROUND ELEVATION : 152.117 mtr
TYPE(S) OF CORE BARREL: NX

STARTED :
COMPLETED :
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY					TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	WATER LOSS		PERMEABILITY		PENETRATION RATE MM/MIN	SPECIAL OBSVS
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100							PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON		
0.00	1.00	Silty Clay	******** ********													Diamond Core Bit			NX	6.00 mtr							D/S obtained
1.00	1.50	SDR	////////// //////////																								SPT 15-17+17=34
1.50	3.00		////////// //////////																								SPT 13-19+20=39
3.00	4.50		////////// //////////																								SPT>50
4.50	6.00		////////// //////////			20 20 20	30 30 40 50					21%															SPT>50
6.00	7.00	Fractured ferrogenous sand stone rock	>>>> >>>>			20	30 50 50				15%																
7.00	8.00		>>>> >>>>				70 50 60 50 40	90				36%															
8.00	9.00		>>>> >>>>				50 50 50 40 30	140				36%					14%	over 15									
9.00	10.00		>>>> >>>>				60 60 60 50	80 90				40%															

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
BORE HOLE NO. : 114
SHEET NO. : 02

LOCATION STAGE IV MAIN PLANT AREA
CO - ORDINATES : 18A+29,10B+95
FEATURE : Plain area

BEARING OF HOLE
ANGLE WITH HORIZANTAL NIL
TOTAL DEPTH : 20.00 mtr

COLLAR ELEVATION :
GROUND ELEVATION : 152.117 mtr
TYPE(S) OF CORE BARREL: NX

STARTED :
COMPLETED :
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV. IN M		LITHOLOGY DESCRIPTION	LITHOLOGY LOG	SIZE OF CORE PIECES <10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	STRUCTURAL CONDITIONS DESCRIPTION	STRUCTURAL CONDITIONS LOG	% CORE RECOVERY 0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	WATER LOSS PARTIAL	WATER LOSS COMPLETE	PERMEABILITY TEST SECTION	PERMEABILITY MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
10.00	11.00	Medium grained ferrrgenous sandstoe rock	&&&&& &&&&&			70	100 110 140						42%			Diamond Core Bit	35%	15 to 8	NX	6.00 mtr							
11.00	12.00		&&&&& &&&&&			50 70 30 60	150 100						46%				25%	over 15									
12.00	13.00		&&&&& &&&&&			30 50 40 60	150					33%					15%	over 15									
13.00	14.00		&&&&& &&&&&			60 40 30 50	150					33%					15%	over 15									
14.00	15.00		&&&&& &&&&&			70 50 30 40	130 90						41%				13%	over 15									
15.00	16.00		&&&&& &&&&&			40 30 30 50	150	180					48%				33%	15 to 8									
16.00	17.00		&&&&& &&&&&	10	20	30 30	120	240					45%				36%	15 to 8									
17.00	18.00		&&&&& &&&&&		20	30	90 90 120 120						47%				24%	over 15									
18.00	19.00		&&&&& &&&&&			50 30 50	90 100 80						40%				10%	over 15									
19.00	20.00		&&&&& &&&&&			50 50 60	90 150						40%				15%	over 15									

Total Depth of Bore Hole : 20.00 m

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
LOCATION STAGE IV MAIN PLANT AREA
BEARING OF HOLE
COLLAR ELEVATION :
STARTED :07-08-2011

BORE HOLE NO. : 115
CO - ORDINATES : 19A+13,10B+93
ANGLE WITH HORIZANTAL NIL
GROUND ELEVATION : 151.638 mtr
COMPLETED : 08-08-2011

SHEET NO. : 01
FEATURE : Plain area
TOTAL DEPTH : 20.00 mtr
TYPE(S) OF CORE BARREL: NX
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV.		LITHOLOGY		SIZE OF CORE PIECES					STRUCTURAL CONDITIONS		% CORE RECOVERY					TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	WATER LOSS		PERMEABILITY		PENETRATION RATE MM/MIN	SPECIAL OBSVS
IN M		DESCRIPTION	LOG	<10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	DESCRIPTION	LOG	0 - 20	20 - 40	40 - 60	60 - 80	80 - 100							PARTIAL	COMPLETE	TEST SECTION	MM/S OR LUGEON		
0.00	1.00	Filling up material	}}}}}}}}} }}}}}}}}																								
1.00	2.00		******** ********																								SPT 4-6-13=19
2.00	3.00	Silty Clay	******** ********																								SPT 12-11-16=27
3.00	4.00		******** ********																								SPT 16-16-23=39
4.00	5.00	SDR	////////// //////////																								N>50
5.00	6.00		////////// //////////													Diamond Core Bit	-		NX	4.00 mtr							N>50
6.00	7.00		???>>> ???>>>																								calcareous formation visible
7.00	8.00	calcarous fractured sand stone rock	???>>> ???>>>		20 20 20	40 40	80					22%															
8.00	9.00		???>>> ???>>>		20	40 60	120					24%					12%	over 15									
9.00	10.00	Medium grained ferrrgenous sandstone rock	&&&&& &&&&&		20	40 40 60	100					26%					10%	over 15									

APPENDIX C

CLAUSES 3.1 AND 3.4

PROFORMA FOR PRESENTING DRILLING INFORMATION — AS PER IS4464:1985

PROJECT : NTPC RAMAGUNDAM
LOCATION STAGE IV MAIN PLANT AREA
BEARING OF HOLE
COLLAR ELEVATION :
STARTED :07-08-2011

BORE HOLE NO. : 115
CO - ORDINATES : 19A+13,10B+93
ANGLE WITH HORIZANTAL NIL
GROUND ELEVATION : 151.638 mtr
COMPLETED : 08-08-2011

SHEET NO. : 02
FEATURE : Plain area
TOTAL DEPTH : 20.00 mtr
TYPE(S) OF CORE BARREL: NX
DRILLING AGENCY M/S GEO TECHNICAL SERVICES

ELEV. IN M		LITHOLOGY DESCRIPTION	LITHOLOGY LOG	SIZE OF CORE PIECES <10MM	10 - 25 MM	25 - 75 MM	75 - 150 MM	>150 MM	STRUCTURAL CONDITIONS DESCRIPTION	LOG	% CORE RECOVERY 0 - 20	20 - 40	40 - 60	60 - 80	80 - 100	TYPE OF BIT	R.Q.D	FRACT FREQ/M	SIZE OF HOLE	CASING	WATER LEVEL	WATER LOSS PARTIAL	WATER LOSS COMPLETE	PERMEABILITY TEST SECTION	PERMEABILITY MM/S OR LUGEON	PENETRATION RATE MM/MIN	SPECIAL OBSVS
10.00	11.00	Medium grained ferrrgenous sandstoe rock	&&&&& &&&&&			40 40 60	80 80					30%				Diamond Core Bit			NX	4.00 mtr							
11.00	12.00		&&&&& &&&&&			60	80 100 110 100						45%				31%	15 to 8									
12.00	13.00		&&&&& &&&&&		20	40 40 60	110 100 100 110	200						78%			62%	8 to 5									
13.00	14.00	calcarous fractured sand stone rock	???>>> ???>>>		20 20	50 60 40 50 60	100						40%				10%	over 15									calcarous formation visible
14.00	15.00		???>>> ???>>>		20 20 20	50 60 40	110					32%					11%	over 15									
15.00	16.00	Medium grained ferrrgenous sandstoe rock	&&&&& &&&&&		20 20 20	30 40 50 40 60 60						34%															thin cross calcareous bands<10 mm
16.00	17.00		&&&&& &&&&&		20 20	40 40 80 40 60 60	80						44%														thick cross calcareous banks>10mm
17.00	18.00	calcarous fractured sand stone rock	???>>> ???>>>		20	40 60 30 60	100 100						41%				20%	over 15									
18.00	19.00		???>>> ???>>>			40 40 40 70	80 100 80							45%			10%	over 15									calcarous formation visible
19.00	20.00	Medium grained ferrrgenous sandstoe rock	&&&&& &&&&&			60 70 60 50 50	80						37%														

Total Depth of Bore Hole : 20.00 m

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.4

Co-ordinates N=13B+36 E=6A+64

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
		Disturbed (DS)	3
Vane (V)		Water Sample (WS)	0

Commencement Date : 21/04/2018
Completion Date : 22/04/2018
Bore Hole Diameter : 150 mm/N.X
Level Of Ground : 154.72 m.
Water Struck At :
Standing Water Level : 4.70 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very dense brownish grey, silty sand with decomposed rock.		100 4.0 cm Pentn. Refusal	DS-1	0.50
		100 4.0 cm Pentn. Refusal	DS-2	1.00
			*SPT-1	1.20-1.24
1.30m.			*SPT-2	1.30-1.34
		NX rotary drilling from 1.30m	R1	CR=40% RQD=NIL 1.30–2.00
Moderately weathered, reddish brown to brownish grey, medium grained, fractured rock.			R2	CR=48% RQD=28% 2.00–2.75
			R3	CR=50% RQD=32% 2.75–3.50
4.25m.			R4	CR=44% RQD=12% 3.50–4.25
Slightly weathered to fresh, brownish grey to reddish brown, medium grained, slightly fractured rock.			R5	CR=52% RQD=24% 4.25–5.00
			R6	CR=60% RQD=32% 5.00–5.75
			R7	CR=62% RQD=48% 5.75–6.50
			R8	CR=64% RQD=52% 6.50–7.25
			R9	CR=68% RQD=54% 7.25–8.00
			R10	CR=71% RQD=25% 8.00–8.75
			R11	CR=81% RQD=48% 8.75–9.50
			R12	CR=78% RQD=36% 9.50–10.25
			R13	CR=68% RQD=48% 10.25–11.00
			R14	CR=78% RQD=NIL 11.00–11.75
			R15	CR=82% RQD=76% 11.75–12.50
			R16	CR=90% RQD=80% 12.50–13.25
			R17	CR=93% RQD=90% 13.25–14.00
			R18	CR=97% RQD=94% 14.00–14.75
			R19	CR=93% RQD=66% 14.75–15.50
			R20	CR=86% RQD=82% 15.50–16.25
17.00m.			R21	CR=96% RQD=80% 16.25–17.00

N.B. – '*' means sample could not be recovered.

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.5

Co-ordinates N=13B+43 E=6A+92

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 17/04/2018
Completion Date : 18/04/2018
Bore Hole Diameter : 150 mm/N.X.
Level Of Ground : 153.18 m.
Water Struck At :
Standing Water Level : 3.40 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	Depth (m)
0.00m. Dense to very dense brownish grey, silty sand		3 10 37 47	DS-1	0.30
			DS-2	1.00
			SPT-1	1.50-1.95
2.50m. Moderately weathered, reddish brown to brownish grey, medium grained, fractured rock.		100 4.0 cm Pentn. Refusal 100 4.0 cm Pentn. Refusal	*SPT-2 *SPT-3	2.40-2.44 2.50-2.54
3.25m.		NX rotary drilling from 2.50m	R1	CR=44% RQD=36% (2.50–3.25)
			R2	CR=64% RQD=33% (3.25–4.00)
			R3	CR=66% RQD=16% (4.00–4.75)
			R4	CR=63% RQD=NIL (4.75–5.50)
			R5	CR=76% RQD=36% (5.50–6.25)
			R6	CR=68% RQD=40% (6.25–7.00)
			R7	CR=90% RQD=56% (7.00–7.75)
			R8	CR=82% RQD=74% (7.75–8.50)
			R9	CR=95% RQD=40% (8.50–9.25)
Slightly weathered to fresh, reddish brown to brownish grey, medium grained, moderately fractured rock.			R10	CR=85% RQD=48% (9.25–10.00)
			R11	CR=84% RQD=80% (10.00–10.75)
			R12	CR=80% RQD=72% (10.75–11.50)
			R13	CR=93% RQD=81% (11.50–12.25)
			R14	CR=95% RQD=94% (12.25–13.00)
			R15	CR=84% RQD=82% (13.00–13.75)
			R16	CR=96% RQD=74% (13.75–15.00)
15.00m.				

N.B. – '*' means sample could not be recovered.

BH-5/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS				CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:	

BORE LOG DATA SHEET

BORE HOLE NO.6

Co-ordinates N=13B+50 E=6A+76

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 19/04/2018
Completion Date : 20/04/2018
Bore Hole Diameter : 150 mm/N.X.
Level Of Ground : 154.66 m.
Water Struck At :
Standing Water Level : 4.60 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Dense to very dense, brownish grey, silty sand with decomposed rocks.		8 13 17 30	DS-1	0.50
			SPT-1	1.50-1.95
2.50m.		100 4.0 cm Pentn. Refusal	*SPT-2	2.50-2.54
Highly weathered, reddish brown to brownish grey, medium grained, fractured rock.		NX rotary drilling from 2.50m	R1	CR=21% RQD=NIL (2.50-3.25)
			R2	CR=26% RQD=NIL (3.25-4.00)
			R3	CR=29% RQD=NIL (4.00-4.75)
			R4	CR=37% RQD=33% (4.75-5.50)
5.50m. Moderately to slightly weathered to fresh, brownish grey to reddish brown, medium grained, slightly fractured rock.			R5	CR=60% RQD=60% (5.50-6.25)
			R6	CR=52% RQD=32% (6.25-7.00)
			R7	CR=56% RQD=40% (7.00-7.75)
			R8	CR=64% RQD=30% (7.75-8.50)
			R9	CR=66% RQD=58% (8.50-9.25)
			R10	CR=76% RQD=40% (9.25-10.00)
			R11	CR=68% RQD=36% (10.00-10.75)
			R12	CR=80% RQD=48% (10.75-11.50)
			R13	CR=84% RQD=32% (11.50-12.25)
			R14	CR=84% RQD=40% (12.25-13.00)
			R15	CR=80% RQD=77% (13.00-13.75)
			R16	CR=82% RQD=60% (13.75-14.50)
			R17	CR=86% RQD=80% (14.50-15.25)
			R18	CR=82% RQD=60% (15.25-16.00)
			R19	CR=82% RQD=58% (16.00-16.75)
18.00m.			R20	CR=84% RQD=62% (16.75-18.00)

N.B. – '*' means sample could not be recovered.

BH-6/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.7

Co-ordinates N=13B+61 E=6A+66

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	1
		Water Sample (WS)	0

Commencement Date : 23/04/18
Completion Date : 24/04/18
Bore Hole Diameter : 150 mm/N.X.
Level Of Ground : 153.97 m.
Water Struck At :
Standing Water Level : 3.90 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very dense, brownish grey sandy silt with decomposed rock.		100 4.0 cm Pentn. Refusal	DS-1	0.50
1.10m.		100 3.0 cm Pentn. Refusal	*SPT-1	1.00-1.04
			*SPT-2	1.10-1.13
Highly to moderately weathered, pinkish grey to whitish grey, medium grained, moderately fractured rock.		NX rotary drilling from 1.30m	R1	CR=44% RQD=24% 1.10
			R2	CR=40% RQD=17% 1.85
			R3	CR=42% RQD=NIL 2.60
			R4	CR=48% RQD=NIL 3.35
			R5	CR=52% RQD=36% 4.10
			R6	CR=48% RQD=NIL 4.85
5.60m.			R7	CR=56% RQD=32% 5.60
Moderately weathered to slightly weathered to fresh, brownish grey to reddish brown, medium grained, slightly fractured rock.			R8	CR=53% RQD=28% 6.35
			R9	CR=60% RQD=52% 7.10
			R10	CR=70% RQD=40% 7.85
			R11	CR=73% RQD=60% 8.60
			R12	CR=65% RQD=24% 9.35
			R13	CR=62% RQD=36% 10.10
			R14	CR=74% RQD=60% 10.85
			R15	CR=80% RQD=40% 11.60
			R16	CR=82% RQD=65% 12.35
			R17	CR=85% RQD=80% 13.10
			R18	CR=82% RQD=60% 13.85
			R19	CR=86% RQD=64% 14.60
			R20	CR=79% RQD=59% 15.35
			R21	CR=86% RQD=60% 16.10
17.60m.			R22	CR=90% RQD=80% 16.85 17.60

N.B. – '*' means sample could not be recovered.

BH-7/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.8

Co-ordinates N=13B+47 E=6A+31

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 13/04/2018
Completion Date : 16/04/2018
Bore Hole Diameter : 150mm./N.X
Level Of Ground : 154.85 m.
Water Struck At :
Standing Water Level : 3.10 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	Depth (m)
0.00m. Very dense, reddish brown, silty sand with decomposed rock.		50 52 2.0 cm Pentn. >100	DS-1	0.50
			DS-2	1.00
			SPT-1	1.50-1.67
		100 3.0 cm Pentn. Refusal	*SPT-2	1.80-1.83
1.90m. Moderately weathered, brownish grey to reddish brown, medium grained, slightly fractured rock.		100 2.0 cm Pentn. Refusal	*SPT-3	1.90-1.92
2.65m.		NX rotary drilling from 1.90m	R1	CR=44% RQD=28% 1.90
			R2	CR=76% RQD=40% 2.65
			R3	CR=78% RQD=NIL 3.40
			R4	CR=79% RQD=39% 4.15
			R5	CR=81% RQD=48% 4.90
			R6	CR=84% RQD=NIL 5.65
			R7	CR=81% RQD=NIL 6.40
			R8	CR=76% RQD=NIL 7.15
			R9	CR=77% RQD=NIL 7.90
Slightly weathered to fresh, brownish grey to reddish brown, medium grained, slightly fractured rock.			R10	CR=64% RQD=NIL 8.65
			R11	CR=66% RQD=24% 9.40
			R12	CR=77% RQD=NIL 10.15
			R13	CR=66% RQD=23% 10.90
			R14	CR=60% RQD=32% 11.65
			R15	CR=76% RQD=20% 12.40
			R16	CR=72% RQD=NIL 13.15
			R17	CR=65% RQD=16% 13.90
			R18	CR=78% RQD=17% 14.65
			R19	CR=80% RQD=60% 15.40
			R20	CR=83% RQD=76% 16.15
			R21	CR=85% RQD=59% 16.90
			R22	CR=91% RQD=60% 17.65
			R23	CR=89% RQD=54% 18.40
			R24	CR=93% RQD=61% 19.15
			R25	CR=80% RQD=67% 19.90
			R26	CR=80% RQD=80% 20.65 21.00
21.00m.				

BH-8/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.9

Co-ordinates N=13B+51 E=6A+07

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 16/04/2018
Completion Date : 19/04/2018
Bore Hole Diameter : 150 mm / N.X
Level Of Ground : 156.28 m.
Water Struck At :
Standing Water Level : 5.50 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very dense, whitish grey, sandy silt with decomposed rock.		16 20 36 56	DS-1 DS-2 SPT-1	0.50 1.00 1.50-1.95
2.00m. Very dense, reddish brown, silty sand with decomposed rock.		21 50 5.0 cm Pentn. N>100	DS-3 SPT-2	2.50 2.70-2.90
3.00m. Moderately weathered, brownish grey to reddish brown, medium grained, moderately fractured rock.		100 3.0 cm Pentn. Refusal NX rotary drilling from 3.00m	*SPT-3	3.00-3.03
3.75m. Moderately weathered, brownish grey to reddish brown, medium grained, moderately fractured rock.			R1	CR=42% RQD=NIL (3.00-3.75)
5.25m. Slightly weathered, brownish grey to reddish brown, medium grained, slightly fractured rock.			R2	CR=53% RQD=13% (3.75-4.50)
			R3	CR=56% RQD=32% (4.50-5.25)
			R4	CR=68% RQD=37% (5.25-6.00)
			R5	CR=76% RQD=13% (6.00-6.75)
			R6	CR=60% RQD=NIL (6.75-7.50)
			R7	CR=68% RQD=41% (7.50-8.25)
			R8	CR=60% RQD=37% (8.25-9.00)
			R9	CR=73% RQD=35% (9.00-9.75)
			R10	CR=74% RQD=62% (9.75-10.50)
			R11	CR=85% RQD=73% (10.50-11.25)
			R12	CR=68% RQD=56% (11.25-12.00)
			R13	CR=76% RQD=60% (12.00-12.75)
			R14	CR=72% RQD=58% (12.75-13.50)
			R15	CR=75% RQD=56% (13.50-14.25)
15.00m.			R16	CR=80% RQD=61% (14.25-15.00)

N.B. – '*' means sample could not be recovered.

BH-9/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.10

Co-ordinates N=13B+44 E=5A+88

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 20/04/2018
Completion Date : 22/04/2018
Bore Hole Diameter : 150 mm/N.X.
Level Of Ground : 156.00 m.
Water Struck At :
Standing Water Level : 5.60 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Dense, brownish grey, clayey silty sand/ clayey sandy silt.		10 16 22 — 38	DS-1	0.50
			DS-2	1.00
			SPT-1	1.50-1.95
			DS-3	2.20
2.20m.		100 4.0 cm Pentn. Refusal	*SPT-2	2.40-2.44
Very dense, brownish grey, silty sand with decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-3	2.50-2.54
2.50m.		NX rotary drilling from 2.50m	R1	CR=38% RQD=NIL 2.50
Highly to moderately weathered, reddish brown to brownish grey, medium grained, moderately fractured rock.			R2	CR=39% RQD=NIL 3.25
			R3	CR=41% RQD=NIL 4.00
			R4	CR=43% RQD=NIL 4.75
5.50m.			R5	CR=52% RQD=NIL 5.50
Moderately weathered, reddish brownish to brownish grey, medium grained, moderately fractured rock.			R6	CR=58% RQD=NIL 6.25
			R7	CR=52% RQD=NIL 7.00
			R8	CR=56% RQD=NIL 7.75
			R9	CR=52% RQD=17% 8.50
			R10	CR=60% RQD=32% 9.25
			R11	CR=54% RQD=17% 10.00
10.75m.			R12	CR=65% RQD=NIL 10.75
Slightly weathered to fresh, brownish grey to reddish brown, medium grained, slightly fractured rock.			R13	CR=80% RQD=55% 11.50
			R14	CR=78% RQD=60% 12.25
			R15	CR=88% RQD=60% 13.00
			R16	CR=80% RQD=60% 13.75
16.75m.			R17	CR=82% RQD=64% 14.50
			R18	CR=84% RQD=62% 15.25
			R19	CR=88% RQD=80% 16.00
				16.75

N.B. – '*' means sample could not be recovered.

BH-10/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.22

Co-ordinates N=14B+81 E=7A+06

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	3	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	3
Vane (V)		Disturbed (DS)	3
		Water Sample (WS)	0

Commencement Date : 19/05/18
Completion Date : 20/05/18
Bore Hole Diameter : 150 mm/N.X.
Level Of Ground : 156.11 m.
Water Struck At :
Standing Water Level : 4.1 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	Depth (m)
0.00m.				
Filled up soil consists of silty sand with ash, brick bats & boulders.		14 18 26 44	DS-1	0.50
			DS-2	1.00
			SPT-1	1.50-1.95
2.30m.			DS-3	2.50
Very dense, brownish grey, sandy silt/ silty sand with decomposed rock.		100 4.0 cm Pentn. Refusal	*SPT-2	2.80-2.84
3.00m.		100 4.0 cm Pentn. Refusal	*SPT-3	3.00-3.04
		NX rotary drilling from 3.00m	R1	CR=32% RQD=NIL
Highly to moderately weathered, pinkish grey to whitish grey, medium grained, moderately fractured rock.			R2	CR=36% RQD=NIL
			R3	CR=41% RQD=NIL
			R4	CR=37% RQD=NIL
			R5	CR=44% RQD=17%
			R6	CR=48% RQD=20%
7.50m.			R7	CR=63% RQD=16%
Slightly weathered to fresh, pinkish grey to whitish grey, medium grained, slightly fractured rock.			R8	CR=76% RQD=NIL
			R9	CR=80% RQD=20%
			R10	CR=78% RQD=NIL
			R11	CR=84% RQD=60%
			R12	CR=75% RQD=55%
			R13	CR=80% RQD=56%
			R14	CR=84% RQD=60%
			R15	CR=78% RQD=54%
			R16	CR=84% RQD=68%
			R17	CR=90% RQD=80%
15.75m.				

3.00 3.75 4.50 5.25 6.00 6.75 7.50 8.25 9.00 9.75 10.50 11.25 12.00 12.75 13.50 14.25 15.00 15.75

N.B. – '*' means sample could not be recovered.

BH-22/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.23

Co-ordinates N=14B+68 E=7A+69

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 29/05/18
Completion Date : 01/06/18
Bore Hole Diameter : 150 mm/N.X
Level Of Ground : 156.85 m.
Water Struck At :
Standing Water Level : 5.10 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m.				
Filled up soil consists of silty sand with ash, brick bats & boulders.		12 18 22 40	DS-1	0.50
			DS-2	1.00
			SPT-1	1.50-1.95
			DS-3	2.50
2.80m.				
Very dense, pinkish grey, sandy silt/ silty sand with decomposed rock.		19 36 50 7.0 cm Penth. N>100	SPT-2	3.00-3.37
			DS-4	3.50
3.80m.		100 4.0 cm Pentn. Refusal	SPT-3	3.70-3.74
		100 4.0 cm Pentn. Refusal	*SPT-4	3.80-3.84
		NX rotary drilling from 3.80m	R1	CR=36% RQD=NIL 3.80
Highly to moderately weathered, pinkish grey to whitish grey, medium grained, moderately fractured rock.			R2	CR=33% RQD=NIL 4.55
			R3	CR=34% RQD=NIL 5.30
			R4	CR=39% RQD=NIL 6.05
6.80m.			R5	CR=52% RQD=21% 6.80
			R6	CR=60% RQD=28% 7.55
			R7	CR=64% RQD=NIL 8.30
			R8	CR=74% RQD=32% 9.05
			R9	CR=80% RQD=36% 9.80
Slightly weathered to fresh, pinkish grey to whitish grey, medium grained, slightly fractured rock.			R10	CR=82% RQD=20% 10.55
			R11	CR=82% RQD=56% 11.30
			R12	CR=86% RQD=60% 12.05
			R13	CR=81% RQD=58% 12.80
			R14	CR=87% RQD=60% 13.55
			R15	CR=86% RQD=60% 14.30
			R16	CR=90% RQD=62% 15.05
16.55m.			R17	CR=92% RQD=80% 15.80
				16.55

N.B. - '*' means sample could not be recovered.

BH-23/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.24

Co-ordinates N=13B+99 E=7A+52

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	2	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	2
Vane (V)		Disturbed (DS)	2
		Water Sample (WS)	0

Commencement Date : 27/05/18
Completion Date : 28/05/18
Bore Hole Diameter : 150 mm/N.X
Level Of Ground : 154.19 m.
Water Struck At :
Standing Water Level : 3.10 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	SAMPLES Depth (m)
0.00m. Very dense, pinkish grey, sandy silt/ silty sand with decomposed rock.			DS-1	0.50
			DS-2	1.00
1.50m.		100 4.0 cm Pentn. Refusal	*SPT-1	1.40-1.44
		100 4.0 cm Pentn. Refusal	*SPT-2	1.50-1.54
Highly to moderately weathered, pinkish grey to whitish grey, medium grained, moderately fractured rock.		NX rotary drilling from 1.50m	R1	CR=32% RQD=NIL (1.50–2.25)
			R2	CR=43% RQD=NIL (2.25–3.00)
			R3	CR=45% RQD=19% (3.00–3.75)
			R4	CR=44% RQD=19% (3.75–4.50)
			R5	CR=43% RQD=NIL (4.50–5.25)
			R6	CR=47% RQD=NIL (5.25–6.00)
			R7	CR=52% RQD=13% (6.00–6.75)
			R8	CR=49% RQD=15% (6.75–7.50)
			R9	CR=45% RQD=NIL (7.50–8.25)
8.25m.			R10	CR=56% RQD=20% (8.25–9.00)
Slightly weathered to fresh, pinkish grey to whitish grey, medium grained, slightly fractured rock.			R11	CR=58% RQD=21% (9.00–9.75)
			R12	CR=74% RQD=48% (9.75–10.50)
			R13	CR=76% RQD=61% (10.50–11.25)
			R14	CR=80% RQD=62% (11.25–12.00)
			R15	CR=78% RQD=74% (12.00–12.75)
			R16	CR=84% RQD=76% (12.75–13.50)
			R17	CR=86% RQD=78% (13.50–14.25)
			R18	CR=90% RQD=60% (14.25–15.00)
15.75m.			R19	CR=93% RQD=82% (15.00–15.75)

N.B. – '*' means sample could not be recovered.

BH-24/Sheet-1

Project : G.I works for proposed FGD for Unit-7, Stage-III, Ramagundam STPS			CETEST
Job No : 4147	Created by : S.NATH	Created on : 04/06/2018	Sheet No:

BORE LOG DATA SHEET

BORE HOLE NO.25

Co-ordinates N=14B+53 E=7A+19

Field Test	Nos	Samples	Nos
Penetrometer (SPT)	4	Undisturbed (UDS)	0
Cone (Pc)		Penetrometer (SPT)	4
Vane (V)		Disturbed (DS)	4
		Water Sample (WS)	0

Commencement Date : 28/05/18
Completion Date : 29/05/18
Bore Hole Diameter : 150 mm/N.X
Level Of Ground : 156.58 m.
Water Struck At :
Standing Water Level : 5.10 m.

DESCRIPTION	SYMBOL	N-VALUE (Each divn.=15.0cm.)	SAMPLES Ref. No	Depth (m)
0.00m.				
Filled up soil consists of silty sand with ash, brick bats & boulders.		10 14 22 (36)	DS-1	0.50
			DS-2	1.00
			SPT-1	1.50-1.95
			DS-3	2.50
Very dense, pinkish grey, sandy silt/ silty sand with decomposed rock.		18 26 32 (58)	SPT-2	3.00-3.45
			DS-4	3.70
3.60m.		100 4.0 cm Pentn. Refusal	*SPT-3	3.80-3.84
3.90m.		100 4.0 cm Pentn. Refusal	*SPT-4	3.90-3.94
		NX rotary drilling from 3.90m	R1	CR=36% RQD=NIL (3.90-4.65)
			R2	CR=38% RQD=NIL (4.65-5.40)
Highly to moderately weathered, pinkish grey to whitish grey, medium grained, moderately fractured rock.			R3	CR=40% RQD=28% (5.40-6.15)
			R4	CR=39% RQD=NIL (6.15-6.90)
			R5	CR=36% RQD=NIL (6.90-7.65)
			R6	CR=42% RQD=13% (7.65-8.40)
08.40m.			R7	CR=66% RQD=28% (8.40-9.15)
Slightly weathered to fresh, pinkish grey to whitish grey, medium grained, slightly fractured rock.			R8	CR=69% RQD=NIL (9.15-9.90)
			R9	CR=82% RQD=66% (9.90-10.65)
			R10	CR=78% RQD=57% (10.65-11.40)
			R11	CR=80% RQD=55% (11.40-12.15)
			R12	CR=82% RQD=62% (12.15-12.90)
			R13	CR=86% RQD=66% (12.90-13.65)
			R14	CR=80% RQD=54% (13.65-14.40)
15.15m.			R15	CR=84% RQD=67% (14.40-15.15)

N.B. – '*' means sample could not be recovered.

BH-25/Sheet-1

Table :1

COAL AND ASH CHARACTERISTICS

Coal Properties for Ramagundam ESP Augmentation				
S.No.	Characteristics	Range of Coal Supplies 95%		
	(as received basis)	Column - 1	Column - 2	Column - 3
1.0	PROXIMATE ANALYSIS	Design	Worst	Best
1.1	Total Moisture (%)	12	15	11
1.2	Ash (%)	42	45	35
1.3	Volatile Matter (%)	22	20	24
1.4	Fixed Carbon (%)	24	20	30
1.5	Total (%)	100	100	100
2.0	ULTIMATE ANALYSIS			
2.1	Carbon (%)	35.28	30.72	40.66
2.2	Hydrogen (%)	2.54	2.3	2.73
2.3	Sulphur (%)	0.45	0.6	0.4
2.4	Nitrogen(%)	0.68	0.6	0.85
2.5	Oxygen(%)(By difference)	7.05	5.78	9.38
2.8	Total Moisture (%)	12	15	11
2.9	Ash (%)	42	45	35
	Total	100	100	100
2.10	GCV (Kcal/Kg)	3400	3000	3800
2.11	Hard Grove Index	50	47	55
3.0	ASH ANALYSIS			
3.1	Silica (%)	61.85	61.3	62.4
3.2	Alumina(%)	27.36	27.42	27.31
3.3	Iron Oxide (%)	5.18	5.4	4.98
3.4	Titania	1.84	1.8	1.88
3.5	Phosphoric Anhydride (%)	0.54	0.54	0.55
3.6	Lime (%)	1.47	1.52	1.42
3.7	Magnesia (%)	1	0.97	1.03
3.8	Sulphuric Anhydride (%)	0.05	0.05	0.05
3.9	Sodium Oxide (%)	0.2	0.08	0.04
3.1	Balance Alkalies (by differenc	0.51	0.92	0.36
	Total	100	100	100
4.0	ASH FUSION RANGE			
	REDUCING ATMOSPHERE			
4.1	Initial Deformation Temp.(oC)	1150	1100	1200
4.2	Hemispherical Temp. (oC)	1300	1250	1350
4.3	Fusion Temperature (oC)	1400	1350	1400

TABLE – 2

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 – 2
LIGHT DIESEL OIL CHARACTERISTICS

AS PER IS 1460-2000

Characteristics	LDO
1. Pour Point (max) Summer	21 deg.C & 12°C for 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 (NOT USED)

TABLE-4

DESIGN CLARIFIED WATER ANALYSIS

S.No	Constituent	As	mg/l
1	Calcium	$CaCO_3$	104
2	Magnesium	$CaCO_3$	88
3	Sodium	$CaCO_3$	59
4	Potassium	$CaCO_3$	4
	Total cations	$CaCO_3$	255
5	HCO3	$CaCO_3$	155
6	P- Alkalinity	$CaCO_3$	0
7	Chloride	$CaCO_3$	54
8	Sulphate	$CaCO_3$	46
	Total Anions	$CaCO_3$	255
9	Silica, Reactive	Si	5
10	Iron (Total)	Fe	0.5
11	pH	-	7.0-7.8
12	Turbidity	NTU	10
13	Total dissolved solids		250-300
14	Temperature	Deg C	20-35

TABLE-5

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 -7.2
5.	Conductivity	Not more than 0.1micro mho/cm excluding the effects of free CO2

TABLE-6

STEAM GENERATOR DATA Stage-I & Stage II (Per Unit basis)

1.	Location	Outdoor
2.	Operation	Base load
3.	Type	Pulverised coal fired
4.	Maximum Continuous Rating	Stage-I 670 Tonns/hr. Stage-II 1725 Tonns/hr.
5.	Steam pressure at SH outlet	Stage-I 157 Kg/cm²(a) Stage-II 178 Kg/cm²(a)
6.	Steam temperature at SH outlet	Stage-I 540 Deg C Stage-II 540 Deg C
7.	Oil for start up and flame stabilisation	LDO/HFO
8.	Fuel oil system sizing	7.5% of Boiler MCR for LDO & 30% of Boiler MCR for HFO
9.	Pulverised coal size	Minimum 70% through 200 Mesh and 99% thru 50 mesh
10.	Type of pulveriser	Vertical spindle mills
11.	Type of oil burners	Air atomised for LDO Steam atomised for HFO
12.	No. of air heaters	Stage I Two (2) Tri-sector APH Stage II Four number (4) Bi-sector APH
13.	No. of ID Fans	Stage-I Two (both working) Stage-II Two (Both working)

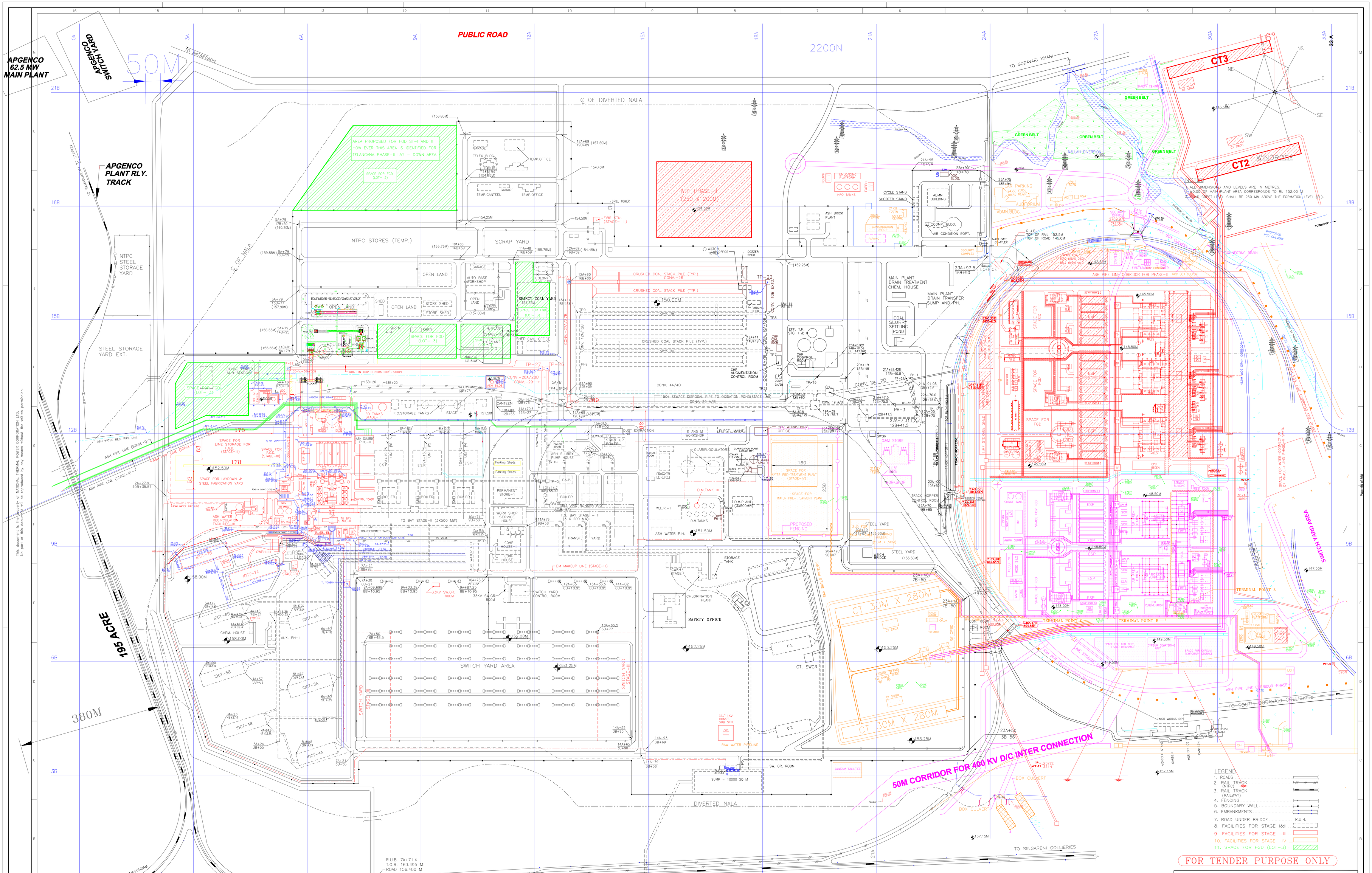
ESP DATA Stage I & Stage II (Per Unit basis)

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

TABLE-7

List of Drawings/Details placed below in this sub section:

Sl.No.	Drawing Description	Drawing No.
1.	General Layout Plan	Enclosed
2.	Chimney foundation	Refer details below



NOTES:

1. ALL DIMENSIONS AND LEVELS ARE IN METRES.
2. BIDDER SHALL MAKE NOTE OF THE SPACE AVAILABLE AND THE LOCATION . OF EXISTING FACILITIESBIDDER SHALL BE RESPONSIBLE FOR ANY DAMAGE TO EXISTING STAGE-I&II FACILITIES DURINGEXECUTION OF STAGE-III FACILITIES AND SHALL MAKE ALL NECESSARY ARRANGEMENTS FOR PROTECTING THE SAME.

FOR TENDER PURPOSE ONLY

REV.NO.	DESCRIPTION	DRAWN	DESIGN	CHKD.	M	E	C	C&I	ES	APPD	DATE
1	SPACE FOR FGD (LOT-3) MARKED BASED ON INPUTS FROM PE-MECH.										28.08.18
0	FOR FR PURPOSE ONLY	MPS									22.08.14
		BINU			CLEARED BY						

NTPC Limited
(A GOVERNMENT OF INDIA ENTERPRISE)
ENGINEERING DIVISION

PROJECT: RAMAGUNDAM SUPER THERMAL POWER PROJECT

TITLE: GENERAL LAYOUT PLAN

SIZE	SCALE	DRG. NO.	REV. NO.
A0	1:3000	3150-999-POC-F-001	1

FILE NAME :Ramagundam40.dwg

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Chimney Details

LOT - 3 CHIMNEY DETAILS

				EXISTING					
Sl. No.	Project	Stage	UNIT	Type of Chimey (single/multiflue)	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)
1	FGUTPP	I	2X210	Twin	Foundation Data is not available, Bidder may conduct Ground Penetration Radar (GPR) Test to know the extent of existing chimney foundations.				
2		II	2X210	Twin					
3		III	1X210	Single	25.00	36.22	Pile	RL (+) 106.00	RL (+) 103.00
4	Farakka	I	3X200	Multi	Foundation Data is not available, Bidder may conduct Ground Penetration Radar (GPR) Test to know the extent of existing chimney foundations.				
5		II	2X500	Twin					
6		III	1X500	Single	32.00	44.1	Pile	RL (+) 25.5	RL (+) 21.75
7	Kahalgaon	I	4X210	Multi	Foundation Data is not available, Bidder may conduct Ground Penetration Radar (GPR) Test to know the extent of existing chimney foundations.				
8		II	3 X 500	Single					
9				Twin					
10	Korba	I	3X200	Single					
11		I		Single					
12		I		Single					
13		II	3X500	Single					
14				Twin					
15		III	1X500	Single	32.0	41.0	Pile	RL (+) 288.5	RL (+) 285.0
16	Ramagundam	I	3X200	Multi	Foundation Data is not available, Bidder may conduct Ground Penetration Radar (GPR) Test to know the extent of existing chimney foundations.				
17		II	3X500	Single					
18				Single					
19				Single					
20	Singrauli	I	5 X 200	Twin					
				Multi					
21		II	2X500	Twin					
22	Vindhyachal	I	6X200	Multi					
				Multi					
23		II	2X500	Twin					
24	Rihand	I	2X500	Twin					

SECTION-I,
SUB-SECTION-C1

SPECIFIC TECHNICAL REQUIREMENT – MECHANICAL

SECTION-I,
SUB SECTION-C1A

SPECIFIC TECHNICAL REQUIREMENT-TANKS

1.0 SCOPE OF SUPPLY

1.1 Supply of Steel plates and fabrication of tanks at site under this specification shall be as per enclosed FGD Tank schedule (Section-III, Annexure-8). Detailed GA & fabrication dwgs. of each type of tank shall be submitted by bidder during detail engineering to suit good engineering practice to the satisfaction of the customer.

1.2 General design, selection of rubber lining, Vinyl Ester (VE) Flake glass lining, Epoxy lining materials, construction features, manufacturing, shop inspection, testing at manufacturer's works, surface preparation, lining, inspection & testing of the lined surface at **Ramagundam** FGD site. For detail specification of rubber lining & Vinyl Ester Flake glass lining refer Sub Section-C1-B and Sub Section-C1-C respectively of section-1.

1.3

a) The connections and accessories which are required to be supplied with each tank by the bidder shall be as indicated in the enclosed FGD Tank schedule (Section-III, Annexure-8).

b) The piping material inside the tank shall be supplied by the bidder. All inlet piping shall be extended up to the bottom of the tank and the clearance between the bottom of the tank and the edge of the inlet piping shall be kept as 500 mm (maximum). The inlet pipes shall be lined with replaceable wear resistant natural rubber lining of minimum 06 mm thickness from inside. Additional thickness of 2 mm in rubber lining shall be provided at bends.

c) The inside piping shall be adequately supported and shall be provided with adequately sized vent (anti-siphoner) connection at pipe top.

d) Weir plates of adequate thickness (minimum 8 mm) shall be provided for all inlet piping.

e) Pad plates on the tanks for supporting outside piping shall be provided by the bidder. Details of the pad plates (sizes, quantity etc.) shall be informed to bidder during detail engineering.

f) Fabrication and supply of all flanges and counter flanges for all nozzles of tank connections shall be included in the scope of work of the bidder. Necessary bolts, nuts and gaskets for these connections shall also be supplied by the bidder. Further rubber lining / VE Flake glass lining of these nozzles including flanges, counter-flanges shall be in bidder's scope of work.

g) The manhole shall be of hinged and bolted type with nuts, bolts and gaskets in bidder's scope of supply. The size of the manhole shall be minimum 800 mm and subjected to customer approval. Bidder shall provide two nos. manhole for each tank, i.e. one no. manhole on shell and one no. manhole at roof.

h) Supply and erection of vent valves shall be in bidder's scope.

1.4 The scope of works shall also include supply and installation of special accessories including agitator supporting arrangements, agitator platform, baffle plates etc. as indicated in FGD Tank schedule (Section-III, Annexure-8). The necessary fixtures and other accessories for mounting these special accessories shall be included in the scope of work of the bidder.

1.5 Baffle plates for the agitators shall be mounted on the tank. The supply and erection of the baffle plates shall be in bidder's scope of work. The minimum no. of baffle plates and minimum dimension of the baffle plates have been indicated in the FGD Tank schedule (Section-III, Annexure-8). The final quantity and dimensions of the baffle plates shall be decided during detail engineering.

1.6 Quantity and size of spare nozzles as per FGD Tank schedule (Section-III, Annexure-8) shall be supplied by the bidder.

1.7 Pipes, fittings, nozzles, flanges and counter flanges along with the rubber lining / VE Flake glass lining shall be supplied by the bidder. The minimum requirement like quantity, size, type etc. are indicated in the FGD Tank schedule (Section-III, Annexure-8) and may undergo change during detail engineering stage and these shall be supplied by the bidder as per the approved drawings / documents for which no commercial implication shall be entertained by BHEL. Material of construction of all pipes, fittings, nozzles, flanges and counter flanges shall be as per tank schedule (Section-III, Annexure-8).

1.8 The minimum number of anchor bolts along with its size shall be finalized during detail engineering. Further, any additional anchor bolts of higher size if found applicable during detailed Engineering as per customer comment shall be provided by bidder without any commercial implication. The material of construction for anchor bolts shall be IS 1367 Part-3.

1.9 Painting of the tanks is included in bidder's scope of work. Painting specifications of storage tanks are given under Painting schedule in Sub Section-C2-C, section-1. Painting requirement specified under Painting schedule are minimum requirement. Any modification in painting requirement found applicable during detained engineering, shall be under bidder's scope without any commercial implication.

1.10 Commissioning spares as required for commissioning of the tanks are in bidder's scope.

1.11 Platforms, inter-connecting platforms, platforms for agitator maintenance, monkey ladder inside tank and for agitator platform approach, staircase (hand railing, knee guard and toe guard (in stair case, agitator platform and all along the periphery of roof of the tank) etc. as per the relevant design code / good engineering practice (as indicated in the tank schedule) shall be included in bidder's scope of work. All staircase treads and platforms shall be 32 mm steel fabricated gratings. Gratings shall be galvanized as given for handrails in painting specification.

2.0 SCOPE OF SERVICES

Services shall include but not be limited to the followings:

2.1 Design, engineering, preparation of detailed fabrication drawings, design calculation, bill of material, tag and piece numbers, welding procedures etc. Stiffeners and other structural framing for supporting the tank shall be designed by the fabricator and properly shown in the fabrication drawings.

2.2 Erection & Commissioning of Tanks.

2.3 Erection & Commissioning of rubber lining / VE Flake glass lining.

2.3 Erection of all foundation bolts / anchor bolts etc. as required for any equipment/ foundation /concrete.

2.4 Erection of the agitators, agitator mounting arrangement., agitator supporting arrangements, shall be in bidder scope. The Agitator shall be provided by BHEL as a free issue item.

2.5 Minor civil work like chipping of foundation, grouting below base plate for all structures, equipment, grouting of pockets, excavation & filling of earth for buried MS pipes if and as required.
Inspection & testing and carrying out demonstration test.

2.6 Inspection & testing and carrying out demonstration test for the rubber lining / VE Flake glass lining of tanks.

2.7 Painting of tank and other equipment within the battery limit.

2.8 Any other equipment / material / services as required to make the installation complete in all respects shall be deemed to be included in bidder's scope of work whether mentioned above or not.

3.0 DESIGN CONSIDERATIONS

3.1 The successful bidder shall furnish design calculations to BHEL during detailed engineering stage for approval along with the Xerox copies of relevant pages of authentic supporting literature e.g. Code, Hand book, National / international Standards etc. Calculation shall be necessarily done in **SI UNITS** only for the followings: -

a) Tanks shall be designed as per IS – 803 / API – 650 / AWWA – D 100 / IS –2825 / BS – 2594 / Good engineering practice as applicable and referred code shall be of latest edition. However, requirement of codes and standards shall be as indicated in the tank schedule, Annexire-8.

b) Weight calculation of plates, appurtenances, platforms & structures separately shall be included in the Design calculation.

c) Design of roof and roof structures for vertical storage tanks along with agitators & agitator platforms shall be designed based on guidelines given in the book titled "Process equipment design" by Brownell and Young. Further, roof structure shall preferably be constructed on external side of roof.

d) Tank stability calculation (wind load / seismic / overturning stability) considering static and dynamic loads of Agitator and its platforms and supporting arrangement shall be done as per API – 650/IS-803, latest edition. However, factors / coefficients as required for the design of tank shall be obtained from BHEL by the bidder after placement of order.

d) Vent sizing calculation shall be done as per API – 2000, latest edition

e) Sizing calculation for vent valve.

3.2 The successful bidder shall indicate references of all the clauses indicating their page number from respective standard in the design calculation during detail engineering stage. All calculations shall necessarily be done in SI units only. All steps including formulas and abbreviations shall be clearly shown in the calculation. All inputs / assumptions shall be indicated in the first sheet of the calculation.

3.3

a) Bottom plate shall be 8.0 mm thick (minimum). Minimum 6 mm (excluding tolerance on plate as per relevant IS) thick plates including corrosion allowance shall be provided for shell plates and minimum 8 mm for roof plates for all tanks. However, Auxiliary absorbent tank shall be provided with minimum 8 mm thickness for shell, refer min. shell plate thickness defined in tank schedule Annexure-8.

Calculation for the plate thickness shall be got approved from BHEL / Customer during detailed engineering stage. However, if the addition / summation of calculated value of plate thickness (excluding tolerance on plate as per relevant IS) / nominal minimum thickness specified in the relevant design code / standard and corrosion allowance of 1.5 mm comes out more than 6 mm then the nearest available (higher side) plate thickness in the market shall be provided for shell and roof plates without any commercial implication. For calculating shell plate thickness. IS 803 to be used. Further minimum thickness of bottom, shell and roof plates have been specified in tank schedule Annexure-8.

b) Negative tolerance on plate thickness shall not be considered in the plate thickness calculation and also shall not be provided in the tank. Only positive tolerance shall be considered.

3.4 All appurtenances and mountings shall also be designed as per relevant clauses of IS: 803 / API – 650.

3.5 Tank shall be suitably constructed for safe, proper and continuous operation under all conditions that can be expected in a plant life without undue strain, corrosion or other operating difficulties.

3.6 In calculating the minimum plate thickness, the specific gravity of the liquid shall be taken as per tank schedule (Section-III, Annexure-8).

3.7 For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature.

3.8 Vessels seams shall be so positioned that they do not pass though vessel connections. For cylindrical vessels consisting of more than two sections longitudinal seams shall be offset.

3.9 Wherever possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer.

3.10 Due consideration shall be given by the supplier for wind load and earthquake effect in the design of tanks.

3.11 For the tanks being of diameter larger than 3.75 m added structural supports in the form of rafter shall be provided.

3.12 Reinforcement in tanks shall be provided as per design code. The reinforced connection shall be completely pre - assembled into shell plate.

3.13 The joint efficiency factor to be adopted for design calculation of shell thickness shall be 0.7.

3.14 All roofs and supporting structures shall be designed to support dead load plus a uniform live load of not less than 150 kg/m^2 of projected area. Further, the static and dynamic loads of the agitator assembly along with the agitator platform shall be considered over and above the uniform live load.

3.15 Staircase / access ladder and hand railing shall be provided as per the relevant codes and standards and tank schedule (Section-III, Annexure-8).

3.16 -VOID-

3.17 Code conformance for flanges / counter flanges shall be ANSI B 16.5. Code conformance for bolts and nuts shall be SA 193 & 194 respectively. Further, all fasteners used in wetted condition must be of

Alloy 926 or better material so that even if it comes in contact with liquid by swelling of rubber, thread remains unaffected. Raw material of fastener must undergo Inter-Granular Corrosion test as per ISO-3651, Part-1 for Nitric Acid test.

3.18 The number & size of nozzles (including flanges, counter flanges and inside piping) indicated in the tank schedule (Section-III, Annexure-8) & Input dwgs (annexure-III, sub Section-D, Section-I) are tentative and bidder guidance purpose only and the same may undergo change during detail engineering stage for which no commercial implication shall be entertained by BHEL.

3.19 Bidder shall furnish the STADD calculation along with the roof structure calculation during detail engineering for checking the stability of roof.

3.20 The tank shall be designed for filled water head / atmospheric pressure and design temperature for the tank shall be as specified tank schedule (Section-III, Annexure-8).

3.21 Bidder to note that surface cleaning shall be of Blast clean type. However, Grit blasting shall be decided during detail engineering for which no commercial implication shall be entertained by BHEL. Further, the surface cleaning of the tanks shall be in line with the requirements specified in the specification for rubber lining / VE Flake glass lining.

3.22 Bidder to note that foundation drawing along with loading data & anchor bolt details shall be provided by bidder within two weeks' time from the LOI. However, Bidder to provide minimum anchor bolts for the Miscellaneous FGD tanks, as specified in the tank schedule (Section-III, Annexure-8).

3.23 All materials, furnished shall conform to the latest editions of America National Standard Code for Pressure piping, Power piping, ANSI B311.1, ANSI B16.11, ASME Boiler and Pressure Vessel Codes, IBR and other applicable ASME, ANSI and Indian Standards. Schedule numbers, sizes and dimensions of all carbon steel, stainless steel and alloy seamless steel pipe shall confirm to ANSI B.36.10 and of stainless steel pipe shall confirm to ANSI B 36.19 unless otherwise specified.

4.0 WELDING

4.1 Welding shall be in accordance with the requirement of IS: 803, 816, 817 and 823 or equivalent and as specified in the specification for rubber lining / VE Flake Glass lining.

4.2 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him, which should meet prior approval of the Engineer.

4.3 All welders shall be BHEL / customer / consultant qualified as per the approved quality plan / field quality plan which will be submitted by the successful bidder during detail engineering stage. WPS and PQR shall be submitted by the successful bidder to BHEL / customer / consultant for review and approval.

5.0 TEST AND INSPECTION

5.1 The particulars of the proposed tests and the procedure for the tests shall be submitted to the Owner / Engineer for approval before conducting the tests. The successful bidder shall submit FQP (field quality plan) and demonstration test procedure for BHEL / customer / consultant's approval during detail engineering stage. In the event of any change in the field quality plan and demonstration test

procedure, the same shall be incorporated by the bidder in the document and approved document shall be adhered by the bidder without any commercial implication.

5.2 DPT / MPI on all welds (100%).

5.3 All cross / Tee joints and butt welds to be Radio graphed in line with the joint efficiency as specified in the design code / Tank schedule, Annexure-8.

5.4 For the offered tanks, fill test shall be carried out for at least 24 hours. Atmospheric storage tanks on inside surface shall be leak tested before painting / rubber lining / VE glass flake lining.

5.5 All quality plans / checklists for various items shall be furnished during detail engineering stage for BHEL / customer's approval and any changes required by BHEL / customer shall be incorporated in the documents and adhered without any price implication. However, minimum requirement of MQP as indicated in the technical specification shall be followed. All necessary items as required for inspection and testing of the tank including instruments shall be arranged by the bidder.

6.0 MANDATORY SPARES:

Not Applicable.

7.0 LIST OF COMMISSIONING SPARES:

SL. NO.	DESCRIPTION OF ITEMS	QUANTITY
1	Rubber Gasket of each size	2 nos.
2	Nuts, bolts & washers of each size (nos. of bolts, nuts & washers as required for each nozzle) as per approved Drg.	1 lot
3	Any other item required for successful commissioning of the tanks including rubber lining / VE Flake Glass lining (to be specified clearly by bidder)	1 lot

8.0 TERMINAL POINTS

- Matching counter flanges for all nozzles mounted on the tank and its accessories. However, counter flanges for all nozzles of tank shall be provided by the bidder.

9.0 EXCLUSIONS

1) Tank foundation & associated civil works, all instruments like level gauges, Level Transmitters, etc are excluded from bidder's scope of work. However, required no. of nozzles for the same shall be in bidder's scope of work.

2) All agitators including the agitator of drain pits/ sumps shall be provided as a free issue item to the bidder. The erection and commissioning of the agitators shall be in bidder's scope of work.

However, BHEL shall arrange for the supervision of the erection and commissioning of the agitator assembly to the bidder as a free issue service.

3) The Sumps/drain pits indicated in the tank schedule (Section-III, Annexure-8) is excluded from bidder's scope of work. However, the erection and commissioning of the agitators and VE Flake glass lining within the sump/drain pits shall be in bidder's scope of work.

4) All valves are excluded from bidder's scope of work.

5) All external piping from the counter flange of the nozzles of respective tanks is excluded from bidder's scope of work. However, matching counter flanges for all nozzle shall be in bidder's scope of work. Further the supply and erection of the piping material inside the tank shall be in bidder's scope. The rubber lining / VE Flake glass lining of the inlet pipes shall be in bidder's scope of work.

10.0 DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

The bidder must submit the drawings / documents as mentioned under "CHECK LIST FOR DOCUMENT TO BE SUBMITTED" (In Section-III, Annexure-I) along with their bid. In absence of any of these documents, BHEL reserves right not to evaluate the offer of the concerned bidder.

11.0 DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

The successful bidder shall submit the drawing / documents as mentioned under SECTION-I, Sub-Section-D, Annexure-IV during detail engineering for approval / information / reference (as the case may be).

12.0 OTHER TECHNICAL REQUIREMENTS

1) 15 days' time is required by BHEL to offer their comments on the drawings and documents being submitted by the bidder (during detailed engineering stage in the event of L.O.I being placed) from the date of receipt.

2) Bidder to depute competent designer (s) at BHEL's office during detailed engineering stage to discuss drawings and other technical documents as and when required by BHEL.

3) Bidder to assess the capability of their sub-vendors in terms of preparation of drawings, calculations, documents, quality assurance, supply of material etc. as per project schedule before placing the order on them. No deviations shall be entertained.

4) Commercial implication includes price implication as well as delivery implication.

5) Size of hand rails on stairway and tank roof / top shall be minimum 32 NB and shall conform to IS 1239 (M). Handrails shall be galvanized as per painting specification.

6) Type of roof for vertical cylindrical storage tanks shall be either supported cone roof or self-supporting cone roof as per latest edition of relevant design code.

7) Commissioning of tanks will consist of installation of all accessories of tanks as per approved drawing/specification, charging of tank, water-fill test (for minimum 24 hours after complete filling of

tank), satisfactory functioning of all accessories, emptying of tank, subsequent painting of complete tanks and changing of gaskets as per specification requirement.

8) Bidder to furnish prices and unit price of each item of proposed tanks as per BHEL's price format only along with the final price bid.

9) Bidder shall check that specifications of all the items are available in the NIT specification. However, in the event of absence of specification for any item, bidder will approach BHEL to furnish the specification of missing items and new specification will be adhered by the bidder for which no commercial implication shall be entertained by BHEL.

10) All tools and plants including welding machines, crane, hydra, fork lift, batching plant etc. and instruments as required for construction, erection and commissioning, trial run and functional demonstration test at site shall be arranged by the bidder.

11) Bidder to furnish list of sub-vendors based on sub-vendor list enclosed with the specification during detail engineering stage for BHEL's / Customer review and approval and items shall be procured from these suppliers only.

12) Dealers are not acceptable for any item of the package. Bidder shall procure all items including plates, structural, flanges, counter flanges etc. from BHEL approved sub vendor only. No argument on this account shall be entertained.

13) All rubber lined pipes shall be provided with flanged type connections only. In other words, Rubber lined pipes shall be flange joined only.

SECTION-I,
SUB SECTION-C1B

SPECIFIC TECHNICAL REQUIREMENT-RUBBER LINING

1.0 SCOPE OF SUPPLY

1 Design, manufacture, testing and supply of rubber lining material for the duty condition for FGD Tanks as specified in Annexure- 8 (Tank schedule), section-III.

2 Erection and Commission. Delivery of material at site, surface preparation for lining surfaces, lining the surface to the satisfaction of the customer shall be under bidder's scope, cost for Erection and Commission shall be included in the offer.

3 10 copies of Operation manuals containing all details of reference drawings and technical data shall be furnished by the Bidder.

2.0 SURFACE PREPARATION

1 The Tanks surface to be lined should be blasted to a bright grey metal finish (Sa 2½ requirement), free from rust, weld marks, oil and any other foreign matter. The blasting is carried out with the help of dry grit (copper sludge)/Sand under dry air pressure of 7 kg/cm2 by Compressor. Surface roughness shall be 50-60 Microns.

2 After blast cleaning, blasted surface will be applied by surface protecting primer to prevent the corrosion. After 100% blasting of the particular Tank is completed, the surface is cleaned by appropriate solvent, so as to see that all the small dust particles are removed. Sharp corner shall be suitable rounded off. Surface should not have any sharp notch.

3 After this procedure suitable bonding agent and 3 to 4 coating of the specially formulated rubber adhesive should be applied for proper bonding of the Rubber Sheets to be lined.

4 Compressor and any other facilities required for grit/shot blasting shall be arranged by vendor. Any hoses provided in the compressed air line shall be tested with air before commencement of grit blasting job.

5 The grit/shot blasting machine shall be provided with safety valve (safe trip) as a protection against over pressure.

6 Scaffolding shall be done by the vendor. Any scaffolding provided by the vendor shall be of steel only.

3.0 GUIDELINES FOR DESIGNING AND FABRICATION OF STEEL CONSTRUCTIONS FOR RUBBER LINING:

1. Please refer Section-II, Sub-Section-A

4.0 RUBBER LINING

1 The lining shall completely cover the roof, sides and internals of Slurry Tanks, support angle, insert plates, openings, Man Hole / Inspection / Flange openings. etc.,

2 The rubber used for the lining of the tank is given below:

3

Sl. No	Tank	Rubber Lining details/ Painting details
1	Auxiliary absorbent tank, Limestone slurry storage Tank and Primary hydro cyclone.	Bromobutyl rubber lining with Shore A hardness as 55±5 and min thickness as mentioned in Annexure-8(Tank schedule),section-III.

2	Process water Tank, Belt Filter Wash Tank and Clarified (Cake wash) Water Tank.	Epoxy lining of minimum 150 micron thickness (3 coats of 50 micron each)

4 After Rubber sheet applied on the surface, rubber sheets should be systematically pressed to the metal surface by the help of mechanical tools like Rubber Rollers and metal thin rollers to remove the air between metal and rubber sheet. All rubber joints are properly overlapped by 25 to 35 mm wide tapered cut rubber sheet. All the joints will be covered by 75 mm X 1.5 - 1.7 mm thick rubber strip.

5 Vendor shall specify the shelf life of the rubber material being supplied and shall furnish the storage methods to be followed at site to ensure that the rubber material shall not be spoilt during storage.

6 Vendor shall submit the surface preparation and lining procedure to the purchaser for approval. The lining work shall start only after obtaining approval from Purchaser.

5.0 INSPECTION AND TESTING OF RUBBER LINING

1 Ageing Test : 70°C for 24 hrs. (IS: 3400 Pt.4)
Change in Tensile Strength: ± 5%
Elongation at break: ± 10%

2 Abrasion Test : Wt. loss – Max. 25%

3 Tensile Strength : 35 kg/cm2 (min) for Bromo Butyl and
40 kg/cm2(min) for Chloro Butyl Rubber

4 Elongation at break : ≥ 300% minimum for 4mm thk rubber specimen

5 Peeling strength : ≥ 3 N/mm

6 Hardness : 55 ± 5° Shore A

7 Spark Test : 1.5 KV/ mm

8 Lining shall be visually inspected to ensure free from poorly weed out fibers, entrapped air and exposed fires. Defects are to be repaired by slandering a generous area around the defected portion and applying a layer of rubber material.

9 Spark test shall be carried out at appropriate areas in the presence of Purchaser. Vendor should conduct test as per relevant standards.

10 After installation, the Rubber lining shall be subjected to testing at site as per relevant standards. If the performance is found not to meet the requirements as specified, the Rubber lining shall be rectified or replaced by the Vendor without any extra cost to the Purchaser.

5.1 FINISHING & INTERNAL TESTING

1 Rubber surface of all flanges and manhole of Equipment will be finished by the mechanical tools to get leakage free surface during commissioning.

2 After above finishing, 100% testing will be carried out for continuity by high frequency high voltage spark tester. If there is any puncture, they are checked and rectified as per the standard procedure of repair (Clause 6.1) as mentioned in procedure.

5.2 REPAIRING PROCEDURE

1 Faulty spots on the rubber lining are cut off down to be substrate and the seams of the remaining rubber are beveled.
2 Rubber sheet with a broad bevel cut is glued on the substrate laid bare.
3 On spots to be repaired of a diameter < 300 mm a second layer of Rubber sheet is glued covering the seams of the first layer.
4 Several spots to be repaired in a small area are jointly covered with a second layer of Rubber sheet.

6.0 PERFORMANCE GUARANTEE

The lining material shall be guaranteed for **an uninterrupted minimum life of 25000 hrs**. Performance parameters to be guaranteed by the vendor and tolerances permitted shall be as indicated in the data sheet. Rubber lining or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters. The lining should be guaranteed for faultless material and workmanship. During Guarantee period any defects noticed due to faulty material and workmanship, shall be rectified by vendor free of cost.

7.0 PACKING

1. The part items of the Rubber lining should be identified by Tag numbers and should be packed as to minimize the possibility of damage during storage or transit. The packing should be suitable for tropical conditions. Vendor should specify the storage requirements for the Rubber lining materials.
2. The list of items identified as dispatch able units shall be furnished along with unit weight and the quantity for preparation of packing slip at BHEL end for dispatch to site and for easy identification, storage and erection at site.
3. Please refer Sub Section- C2 – B, SECTION – I for Packing Procedure.

8.0 DOCUMENTATION

8.1 DATA TO BE FURNISHED BY THE VENDOR AFTER RECEIPT OF PURCHASE ORDER

1 List of Drawing and documents to be submitted for review, approval and information with submission dates
2 Quality Assurance Plan to be submitted for approval.
3 Detailed dimensional General Arrangement drawing of the lining surfaces.
4 This drawing shall indicate all the design data and information about the material, scope of work and weight of the material supply, Packing procedure etc.
5 Installation, operation and maintenance manual.
6 Surface preparation and Lining procedures.

SECTION -1
SUB- SECTION- C1C

SPECIFIC TECHNICAL REQUIREMENT
FLAKE GLASS LINING

1. INTENT OF SPECIFICATION

a) This Specification defines the minimum requirements of glass flake lining of Slurry Tanks & Slurry sumps in the Flue Gas Desulphurization (FGD) plant.

b) Tanks / Sumps to be lined contain Limestone Slurry / Gypsum Slurry / Process water. Slurry Tank Details and Slurry conditions are given in Annexure-8 Tank Schedule. The glass flake lining shall offer better resistance to corrosion/erosion and shall be based on Vinyl ester resin. Thickness of glass flake lining required is 3 mm thk.

c) This specification covers the general design, selection of suitable glass flake material/resin, manufacture, shop inspection (as per latest applicable statutes, regulation and safety codes in the locality where the lining are to be carried out) and delivery at site, surface preparation of lining surface, lining the surface to the satisfaction of the customer, jointly calculation of total area lined, inspection of the lining at site, handling over to the ultimate customer.

d) Compliance to this specification shall not relieve the vendor of the responsibility of furnishing glass flake lining materials of proper design, materials and workmanship to meet the specified requirements.

e) In case of deviation, it shall be listed in the vendor's proposal under separate section titled as “list of deviations/exceptions” to the enquiry documents. Any deviation not mentioned in this list , but mentioned elsewhere in the proposal will not be considered.

2.0 CODES AND STANDARDS:

The glass flake lining shall conform to the latest version of Indian/British/American/International Standards. Nothing in this specification shall construe to relieve the contractor of the required statutory responsibility. The Glass Flake Lining material shall be designed for the corrosion protection of the Slurry tank. The lining shall be glass flake filled vinyl ester based coating system. Only Proven material has to be offered by the bidder

REFERENCE STANDARDS:

ASTM D 4285	Standard Test Method for Indicating Oil or Water in Compressed Air
ASTM D 4541	Standard Test Method for Pull-Off Strength of Coating Using Portable Adhesion Testers
ASTM E 337	Standard test Method for Relative Humidity by Wet and Dry Bulb Psychrometer
ASTM D 4618	Standard Specification for Design and Fabrication of Flue Gas Desulfurization System Components for Protective Lining Application

ASTM D 5162	Practice for Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates
NACE Standard RP0178-2003	Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be lined for Immersion Service
ISO 8501-1, 1988	Preparation of Steel Substrates Before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness
SSPC"PA2	Measurement of Dry Paint Thickness with Magnetic Gauges

3.0 SCOPE OF SUPPLY

a) Complete selection and procurement/manufacture of all materials required for lining, storage, preparation of the surfaces for lining near site and installation of lining. All equipments required for lining shall be arranged by the vendor.

b) Erection and Commissioning of the glass flake lining as per the requirement. Delivery of material to site, Storage of the material, surface preparation of the surfaces to be lined, lining the surface to the satisfaction of the customer and testing the lined surface for proper adhesion, complete coverage and intactness with the base material/surface shall be under bidder's scope, cost for Erection and Commissioning shall be included in the offer. The lining shall extend through all internal surfaces and over flange faces. The lining shall cover all the baffles inside the tank.

c) To install the linings, full scaffolding access shall be provided to reach the internal walls and the entire area. Scaffold shall be properly erected with full planking in all work areas. Scaffolding shall not contact wall surfaces in work areas during lining application and surface preparation

d) The execution of the surface preparation and lining shall be carefully planned in stages to obtain optimum lining quality with freedom from contamination and overspray or damage to lined surfaces from preparation in adjacent areas. Surface preparation will commence from the top and proceed progressively to the wall base and floor.

e) Lining and preparation works shall be staggered or proceed progressively in order to meet cleanliness requirements or over coating times indicated in this specification.

f) Air-Compressor, Airless Spray pumps, hopper, blasting hose, lining hose, spray tip, blasting gun, spray gun and other equipment for blasting and spray application has to be arranged by lining vendor. Power & water required will be as per NIT. In case of Diesel compressor, vendor to arrange the diesel themselves. Compressed air and instrument air will not be provided. Any cold storage container, if required, shall be arranged by vendor. Any

scaffolding shall be made of Steel only. Scaffolding material shall be arranged by vendor. All travel, TA/DA, Stay charges, site visit charges shall be in vendor's scope.

g) Copies of Operation and Maintenance Manuals containing all details of reference drawings and technical data shall be furnished by the Bidder as specified elsewhere in the specification.

4.0 The glass flake lining used for the lining of the tanks/sumps is given as below:

Sl. No	Tanks/Sumps	Lining details of interior surface
1	Waste water Tank, Secondary Hydro cyclone feed Tank and Filtrate water Tank, Limestone Area drain pit, Gypsum dewatering area drain pit, Absorber Area Drain Pits	Vinyl ester-based Glass Flake lining of **min 3 mm thickness.**

5.0 ATMOSPHERIC CONDITION REQUIREMENTS

This section deals with the atmospheric condition requirement to be checked while undertaking the Glass Flake Lining at site.

1. Blasting or Coating shall not be applied if following conditions prevail.

   - When temperature of the surface to be coated is less than 3°C above the dew point, or the relative humidity is higher than 85%.
   - When the base metal temperature is greater than 60°C.
   - When the atmospheric temperature is below 4°C.
   - When there is, in the opinion of lining Contractor, the likely hood of an unfavourable change in the weather condition within 2 hours after coating.
   - When there is deposition of moisture in the form of rain or condensation.
   - Any other specific recommendations of lining manufacturer.

2. Humidity shall be calculated by bidder using whirling hygrometer whose thermometers are calibrated.

3. Surface temperature shall be measured using suitable temperature gauge and calibration certificate of the same shall be provided by bidder.

4. Record will be maintained throughout the execution period. Readings shall be taken once in every 4 hours up to the time work is in progress. The frequency of reading should be increased during adverse weather conditions.

5. While working in unfavourable weather conditions (like monsoons or winters or if provided for in the contract or in large confined spaces where blasting and priming of the entire surface cannot be completed in one day's operation, use of dehumidifier shall be resorted to. The dehumidification equipment will have to be maintained in such a way

that the humidity is around 65% -75% inside the sump at all times during the work. No flash rusting of the blast surface should take place till the time it receives a primer coat.

6. Where dehumidification equipment is to be used the humidity readings are to be taken inside and outside the equipments to be coated. Dehumidification machine shall be arranged by vendor.

7. Dehumidification equipment may not be necessary for contained space working if work is done at near ideal atmospheric conditions as described above.

8. In cases where dehumidification is not possible, alternate methods of warming up the work front like use of halogen lights, room heaters are to be adopted.

9. Humidity is to be taken at the location where the blasting coating operations taking place.

5.1 APPLICATION & MEDIUM:

Glass flake lining is done in order to protect the slurry tanks & sumps which contain limestone/gypsum slurry. Coated surfaces are exposed to slurry whose conditions are given in Anexure-8.

6.0 PRELIMINARY CHECK REQUIREMENTS

This section deals with the preliminary check requirements to be done while doing the lining work.

6.1 CHLORIDE CONTAMINATION TEST:

The 2% ferricyanide paper method will generally be used to determine the chloride contamination as described below:

1. Apply de-mineralized water on approximate 12 cm^2 area of substrate and wait for 3 to 4 minutes.
2. Remove excess moisture by patting the substrate with clean lint free cloth.
3. Press a ferricyanide paper of approximate 12 cm^2 area against the substrate for approximately 5 seconds and remove the paper.
4. Total absence of blue spots on paper indicates the substrate is free from soluble salts
5. Light speckling paper indicates the substrate has still contamination but it is as the acceptance level. The component should be released for further process.
6. Large blue spots on the paper indicate the substrate is heavily contaminated.
7. In this case the following procedure to be done before coating.
   i. Pressures wash the substrate with copious amount of town water.
   ii. Dry the substrate completely.
   iii. Re-blasts the surface.
   iv. Follow the salt contamination checking procedure again till you get the desired results.
8. The Ferricyanide papers should be stored by vendor in air tight container before and after use and the shelf life of Ferricyanide paper shall be one month.

6.2 ABRASIVE DRYNESS CHECK:

The abrasive to be used will be checked for dryness by taking a small quantity of abrasive on a filter /tissue paper and checking of traces of moisture absorbed in the filter/tissue paper. Frequency of test shall be once in day prior to blasting operation.

6.3 COMPRESSED AIR DRYNESS CHECK:

Compressed air to be used for blasting shall be free from oil & moisture and shall be tested adopting "Blotter Test" by vendor. A piece of blasting Paper will be held in front of blast hose nozzle to check for traces of oil/moisture captured by the blotting Paper. Frequency of test shall be once in day prior to blasting operation.

7.0 SURFACE PREPARATION

This section deals with the methods of surface preparation before coating application

7.1 MASKING:

1. Bidder to ensure that areas not being coated are fully and adequately masked.
2. Bidder to ensure that stud holes, dowel/oil ways etc. are suitably masked or plugged to prevent ingress of blasting abrasives.

7.2 SURFACE PREPARATION METHODS:

The method of surface preparation dry abrasive manual blasting shall be done as follows:

1. Surface to be coated shall be abrasive blasted. Before this operation, removal of existing coating to be carried out by chipping, grinding or by other suitable means. The walls of the tanks are painted with min 60µ DFT of Red Oxide Phosphate(rust proof primer), which is to be removed by vendor during blasting. Clean & dry Copper Slag Abrasive shall be used for ferrous base substrate.

2. Bidder is requested to go through all sections of the Typical GAD drawing of Slurry tank. Vendor my raise their observations during pre-bid query. Any other new requirements brought forward during technical evaluation stage shall not be considered by BHEL.

3. The minimum recommended compressed air required for Blasting shall be 7.0 m3/min at 6 kg/cm² pressure. NACE No.1/SSPC-SP-5 equivalent to SA 2½ of Swedish Standard blast profile (75 to 100 Microns) to be followed for cleaning the surface.

4. The blasted surface shall be cleaned with dry compressed air/vacuum cleaner or with clean brush so that there is no presence of Dust & other foreign material. The surface will be then checked for chloride contamination (Refer Clause.5.1 for Chloride contamination check procedure). If contamination is found then the surface to be washed and reblasted till contamination gets removed. Vendor to ensure that the blasted surface free from chloride contamination
5. When cleanliness and blast profile are acceptable, the masking tape adjacent to the area to be coated shall be peeled back to prevent overlap and subsequent edge contamination.

6. If the blasted surface has not been primed within specified time or if there is any previous visible sign of blast condition change then the surface shall be checked for metallic salt contamination and shall be reblasted. Where large areas are required to be blasted in a day, blasting shall be carried out from morning to evening ensuring weather condition. This shall be followed by a light sweep blast of the entire area, before priming. The blast cleaned surface shall be blown off with

dry oil free compressed air or vacuum cleaned. A cell tape shall be thoroughly pasted to the cleaned surfaces. The tape shall be removed after a minute to check presence of dust if any. Comparator shall be used by vendor for checking the blast profile.

8.0 COATING APPLICATION

This section deals with the methods & requirements of coating application.

8.1 MIXING:

1. All coating material tins shall be individually stirred thoroughly to obtain a homogenous consistency.
2. While doing spray application, the tins which come in pre measured kits will be fully mixed individually using a pneumatic stirrer. While doing hand application only small batches of 1 Kg. capacity shall be taken. Here the mixing will be done by using a metal spatula.
3. The mixing ratios as specified in the respective data sheet will be strictly adhered to. The base will be weighed out in kgs using mechanical weighing machines calibrated at site using any standard factory packed commercial product available freely in the market. The catalyst will be measured out in ML using marked syringes or measuring cylinders.

8.2 APPLICATION PROCESS:

1. The preparation and application of coating is done as per relevant product data sheet. Reference will be made to product datasheet or where appropriate, contract specifications for carrying out coating.
2. Coating in confined spaces should be done when the ambient temperature is low to avoid excess build up of styrene fumes.
3. The entire thickness will be built in multiple coating.
4. Each coat will consist of minimum two passes of wet on wet in perpendicular directions.
5. The Dry film thickness will built of each coat will be checked and recorded.
6. All the other people working with the paint will be provided with eye splash goggles and masks.
7. Glass flake lining material shall be chosen considering the slurry conditions given in Annexure-III
8. Minimum and maximum intercoat intervals are as follows.
   a. For primer coat -At 20ºC minimum 2 hours, maximum 14 hours.
   b. For build-up coats-minimum tack free of previous coat, maximum 3 days.
9. Primer coat shall be of 75-100 µm thickness
10. Built up Coat shall be of 3000-3100 µm in multiple coats.
11. Total System DFT: 3000 microns approx
12. All weld joints phase transition joints will receive a stripe coat by brush in the same sequence of coating on the shell.

8.3 CURING & FINISH:

1. Curing:

The completed linings shall be allowed to cure for a minimum of 48 hrs at 30°C prior to being placed in service. However, curing time shall be as per the datasheet provided by vendor for a proven material.

2. Finish:

It is to be noted that the coating will follow the profile of substrate. Any unevenness or other defects in the substrate may be reflected in the finish coating also. The finished coating shall have a matt/semi-glossy finish. A few local paint sag marks will not affect performance of coating and cannot be completely avoided. Hence this is permitted.

9.0 INSPECTION AND TESTING OF GLASS FLAKE LINING

After the completion of lining, the following tests shall be conducted by the vendor to assess the quality of glass flake lined surfaces.

1. Lining shall be visually inspected to ensure that it shall be free from poor weed out fibers, entrapped air and exposed fires. The Glass flake lining shall also be subjected to testing at site as per relevant standards.
2. Testing of coatings is normally carried out as soon as they are sufficiently cured to give true thickness & to withstand damage by the test equipment. If defects are found, repair will be carried out as per clause 10.0
3. Spark test shall be carried out at appropriate areas in the presence of Purchaser. Vendor should conduct holiday test as per relevant standards. If the performance is found not to meet the requirements as specified, the Glass flake lining shall be rectified or replaced by the Vendor without any additional cost to the Purchaser. The repair shall be carried out as per clause 10.0
4. Proper documentation with details of tests conducted by the vendor for evaluation of glass flake lining shall be submitted to the purchaser.

10.0 REPAIRING PROCEDURE FOR GLASS FLAKE COATING

1. If the exposed or damaged surface less than 10cm² then such repair can be carried out without grit blasting. Any area in excess of this amount should be grit blasted using a vacuum blaster where possible.
2. In case of damage area less than 10cm² then it can be repaired as following.
    a. De-contaminate surrounding area by using a suitable solvent such as methylated spirit, acetone, xylene etc. After washing clean and allow solvent to evaporate.
    b. Roughen up exposed metal & clean using rotary wire brush or a coarse emery paper with at least 60 grade grit. Brush away residues then further roughen surface of the existing coating up to 100 mm away from the damaged area. Brush away residues & ensure the whole area is clean.
    c. Apply a thin coat of material to the surface of the exposed metal only taking care not to cover more than a few millimetre of the existing coating. Allow this freshly applied material to become tack-free.
    d. Brush styrene monomer over the whole surface to be repaired (i.e. the whole area roughened by emery) & allow to evaporate from the surface.
    e. Apply at least 2 main coats material over the treated area taking care not to brush on to any roughened or contaminated areas. The Glass flake should be allowed to harden sufficiently to bear the weight of next coat before application of further coats. However, it does not need to be tack-free between coats.

11.0 PERFORMANCE GUARANTEE

The lining shall be guaranteed for uninterrupted minimum life of 25,000 hrs. Performance parameters to be guaranteed by the vendor and tolerances permitted shall be as indicated in the data sheet. Glass Flake lining or any portion thereof is liable for rejection, if it fails to give any of

the guaranteed performance parameters. During Guarantee period any defects noticed due to faulty material and workmanship, shall be rectified by vendor free of cost.

12.0 PACKING

The part items of the Glass flake lining should be identified by Tag numbers and should be packed as to minimize the possibility of damage during storage or transit. The packing should be suitable for tropical conditions. BHEL site will arrange for the space for storage. Vendor shall make arrangements for storing the Glass flake lining materials in AC containers at site. The list of items identified as despatchable units shall be furnished along with unit weight and the quantity for preparation of packing slip at BHEL end for dispatch to site and for easy identification, storage and erection at site.

Notes:

1. Lining material chosen shall withstand a maximum service temperature of 85 deg C.
2. Procedure for lining application duly certified by lining manufacturer shall be submitted for approval.

13.0 DOCUMENTATION

DATA TO BE FURNISHED BY THE VENDOR AFTER RECEIPT OF PURCHASE ORDER

1. List of Drawing and documents to be submitted for review, approval and information with submission dates.
2. Quality Assurance Plan to be submitted for approval.
3. Detailed dimensional General Arrangement drawing of the lining surfaces. This drawing shall indicate all the design data and information about the material, scope of work and weight of the material supply, Packing procedure etc.
4. Installation, operation and maintenance manual.
5. Surface preparation and Lining procedures.

CUSTOMER SPECIFICATION

Sub Section-C2 - A

CUSTOMER SPECIFICATION: TECHNICAL REQUIREMENT

furnish the minimum ball diameter below which the balls shall be replaced.

6.05.06 Facility shall be provided for on-load loading of steel balls to the mill.

6.05.07 The ball mill shall be driven by a motor through a peripheral gear/ central drive system. An auxiliary motor shall also be provided for inching of mills after trip and during maintenance.

6.05.08 The lube oil system shall have 100% stand-by arrangement for lube oil pumps and oil coolers of each circuit with independent pump / cooler. Wherever required duplex oil filters shall be provided.

6.05.09 The mill auxiliaries like separator tanks, mill circuit pump, hydro-cyclones and all connecting pipes handling limestone slurry shall have replaceable rubber linings.

6.06.00 Limestone Slurry Preparation / Storage Tank

6.06.01 The contractor shall provide two (2 nos.) slurry storage tank, common for all mills. Each tank shall be sized to meet 12 hours continuous limestone requirement of all the units operating at Design point. For tank volume calculation, solid concentration (by weight) in the slurry shall be assumed, not more than 20% or actual required whichever is lower.

6.06.02 The storage tanks shall be equipped with sufficient number of agitators, to avoid settling of limestone, as per the proven practice of the supplier. The agitators shall be designed to meet the requirements stipulated in Cl. No. 11.00.00 of this Sub-Section.

6.06.03 The limestone mill circulation tanks shall be installed indoor beneath the hydro cyclone stations. The slurry storage tank shall be located outdoor.

6.06.04 The slurry preparation tank shall be CS construction with replaceable chlorobutyl/bromobutyl rubber lining of minimum 5 mm thickness.

6.07.00 Limestone Slurry Supply Pumps & Piping

6.07.01 2x100% centrifugal type limestone slurry pump shall be provided for each unit. Each limestone slurry pump shall be sized to supply the limestone requirement of one (1 no.) unit, under the following conditions all occurring together.

(i)	Load	Design point
(ii)	Flow	110% of one absorber requirement with the limestone requirement at Design point.

	(iii)	Head	As per system requirement.
	(iv)	Margins	Flow 10% (minimum) Heads 15% (minimum)
	(v)	Solids Concentration	Max. 30% by weight or actual as per suppliers practice, whichever is minimum.

6.07.02 The limestone slurry pumps shall be designed to meet the requirements stipulated in Cl. No.8.00.00. of this Sub-Section.

6.07.03 The limestone slurry pipes shall be sized to minimize erosion and avoid settling of the limestone at part load operation. The slurry pipes shall be lined with replaceable wear resistant natural rubber lining of minimum 6 mm thickness. Additional thickness of 2 mm in rubber lining shall be provided at bends.

6.07.04 Automatic flushing equipment for all lime slurry pumps and pipes shall be supplied.

7.00.00 GYPSUM DEWATERING SYSTEM

7.01.00 A common gypsum dewatering system for all the units operating at Design point is envisaged. Contractor shall supply a two stage gypsum dewatering system, consisting of a primary stage of sets of hydro-cyclones and secondary stage of vacuum belt filters for dewatering of gypsum from absorber up to less than 10% moisture. All the equipments supplied shall be proven design with previous installations for similar capacities.

7.02.00 The Contractor shall provide 2x100% gypsum dewatering system with each stream sized to dewater 110% of the maximum gypsum produced by all the units operating at Design point. All other stipulations with respect to sizing and design of the dewatering system, auxiliaries and other systems shall be in line with this specification.

7.03.00 Primary Dewatering Hydro-cyclones

7.03.01 Each set of primary dewatering hydro-cyclone shall be sized to dewater the gypsum slurry produced by all the units operating at Design point with an additional 10% margin. The outlet water content in the gypsum shall be as per the requirement of the vacuum belt filters.

7.03.02 Each set of primary hydro-cyclone shall be provided with 10% spare hydro-cyclones. The capacity defined in the previous clause shall be met with spare hydro-cyclones out of service.

7.03.03 The primary hydro-cyclone shall be installed directly above the belt filters. The overflow of the hydro-cyclones shall be taken to Hydro-cyclone Waste Water tank via secondary hydro-cyclone feed tank and secondary waste water hydrocyclone as

shown in the relevant tender drawing.

7.03.04 Hydro-cyclones shall be of modular construction. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.

7.03.05 The hydro-cyclone shall be of proven design. The primary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose. The feed chamber shall be provided with a minimum rubber lining thickness of 12mm. The liners shall have a minimum wear life of not less than 7000 hrs.

7.04.00 Vacuum Belt Filters

7.04.01 Each vacuum belt filter shall be sized to meet the following requirements, all occurring together, with an inlet solid concentration of not more than 45% or outlet of hydro-cyclones whichever is minimum:

a. Capcity	110% of gypsum produced by Absorbers of all the units operating at Design point.
b. Outlet Moisture	10% max.
c. Gypsum Purity	90% (minimum)
d. Chloride content	< 100 ppm

7.04.02 The vacuum belt filter shall be proven design in operation for similar capacities. The filter cloth shall be polyester or polypropylene as per the proven design of the supplier and shall be guaranteed for a minimum life of not less than 7000 hrs.

7.04.03 The complete frame of the filter and all parts in contact with gypsum shall be made with corrosion resistant material.

7.04.04 In case, the contractor offers a design with an underlying belt for carrying the filter cloth, the same shall be endless, factory vulcanized rubber belts. The belt shrouds and the sealing belts shall provide a leak tight arrangement to prevent overflow of gypsum slurry. The sealing belt shall have minimum life of not less than 7000 hrs.

7.04.05 The vacuum box shall ensure tight sealing with the belt/cloth and shall be of proven design.

7.04.06 The belt filter shall have an automatic cloth tracking mechanism and shall be provided with all required instrumentation as per the supplier's proven practice. The

	belt filter shall have an automatic cloth tensioning mechanism.
7.04.07	The filter shall be provided with minimum 2 stages of cake washing for removing impurities in the gypsum. For cake washing only clarified water shall be used. For this purpose, one (1) clarified water storage tank (minimum 1 hr storage) shall be provided along with 2x100 cake washing pumps for each Vacuum Belt Filter . One stage of cloth washing arrangement shall also be provided along with 2x100 cloth washing pumps for each Vacuum Belt Filter.
7.04.08	The filtrate from gypsum slurry and from cake washing shall be taken to a common or separate vacuum receiver tank(s) as per the proven practice of the supplier. Each belt filter shall have an independent vacuum pump.
7.04.09	Gypsum cake from each belt filter shall be discharged through a hopper onto belt conveyor being provided by the Contractor.
7.04.10	A 2 m (min.) wide platform shall be provided around each belt filter for easy approach & maintenance. Handling facilities for replacement of heavy components of the belt shall also be provided.
7.05.00	**Vacuum System**
7.05.01	The filtrate from each belt filter, cake washing & cloth washing shall be taken to a common or separate receiver tank(s) as per the supplier's proven practice.
7.05.02	Each belt filter shall be provided with an independent vacuum pump sized to meet the requirements of the belt filter operating at its maximum capacity. An additional margin of 10% (min.) over the above capacity shall be provided for each vacuum pump.
7.05.03	The vacuum pump shall be of low speed liquid ring type of proven design. The design of the vacuum pumps shall avoid cavitations under all operating conditions. The seals shall be of proven design.
7.05.04	Silencers shall be provided, if required, to limit the noise level to values stipulated elsewhere in this specification.
7.05.05	The vacuum receiver and pump internals shall be suitably lined to protect against the corrosive environment. The material selected for vacuum pumps & vacuum receivers shall be proven for similar application.
7.05.06	Each vacuum receiver tank(s) shall be provided with slide plate type pneumatic vacuum breaker. The plate shall be stainless steel with a min. thickness of 3 mm.
7.06.00	**Filtrate System**
7.06.01	Water from vacuum receiver tank(s) and the secondary waste water hydrocyclone

	underflow shall be taken to a common filtrate tank for recirculation to the absorber tanks.
7.06.02	2x100% horizontal centrifugal pumps shall be provided for recirculation of filtrate water to absorber. 2x100% horizontal centrifugal pumps shall be provided for wash water requirements of belt filter. Alternatively, wash water pump may take suction from the vacuums receiver tanks. Each pump shall be provided with 100% standby in such a case.
7.06.03	The pump shall be capable of pumping of filtrate water with solid concentration of not less than 10% & particle lumps of 6-7mm. A 10% margin shall be provided in each of the pump.
7.07.00	**Waste Water System**
7.07.01	The overflow of the primary hydro-cyclones shall be taken to a secondary hydrocyclone feed tank for feeding the secondary waste water hydro-cyclones.
7.07.02	The secondary hydrocyclone feed tank shall be sized to provide a minimum storage of 1 hr of primary hydro-cyclone overflow with all the units operating at Design Point and no outflow from the tank.
7.07.03	2x100% horizontal centrifugal pumps shall be provided to feed the secondary hydro-cyclones.
7.07.04	Each set of hydro-cyclone shall be sized to process the maximum discharge from the secondary hydro-cyclone feed pumps. A minimum 10% spare hydro-cyclones shall be provided in each set. Secondary Hydro-cyclones shall be of modular construction and of proven design. The secondary hydro-cyclone shall be made up of polyurethane or urethane materials. It shall be possible to remove and replace individual hydro-cyclone with the set in service. Individual isolation valve shall be provided for each hydro-cyclone for this purpose.
7.07.05	The secondary waste water underflow shall be taken to the adequately sized filtrate tank, while the overflow shall be taken to a waste water tank. In case Bidder opts to provide additionally Lamella separator before the waste water tank and after the secondary hydro cyclone for removing impurities from the system, the solids concentration in waste water up to max 10% can be acceptable .However, the required moisture content in Gypsum & required Gypsum quality shall be complied.
7.07.06	1x100% Waste water tank shall be provided which shall be sized for 8 hrs storage of waste water with all the units operating at Design point and no out flow from the tank. The Waste water Tank shall be complete with Agitator, level transmitters etc. The waste water collection tank shall be of Steel construction with rubber lining. 2x100% horizontal centrifugal pumps shall be provided for pumping the waste water from waste water tank at required pressure to waste water terminal point as

	indicated in Sub-section IV, Part A, Section VI of the Technical Specification. The material of Casing and impeller shall be rubber lined Cast Iron (IS:210 Gr FG260). Shaft and Shaft Sleeves shall be Stainless Steel-410.
7.07.07	All piping, valves & instrumentation upto the employer's terminal point shall be in the contractor's scope. Contractor shall provide the complete lime dosing system to correct the pH of the waste water by lime (83% purity) dosing shall be provided and after mixing of the effluent (using re-circulation system of the pumping system), the effluent shall be discharged once the waste water has been neutralized to desired pH. A pH monitor shall be provided at the discharge of the pumps for measurement and control. Complete lime storage, feeding & dosing system shall be in contractor scope. The complete waste water neutralization system shall be automated and controlled from the control room.
7.07.08	Contractor shall provide 2x 100% Lime Neutralization tanks which shall be of minimum 8 hr capacity made of carbon steel with rubber lining along with 2x100% Lime storage silos. The tanks shall be provided with SS dissolving basket, Agitator of SS construction, drain, over flow and dosing connection, level transmitters, Agitators etc. The storage silos and hopper cones shall be fabricated of minimum 10 mm thick carbon steel with a SS lining of grade SS304 of minimum 4 mm thickness in the complete cones to ensure reliable discharge of material. The design of storage silos shall confirm to IS 9178 or any other proven international standards. The storage silo shall be capable of feeding the lime by motorized rotary feeding system to the Lime Neutralization tank.
7.07.09	Contractor shall provide 2x 100% Lime Storage Silos for feeding lime to the Lime Neutralization tanks. The lime storage silo shall be of minimum 24 hr capacity equivalent to the requirements of FGD system of all the units at Design point and shall be complete with supporting steel structure, platforms, power operated outlet gates, level switches, air relief devices, etc. For dust free operation each silo should be provided with a covering arrangement and a self cleaning bag filter system of suitable capacity containing blower, automatic/on-load cleaning system, etc.
7.07.10	Bucket conveyors shall be provided by the contractor to feed lime to each of the lime storage silos from ground level. The Bucket conveyors shall be sized to completely feed each lime silo within 2 hrs. Adequate storage and feeding system required for feeding the lime to the Bucket conveyors is also in the Contractor's scope.
7.07.11	A storage room for storing minimum one (1) month requirement of lime for all the units shall also be provided by the contractor.
7.08.00	**Auxiliary Absorbent Tank**
7.08.01	The Contractor shall provide an auxiliary absorbent tank, for the unit, sized to contain the complete slurry of one absorber tank at its maximum level equipped with all necessary pumps, valves, piping and controls to transfer the tank's contents back to the absorber to refill the absorber sump It should be possible to discharge the each absorber into the Auxiliary Absorbent tank within 2 hours.

7.08.02	The contractor shall provide 1 x100% pump to pump back the slurry from the sump back to the absorber in a maximum time of 8 hours.
7.08.03	Agitation shall be provided to prevent settlement of slurry by side entry agitators with emergency flush start system. Sufficient number of agitators shall be provided in the tank by the contractor to prevent the solids from settling down.
7.08.04	The Auxiliary Absorbent tank shall be made of minimum 7 mm thick carbon steel with minimum 4 mm thick rubber lining of best quality bromine butyl rubber and shall also be equipped with all necessary pumps, valves, piping and controls to transfer the tank's contents back to the absorber.
7.08.05	The Auxiliary Absorbent tank shall be equipped with an opening to enable easy entry of a man with wheelbarrow.
7.08.06	Suction screens shall be installed to protect the pump.
8.00.00	**SLURRY PUMPS**
8.01.00	This Clause covers the design, manufacture and erection of all slurry pumps for the FGD system including the Absorber slurry recirculation pumps, Gypsum bleed pumps, Limestone slurry feed pumps, Mill circuit pumps and any other pump handling slurries.
8.02.00	The Contractor shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian / International (ASME / EN / Japanese) Standards.
8.03.00	The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type capable of delivering the rated flow at rated head with margins as specified in the respective clauses. The slurry concentration in the pump shall not exceed 30% by weight except for Mill circuit slurry pumps for which the slurry concentration in the pump shall not exceed 55% by weight.
8.04.00	All the slurry pumps shall be provided with motorized suction and discharge valves. In addition, flushing water lines with motorized/ pneumatic valves shall be provided for each pump for automatic flushing of the pump after each shut down. The flushing water for the pumps shall be taken from the process water supply. The process water lines shall be provided with pneumatic/motorized valves as per the proven practice of the Bidder.
8.05.00	In case of pump with rubber lined casing, the casing should be radially split to allow easy removal of impeller.
8.06.00	All the pump wear parts in contact with the slurry shall be provided with replaceable rubber/elastomer liners suitable for the fluid handled. The Bidder can also offer an hi

	chrome alloy line pump if the Bidder has previous experience of the same for similar applications. The material used by the contractor shall be proven in previous installations.
8.07.00	For absorber recirculation service a Silicon carbide/hi-chrome impeller and SiC lining for casing can also be accepted if the manufacturer has supplied a similar pump for a previous installation for similar service.
8.08.00	The material and thickness of the liners shall ensure a minimum service life of 2 years before replacement. All the wear parts of the pump shall be guaranteed for a minimum wear life of not less than 14000 hrs.
8.09.00	The design of the shaft shall ensure that the operating speed is at least 20% above the critical speed of the shaft.
8.10.00	The pump shall be provided with seals of proven type and shall be designed for minimization of seal water consumption. The shaft shall be supported on heavy duty ball/roller bearings.
9.00.00	**VERTICAL SUMP PUMPS**
9.01.00	Contractor shall provide sumps of adequate capacity in the each absorber area, limestone grinding area and gypsum dewatering area for containing the over flow from the respective systems. Acid resistant tiles or other suitable material of standard thickness as per bidders proven practice shall be provided as liner. Contractor shall make arrangements for pumping the drainage water back to the respective system with vertical sump pumps. Agitators shall also be provided to avoid settling of solids in the sump. Adequate redundancy in line with the standard practice adopted by the bidder shall be provided. This Clause covers the design, manufacture and erection of all vertical sump pumps for the FGD system.
9.02.00	The contractor shall offer only proven design in successful operation in similar application at previous installations. The design, manufacture, installation and testing of the pumps shall follow the latest applicable Indian / International (ASME / EN / Japanese) Standards.
9.03.00	The pumps shall be designed for continuous operation. The pump shall be single stage centrifugal type with semi open or open impeller. The pump impeller shall be cantilever type and shall not be supported below the base plate for easy withdrawal.
9.04.00	The pump shall deliver the rated flow at rated head with margins as specified in the respective clauses. The pump shall be capable of pumping of filtrate water with solid concentration upto 10% & particle lumps of 6-7mm. Sump pumps handling slurry shall be designed with a maximum concentration of 30% solid by weight.
9.05.00	The material chosen for the pump components shall be suitable for the fluid handled

	and shall be proven in similar application.
9.06.00	The pumps shall not be supported below the base plate level for easy withdrawal without entering the sump.
10.00.00	**SLURRY & PROCESS WATER TANKS**
10.01.00	All the slurry tanks (Slurry Tanks, Filtrate Tank, Secondary hydro cyclone feed tank, vacuum receiver tank, Waste water Tank, Lime Neutralization tanks etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.5 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. Tanks shall be made from IS:2062 quality mild steel plates of tested quality. The tanks shall be of welded construction. Interior surface of the tanks shall be lined with the following: Wastewater tank, Filtrate tank, Secondary hydro cyclone feed tank: Vinyl Ester based flake glass lining of minimum 3 mm thickness Slurry tanks: Replaceable Chlorobutyl/ Bromobutyl rubber lining of minimum 4 mm thickness The outside surface of the tanks shall be coated with paint as approved by the Employer. Coarse-screen(s) at suction-side of slurry recirculation pumps shall be provided.
11.00.00	**AGITATORS**
11.01.00	Agitators shall be supplied in tanks and vessels to prevent caking and settlement of particles out of the slurry, e.g. in the absorber vessel, limestone mill recycle tanks, limestone slurry tank, Auxiliary Absorbent tank, and sumps etc.
11.02.00	All agitators shall be designed for continuous operation unless otherwise specified. Horizontal agitators shall be used for Absorber. Vertical agitators can also be used for Absorber, if it is only the standard & proven practice of the Contractor for the offered Absorber design. In other vessels and tanks vertical agitators are also acceptable if they are of proven make and the Bidders standard practice which can be proven by means of suitable references. The design of the agitators shall be of proven type.
11.03.00	Standard type agitators with suitable characteristics shall be used wherever practical. The agitators shall be complete with motor, gearbox, agitator shaft, coupling, safety guards, mechanical seal (for side entry agitators), impeller, support legs, agitator mounting flange including bolts nuts and gasket etc.
11.04.00	All agitator parts and accessories in contact with the stirred fluid shall be constructed of materials specifically designed for the conditions and nature of the stirred fluid and be resistant to erosion and corrosion.
11.05.00	The material for the shaft (which is continuously in contact with slurry) and agitator

	blades of the Absorber Agitators shall be made with Alloy 926 or better material. For Agitators in other tanks, agitator blades shall be made with Alloy 926 or better material & shaft can be rubber lined. This does not release the Contractor of the responsibility for selecting the correct materials.
11.06.00	Each agitator and its associated equipment shall be arranged in such a manner as to permit easy access for operation, maintenance and agitator removal without interrupting plant operation. It shall be possible to remove the sealing devices of the Agitators of the absorber vessel without having to drain completely the absorber.
11.07.00	To prevent mechanical blocking load start-up after standstill of pumps, piping and agitators for slurries shall be applied with C-hose connection.
11.08.00	Lifting lugs and eyes and other special tackle shall be provided as necessary to permit easy handling of the agitators and their components.
11.09.00	Static and dynamic (as far as applicable) balancing of all agitators shall be carried out after assembly.
11.10.00	All agitator parts and components shall be designed and calculated for fatigue life, considering maximum bending loads, induced by fluctuating hydraulic forces and torsional loads, based on the installed motor power. For side entry agitators the alternating bending moment resulting from impeller and shaft weight has to be considered additionally.
11.11.00	All exposed moving parts shall be covered by guards.
11.12.00	Side entry agitator shall be flange mounted.
11.13.00	The shape of the impeller blades of side entry agitators shall be designed to avoid wear on the impellers which will affect the agitator performance as specified for a minimum period of 2 years of continuous operation under design conditions for the range of coal & limestone specified in the specification. In order to avoid excessive wear impeller tip speeds must not exceed 12 m/s.
11.14.00	Belt drives (if applied) shall be properly designed to provide a minimum lifetime of 2 years under design conditions
12.00.00	**SLURRY LINES AND VALVES**
12.01.00	Slurry pipes shall be designed to keep the velocity above the settling velocity under all operating conditions. The contractor may provide a recirculation line with motorized isolation valve / restriction orifice made of erosion resistant material for the above purpose.
12.02.00	All the pipes handling slurry shall be provided with replaceable rubber lining of proven quality. The Contractor can provide slurry pipes of size lower than 300 NB made up of FRP material (silicon carbide coating on slurry exposed surface) if it has previous experience of providing the same. Outer surface of the pipes should be fire retardant.
12.03.00	The isolation valves provided in all the slurry lines shall be of knife gate type/butterfly

type unless specifically mentioned. Motorized actuators shall be provided for valves requiring frequent operation as indicated in the relevant scheme.

12.04.00 The valves shall be of proven type and the contractor shall submit a detailed valve schedule for employer's approval. Reference list for previous installations for similar application shall also be furnished to the employer.

12.05.00 Bidder shall provide all necessary arrangements for purging & flushing of all the process pipelines, equipments etc.

13.00.00 PROCESS WATER STORAGE TANKS & PUMPS

13.01.00 Two (2) Process water Storage tanks (each tank catering to the requirements of all the units operating at Design Point) along with two numbers of 2x100 % Booster water pumps, if required, (Each pump catering to the process water requirements of all the units operating at Design Point) along with all necessary piping, valves, control & instrumentation to feed the clarified water shall be provided by the Contractor. Process water Storage level shall be automatically controlled at operating level by controlling the water flow from the makeup water from terminal point. The process water storage tank shall be designed to store 15 minutes of total maximum water required for the entire FGD process (including absorber system and mist eliminator washing system, limestone grinding and slurry preparation system and gypsum dewatering system, etc.) for the units operating at Design point. All the process water storage tanks shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.50 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the bidder. Tanks shall be made from IS:2062 quality mild steel plates of tested quality. The tank shall receive water supplied (as identified in Subsection titled "Terminal points" in Part-A of Technical Specification) by Employer. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.

13.02.00 2x100% Process Water Pumps shall be provided for each unit connected to each of the Process water Storage tanks along with all necessary piping, valves, control & instrumentation. Each pump catering to process water requirement of one unit. The capacity of the pumps shall be such that it shall meet the maximum process water requirement of each unit. A further 10% margin shall be provided over the above capacity for all the above pumps.

13.03.00 2x100% Mist Eliminator Wash Water Pump for each unit connected to each of the Process water Storage tanks along with all necessary piping, valves, control & instrumentation shall be provided by the Contractor. Alternatively, Contractor can use process water pumps for mist eliminator washing if it is the standard & proven practice of the Contractor or its Technology Collaborator. Each pump shall cater to maximum mist washing requirement of one unit. The capacity of the pumps shall be such that the total capacity of working pumps is sufficient to meet the maximum

	wash water requirements of mist eliminators of the absorber. A further 10% margin shall be provided over the above capacity for all the above pumps.
13.03.04	Two (2) clarified water Storage tanks along with two numbers of 2x100 % clarified Booster water pumps from terminal point shall be provided by the Contractor. The two tanks shall be interconnected with an isolation valve.
13.03.05	2x100% clarified water Pumps connected to each of the clarified water Storage tanks for each dewatering stream. Each pump catering to clarified water requirement of each dewatering stream.
13.03.06	The type of pumps shall be horizontal centrifugal type designed for continuous operation with semi open or closed impeller. Casing, Gland and Stuffing Box shall be of 2.5 Ni Cast Iron to IS:210 Grade FG 260 or equivalent. Impeller, Wearing rings (as applicable) shall be of Stainless Steel -316 grade and Shaft & Shaft sleeves shall be of SS-410 grade. Pump re-circulation line shall be provided for pumping system. Pumps shall be provided with accessories such as Y-type suction strainers, Coupling guard, drain plugs, vent valves etc.
13.03.07	All the Process water tanks (Process water Storage tanks, Clarified water tank, Emergency water storage tanks etc.) shall be designed, fabricated, erected and tested in accordance with the IS:803, latest edition. Additional Corrosion allowance of 1.5 mm on the minimum tank shell thickness as calculated by IS:803, latest edition shall be provided by the Contractor. Tanks shall be made from IS:2062 quality mild steel plates of tested quality. The tanks shall be of welded construction. Interior surface of the tanks shall be lined with replacable chlorobuty/bromobutyl rubber lining of minimum 4 mm thickness or with vinly ester based flake glass lining of minimum 3 mm thickness or Epoxy lining minimum three coats of 150 micron thickness and the outside surface shall be coated with paint as approved by the Employer. The Tanks shall be provided with drain, manholes, over flow & inlet level control valves etc.
14.00.00	**Approach and Handling Facilities**
14.01.00	Proper approach shall be provided for access to all equipments during normal operation and maintenance. Unless otherwise specified, platforms, staircase and ladders shall follow the stipulations specified elsewhere in this specification.
14.02.00	Equipments requiring monitoring during regular operation shall be approachable from the ground floor through staircase. Staircase with minimum width of 1200 mm shall be provided for approach to elevated structures at 5m height from the nearest platform. Below this height a vertical ladder with minimum clear width of 600 mm may also be acceptable.
14.03.00	Platform with a minimum clear width of 1000 mm shall be provided all around the lowest absorber spray levels and mist eliminators. Similar platforms shall be provided at subsequent elevations if they are more than 3000 mm apart from each

	other. An adequately sized manhole with platform (min. 2 sq. m) shall be provided above each spray level. Ladders/staircase shall be provided for the access to the platform.
14.04.00	The absorber slurry recirculation pumps, gypsum bleed pumps and limestone feed pumps shall be mounted on the ground level. Suitable approach and platforms shall be provided for all the valves required during regular operation.
14.05.00	A 1500 mm space shall be provided around all pumps, except absorber recirculation pumps, where a 2000 mm space shall be provided.
14.06.00	Platform with a minimum width of 1500 mm shall be provided all around the pulverizers and feeders. Approach along with suitable platforms shall be provided for ball loading hoppers.
14.07.00	A 1000 mm wide platform with suitable approach shall be provided around each hydro-cyclone.
14.08.00	A 2000 mm wide floor/platform shall be provided all around each belt filter.
14.09.00	Contractor shall provide motorized hoists and trolleys for all items requiring maintenance and weighing 500 kg or more. All auxiliary structures, monorails, runway beams for all lifting tackles, hoists etc., are included in Contractor's scope of supply. Access ladders with suitable platform shall also be provided for approach to all motorized hoists/trolleys mounted on their runway beams for the maintenance of hoists/trolleys. Items weighing more than 50 kg and required to be replaced for maintenance shall be provided with manual hoists/trolleys with runway beams/supporting structure etc.
14.10.00	The regular basement floor is not acceptable in FGD area. Further local Pits/trenches shall be avoided as far as possible.
14.11.00	Handling arrangement of milling system, Booster fans, Slurry recirculation pumps, oxidation blower, belt feeder system etc. complete with crane/monorail along with removal space for maintenance shall be provided by the Contractor.
14.12.00	Approach for removal of equipment for maintenance shall be provided.
14.13.00	All other safety requirements as per the Factories Act, National Electricity code shall be complied with while developing Layout.
14.14.00	Cable trenches/slits, if unavoidable, shall be provided with adequate cushioning of sand and the same shall be covered with PCC.
14.15.00	Each Equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of Factories Act and Statutory bodies/insurance companies.

14.16.00 Minimum Headroom (free height) under all floors, ducts, walkways and stairs shall be 2.50 M.

14.17.00 Inter-connecting pipes/cables between various facilities of FGD plant shall be routed on the steel trestles to be provided by the Contractor. The clear head room for the same shall be minimum 8 M.

15.00.00 ELEVATORS

15.01.00 Elevators shall be designed based on following criteria :

(i)	Type of service	One (1) no. Passenger cum goods elevator per Absorber (higher than 20 m) & for Mill Building
(ii)	Design/construction/installation codes	(a) Latest edition of IS:14665 (All parts) AND also meeting any additional requirements of IS:4666, IS:1860 and IS:3534. (b) Any other equivalent code, subject to Employer's approval.Load carrying capacity
(iii)	Capacity	1000 kg (minimum).
(iv)	Rated speed	1.0 m/s.
(v)	Total Travel	As per FGD supplier's recommendations subject to Employer's approval.
(vi)	Number of floors to be served	As per requirement and subject to Employer's approval
(vii)	Entrance	As per requirement and subject to Employer's approval
(viii)	Entrance and platform size	As per design/installation codes at (ii) above
(ix)	Drive/motor	As per Electrical Specifications.
(x)	Method of control	As per Electrical Specifications.
(xi)	Machine room and lift Shaft	Pressurized dust proof or Airconditioned machine room as per the

CUSTOMER SPECIFICATION: PROJECT SPECIFIC GENERAL REQUIREMENTS

1.00.00 **INTRODUCTION**

This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical specifications and requirements brought out in Section-VI, the Technical Specification and the Technical Data Sheets.

2.00.00 **BRAND NAME**

Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific item mentioned shall be understood to be indicative of the function and quality desired, and not restrictive; other manufacturer's products may be considered provided sufficient information is furnished to enable the Employer to determine that the products proposed are equivalent to those named.

3.00.00 **BASE OFFER & ALTERNATE PROPOSALS**

The Bidder's proposal shall be based upon the use of equipment and material complying fully with the requirements specified herein. It is recognised that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered, provided the base offer is in line with technical specifications and such proposals meet the specified design standards and performance requirement and are acceptable to the Employer. Sufficient amount of information for justifying such proposals shall be furnished to Employer alongwith the bid to enable the Employer to determine the acceptability of these proposals.

4.00.00 **COMPLETENESS OF FACILITIES**

4.01.00 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure a completely engineered plant shall be provided.

4.02.00 All equipments furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation of the equipment and for the safety of the operating personnel, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

All same standard components/ parts of same equipment provided, shall be interchangeable with one another.

4.03.00 For the C&I systems, the Contractor shall be required to provide regular information about future upgrades and migration paths to the Employer.

5.00.00 **RULES, REGULATIONS, CODES & STANDARDS**

5.01.00 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this specification shall comply with all currently applicable statutory regulations and safety codes of the Republic of India, NTPC rules/codes of practices as well as of the locality where they will be installed, including the following:

a) Indian Electricity Act

b) Indian Electricity Rules

c) Indian Explosives Act

d) Indian Factories Act and State Factories Act

e) Indian Boiler Regulations (IBR)

f) Regulations of the Central Pollution Control Board, India

g) Regulations of the Ministry of Environment & Forest (MoEF), Government of India

h) Pollution Control Regulations of Department of Environment, Government of India

i) State Pollution Control Board.

(j.) Rules for Electrical installation by Tariff Advisory Committee (TAC).

(k.) Building and other construction workers (Regulation of Employment and Conditions of services) Act, 1996

(l.) Building and other construction workers (Regulation of Employment and Conditions of services) Central Rules, 1998

(m.) Explosive Rules, 1983

(n.) Petroleum Act, 1984

(o.) Petroleum Rules, 1976,

(p.) Gas Cylinder Rules, 1981

(q.) Static and Mobile Pressure Vessels (Unified) Rules, 1981

(r.) Workmen's Compensation Act, 1923

(s.) Workmen's Compensation Rules, 1924

(t.) NTPC Safety Rules for Construction and Erection

(u.) NTPC Safety Policy

(v.) Any other statutory codes / standards / regulations, as may be applicable.

5.02.00 Unless covered otherwise in the specifications, the latest editions (as applicable as on date of bid opening), of the codes and standards given below shall also apply:

a) Bureau of Indian standards (BIS)

b) Japanese Industrial Standards (JIS)

c) American National Standards Institute (ANSI)

d) American Society of Testing and Materials (ASTM)

e) American Society of Mechanical Engineers (ASME)

f) American Petroleum Institute (API)

g) Standards of the Hydraulic Institute, U.S.A.

h) International Organisation for Standardisation (ISO)

i) Tubular Exchanger Manufacturer's Association (TEMA)

j) American Welding Society (AWS)

k) National Electrical Manufacturers Association (NEMA)

l) National Fire Protection Association (NFPA)

m) International Electro-Technical Commission (IEC)/European Norm (EN)

n) Expansion Joint Manufacturers Association (EJMA)

o) Heat Exchange Institute (HEI)

p) IEEE standard

q) JEC standard

5.03.00 Other International/ National standards such as DIN, JIS, VDI, EN, BS, GOST etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish specifically the variations and deviations from the standards mentioned elsewhere in the specification together with the complete word to word translation of the standard that is normally not published in English.

5.04.00 Not used.

5.05.00 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

5.06.00 Two (2) English language copies of all national and international codes and/or standards used in the design of the plant, equipment, civil, structural and architectural works shall be provided by the Contractor to the Employer within two calendar months from the date of the Notification of Award.

5.07.00 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.

5.08.00 A detailed list of standards apart from those mentioned in the respective detailed specifications in other parts of Section-VI to which all equipment/systems/civil works should conform as indicated in this Part C and elsewhere in the specification.

6.00.00 **EQUIPMENT FUNCTIONAL GUARANTEE**

6.01.00 The functional guarantees of the equipment under the scope of the Contract is given in Section-VI Part - A of Technical Specifications. These guarantees shall supplement the general functional guarantee provisions covered under Defect liabilities Section-IV, General Conditions of Contract.

6.02.00 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.

7.00.00 **DESIGN OF FACILITIES/ MAINTENANCE & AVAILABILITY CONSIDERATIONS**

7.01.00 **DESIGN OF FACILITIES**

All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.02.00 **MAINTENANCE AND AVILABILITY CONSIDERATIONS**

Equipment/works offered shall be designed for high availability, low maintenance and ease of maintenance. The Bidder shall specifically state the design features incorporated to achieve high degree of reliability/ availability and ease of maintenance. The Bidder shall also furnish details of availability records in the reference plants stated in his experience list.

Bidder shall state in his offer the various maintenance intervals, spare parts and man-hour requirement during such operation. The intervals for each type of maintenance namely inspection of the furnace, inspection of the entire hot gas path and the minor and major overhauls shall be specified in terms of fired hours , clearly defining the spare parts and man-hour requirement for each stage.

Lifting devices i.e. hoists and chain pulley jacks ,etc. shall be provided by the contractor for handling of any equipment or any of its part having weight in excess of 500 Kgs during erection and maintenance activities.

Lifting devices like lifting tackles, slings, etc. to be connected to hook of the hoist / crane shall be provided by the contractor for lifting the equipment and accessories covered under the specification.

8.00.00 **DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR**

8.01.00 Bidders may note that this is a contract inclusive of the scope as indicated elsewhere in the specification. Each of the plant and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely

engineered plant shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

Each main and auxiliary equipment/item of the plant including instruments shall be assigned a unique tag number. The assignment of tag numbers shall be in accordance with KKS system. In all drawings/documents/data sheet etc. KKS tag number of the equipment/item/instrument etc. shall be indicated.

The Contractor shall furnish engineering data /drawings in accordance with the schedule of information as specified in Technical Data Sheets and Technical Specification.

A comprehensive engg and quality coordination procedure shall be finalized with the successful bidder covering salient features as described in this section of specifications.

8.02.00 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in **Annexure-VI** to this Part-C, Section-VI of the Technical Specification.

8.03.00 The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following:

8.03.01 A) **BASIC ENGINEERING DOCUMENTATION**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Plant Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

i) System description of all the mechanical, electrical, control & instrumentation & civil systems.

ii) Technology scan for each system / sub-system & equipment.

iii) Selection of appropriate technology / schemes for various systems/ subsystems including techno-economic studies between various options.

iv) Optimisation studies including thermal cycle optimisation.

v) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations alongwith all calculations justifying and identifying the sizing and the design margins.

vi) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

vii) Operation Philosophy and the control philosophy of the equipments/system covered under the scope.

ix) General Layout plan of the FGD System incorporating all facilities in Bidder's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.

x) Basic layouts and cross sections of the main plant building (various floor elevations), boiler, fuel oil area and other areas included in the scope of the bidder.

xi) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Plant Definition Manual (PDMs) including techno-economic studies, which shall then be mutually discussed & finalised with the Employer.

B) **DETAILED ENGINEERING DOCUMENTS**

~~i) General layout plan of the FGD System.~~

ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.

~~iii) Flow diagram, process and instrumentation diagrams along with write up and system description.~~

~~iv) Performance curves for Absorber~~

v) Piping isometric, composite layout and fabrication drawings.

vi) Piping engineering diagrams, pipe and fittings schedules, valve schedules, hanger and support schedules, insulation schedules.

vii) Technical data sheets for all bought out and manufactured items. Contractor shall use the Employer's specifications as a base for placement of orders on their sub vendors.

~~viii) Detailed design calculations for components, system, piping etc., wherever applicable including sizing calculations for all auxiliaries like mills, fans etc. as per criteria specified elsewhere in specification.~~

ix) Absorber sizing calculations. Absorber performance data.

x) Mass Balance Diagram

xi) Characteristic Curves/ Performance Correction Curves.

xii) Comprehensive list of all terminal points which interface with Employer's facilities, giving details of location, terminal pressure, temperature, fluid handled & end connection details, forces, moments etc.

xiii) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

xiv) Protection system diagrams and relay settings.

xv) Cables schedules and interconnection diagrams.

xvii) Cable routing plan.

xviii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, and installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xix) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xx) Sequence and protection interlock schemes.

xxi) Type test reports, insulation co-ordination study report

xxii) Control system configuration diagramsand card circuit diagrams and maintenance details.

xxiii) Detailed Control system manuals.

xxiv) Detailed flow chart for digital control system.

xv) Mimic diagram layout, Assignment for other application engg.drawings and documents.

xxvi) ~~Civil and~~ Structural works drawings and documents for all structures, facilities, architectural works, foundations underground and overground works and super-structural works as included in the

scope of the bidder civil calculation sheets including structural analysis and design alongwith output results.

xxvii) Underground facilities, levelling, sanitary, land scaping drawings.

xxviii) Geotechnical investigation and site survey reports (if and as applicable).

xxix) Model study reports wherever applicable.

xxx) Functional & guarantee test procedures and test reports.

xxxi) Documentation in respect of Quality Assurance System, and Documentation in respect of Commissioning, as listed out elsewhere in this specification.

xxxii) Maintenance schedule for ~~Absorber & auxiliaries~~ clearly indicating interval, duration if shutdown required, manhours required and tools & tackles required for maintenance.

The Contractor's while submitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter alongwith the date vide which the submissions are made.

8.03.02 **INSTRUCTION MANUALS**

The Contractor shall make first submission of instruction manual for all the equipments covered under the Contract as per agreed engineering information schedule. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in **Annexure-IV.** The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

A) ERECTION MANUALS

The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipments like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection and General Safety procedures to followed during erection/installation.

h) Procedure for initial checking after erection.

i) Procedure for testing and acceptance norms.

j) Procedure / Check list for pre-commissioning activities.

k) Procedure / Check list for commissioning of the system.

l) Safety precautions to be followed in electrical supply distribution during erection.

B) OPERATION & MAINTENANCE MANUALS

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number Each section of the manual shall be divided by a stiff divider of the same size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O & M manuals shall be as follows:

1) <u>Chapter 1 - Plant Description</u>: To contain the following sections specific to the equipment/system supplied

(a) Description of operating principle of equipment / system with schematic drawing / layouts.

(b) Functional description of associated accessories / controls. Control interlock protection write up.

(c) Integrated operation of the equipment alongwith the intended system. (This is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

(d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment alongwith its accessories and auxiliaries.

(e) Design data against which the plant performance will be compared.

(f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

(g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

(h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

(a) Protection logics provided for the equipment alongwith brief philosophy behind the logic, Drawings etc.

(b) Limiting values of all protection settings.

(c) Various settings of annunciation/interlocks provided.

(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.

(e) Do's and Don'ts related to operation of the equipment.

(f) Safety precautions to be take during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

(g) Parameters to be monitored with normal value and limiting values.

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

(k) Routine Operational Checks, Recommended Logs and Records

(l) Change over schedule if more than one auxiliary for the same purpose is given.

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance- To contain the following sections specific to the equipment supplied.

(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.

(c) List of Special T/ P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.

(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.

(f) Overhauling schedules linked with running hours/calendar period alongwith checks to be done.

(g) Long term maintenance schedules

(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at

longer intervals to ensure trouble free operation and quantity required for complete replacement.

(j) Tolerance for fitment of various components.

(k) Details of sub vendors with their part no. in case of bought out items.

(l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares to NTPC.

(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.

(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

8.03.03 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-VI. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to the Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer for records and number of copies shall be as mentioned in Annexure-VI.

8.03.03 **PLANT HANDBOOK AND PROJECT COMPLETION REPORT**

8.03.03.01 **PLANT HANDBOOK**

The Contractor shall submit to the Employer a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipments and systems covering the complete project including

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

vii) General layout plan and layout of main plant building and auxiliary buildings

viii) Important Do's & Don't's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Employer's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03.02 **PROJECT COMPLETION REPORT**

The Contractor shall submit a Project Completion Report at the time of handing over the plant.

8.03.04 **DRAWINGS**

a) i) All the FGD plant layouts shall be made in computerised 3D modelling system. The Employer reserves the right to review the 3D model at different stages during the progress of engineering. The layout drawings submitted for Employer's review shall be fully dimensioned and extracted from 3D model after interference check.

ii) All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per **Annexure-VI** of Part-C. The soft copies shall be uploaded by the vendors in C-folders, a Web-based system of NTPC ERP, for which a username and password will be allotted to the new vendor by NTPC.

Similarly, the vendor can download the drawings/documents, approved/ commented by NTPC, through above site.

The soft copies of identified drawings/documents shall be in pdf format, whereas the attachments/reply to the submitted document(s) can be in .doc, .xls, .pdf, .dwg or .std formats.

iii) Final copies of the approved drawings along with requisite number of hard copies shall be submitted as per **Annexure-VI** of Part-C.

iv) Contractor shall prepare the model of all the facilities located in FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE (including all

facilities), and any other facility in an integrated & intelligent 3D software solution using rule-based, data centric 3D Design software with equipment drawings, data sheets, intelligent P&ID correlated with intelligent 3D Model, BOQ, schematics and logic diagrams etc. attached to the respective equipment / systems in the aforesaid 3D model. Contractor shall make a presentation on 3D model every 3 months from LOA to enable NTPC to review the progress of engineering. After the completion of engineering the corresponding complete 3D review model shall be handed over to the employer for its reference.

Contractor shall provide 3D model (which shall include visual interference check, walk-through animation, video simulation for major equipment placement and removal, visual effect, photo realism etc), which is extracted from intelligent 3D model, for employer's review as & when desired by employer. However, all piping layouts, equipment layouts, floor plans, ducting layout (Air/flue gas, A/C, Ventilation etc.), General Arrangement drawings of major buildings, structural arrangement drawings and RCC layout drawings shall necessarily be extracted from the aforesaid 3D model and submitted for employer's review along with the 3D review model to enable NTPC to review and approve these drawings.

b) All documents/text information shall be in latest version of MS Office / MS Excel / PDF FORMAT as applicable.

c) All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

d) Each drawing submitted by the Contractor (including those of subvendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

e) The drawings submitted by the Contractor (or their subvendors) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

Similarly, all the drawings/ documents submitted by the Contractor during detailed engineering stage shall be marked "FOR APPROVAL" or "FOR INFORMATION" prior to submission. Further, space shall be identified on each drawing for Approval stamp and electronic signature.

f) The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the project. The review of these documents/ data/ drawings by the Employer will cover only general conformance of the data/ drawings/ documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and/ or approval by the Employer/ Project Manager shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

g) After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer.

h) All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment /system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

i) Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/ approval of Employer piror to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/ representative of Employer based on requirements of such piping indicated in approved/ finalised Flow Scheme/ Process & Instrumentation Diagrams and/or the requirements cropping up for draining & venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining & venting arrangement as per site suitability.

j) As Built Drawings

After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to “as built” conditions and submit no. of copies as per **Annexure VI**.

k) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission. The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/ drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

l) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The Employer shall review the drawings and return soft copy to the Contractor authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Contractor to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

m) All engineering data submitted by the Contractor after final process including review and approval by the Project Manager/ Employer shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Project Manager in writing.

n) The Contractor shall submit drawings in line with the suggestive MDL covered in Part-B, Section-VI of Technical Specification and which shall be duly integrated with approved PERT network.

8.04.00 **ENGINEERING INFORMATION SUBMISSION SCHEDULE**

Prior to the award of Contract, a Detailed Engineering Information Submission Scheduler/Master Drawing List duly integrated with approved PERT network shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information alongwith the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

i) Information that shall be submitted for the approval to the Employer before proceeding further, and

ii) Information that would be submitted for Employer's information only.

The Master Drawing List (MDL) shall be updated periodically and submitted to the employer, highlighting the changes made in MDL.

The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The early submission of drawings and data is as important as the manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress.

8.05.00 **ENGINEERING PROGRESS AND EXCEPTION REPORT**

8.05.01 The Contractor shall submit every month an Engineering progress and Exception Report giving the status of each engineering information including

a) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

b) Drawings which were not submitted as per agreed schedule.

8.05.02 The draft format for this report shall be furnished to the Employer within four (4) weeks of the award of the contract, which shall then be discussed and finalised with the Employer.

8.06.00 Engineering Co-ordination Procedure

8.06.01 The following principal coordinators will be identified by respective organizations at time of award of contract:

NTPC Engineering Coordinator (NTPC EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

Contractor's/ Vendor's Engineering Coordinator (VENDOR EC):

Name :

Designation :

Address :

a) Postal :

b) Telegraphic / e-Mail :

c) FAX : TELEPHONE :

8.06.02 All engineering correspondence shall be in the name of above coordinators on behalf of the respective organizations.

8.06.03 Contractor's/Vendor's Drawing Submission and Approval Procedure:

a) All data/information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for NTPC's information/ interface and or review and approval are referred by the general term "drawings".

b) The 'Master drawings list' indicating titles, Drawing Number, Date of submission and approval etc. shall be finalised mutually between Contractor and Employer before the award of contract. This list shall be updated if required at suitable interval during detailed engineering.

c) All drawings (including those of subvendor's) shall bear at the right hand bottom corner the 'title plate' with all relevant information duly filled in. The Contractor shall furnish this format to his subvendor along with his purchase order for subvendor's compliance.

d) Employer and contractor shall follow their own numbering systems for the drawings. However, Employer shall intimate the contractor, NTPC drawing number on receipt of the first submission of each drawing. Vendor, thereafter, shall indicate NTPC's drawing number in subsequent Submission, in the space provided for this purpose in title plate, in addition to his own drawing number.

e) The contractor shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data / drawings at site which are needed as an input to the engineering. The contractor shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Employer's scope and submit all necessary drawings/ documents for the same.

f) Drawings must be checked by the Contractor in terms of its completeness, data adequacy and relevance with respect to engineering schedule prior to submission to the Employer. In case drawings are found to be submitted without proper endorsement for checking by the Contractor, the same shall not be reviewed and returned to the Contractor for re-submission.

g) The Contractor shall submit adequate prints of drawing / data / document for Employer's review and approval. The drawings submitted by the Contractor/vendor shall be reviewed by NTPC and their comments shall be forwarded within four (4) weeks of receipt of drawings. Upon review of each drawing, depending on the correctness and completeness of the drawing, the same will be categorized and approval accorded in one of the following categories :

CATEGORY- I:	Approved
CATEGORY- II	Approved, subject to incorporation of comments/ modification as noted. Resubmit revised drawing incorporating the comments.
CATEGORY –III	Not approved. Resubmit revised drawings for approval after incorporating comments/ modification as noted.
CATEGORY -IV	For information and records.

h) Contractor shall resubmit the drawings approved under Category II, III & IVR within three (3) weeks of receipt of comments on the drawings, incorporating all comments. Every revision of the drawing shall bear a revision index wherein such revisions shall be highlighted in the form of description or marked up in the drawing identifying the same with relevant revision Number

enclosed in a triangle (eg. 1, 2, 3 etc). Contractor shall not make any changes in the portions of the drawing other than those commented. If changes are required to be made in the portions already approved, the Contractor shall resubmit the drawing identifying the changes for Employer's review and approval. **Drawings resubmitted shall show clearly the portions where the same are revised marking the relevant revision numbers and Employer shall review only such revised portion of documents.**

i) In case, the Contractor/ Vendor does not agree with any specific comment, he shall furnish the explanation for the same to NTPC for consideration. In all such cases the Contractor shall necessarily enclose explanations along with the revised drawing (taking care of balance comments) to avoid any delay and/or duplication in review work.

j) It is responsibility of the Contractor/ Vendor to get all the drawings approved in the Category I & IV (as the case may be) and complete engineering activities within the agreed schedule. Any delay arising out of submission and modification of drawings shall not alter the contract completion schedule.

k) If Contractor/ Vendor fails to resubmit the drawings as per the schedule, construction work at site will not be held up and work will be carried out on the basis of comments furnished on previous issues of the drawing.

l) These comments will be taken care by the contractor while submitting the revised drawing.

The contractor shall use a single transmittal for drawings. Submission. This shall include transmittal numbers and date, number of copies being sent, names of the agencies to whom copies being sent, drawing number and titles, remarks or special notes if any etc.

9.00.00 **TECHNICAL CO-ORDINATION MEETING**

9.01.00 The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings (TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at NEW DELHI / NOIDA or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

9.02.00 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks from the date of receipt of the drawing .The

comments of the Employer shall then be discussed across the table during the above Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.

9.02.01 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.

9.02.02 Should any drawing remain unapproved for more than six (6) weeks after it's first submission ,this shall be brought out in the monthly Engineering Progress and Exception Report with reasons thereof.

9.03.0 Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.

10.00.00 **DESIGN IMPROVEMENTS**

The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

11.00.00 **EQUIPMENT BASES**

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base, unless otherwise specifically agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

12.00.00 **PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards shall be designed for easy installation and removal for maintenance purpose.

13.00.00 **LUBRICANTS, SERVO FLUIDS AND CHEMICALS**

13.01.00 I. All the first fills of consumables and one years topping requirement of consumables such as greases, oil, lubricants, servo fluids / control fluids, gases and essential chemicals etc. which will be required to put the equipment covered under the scope of specifications, into successful commissioning / initial operation and to establish completion of facilities shall be supplied by the Contractor. Suitable standard lubricants as available in India are desired. Efforts should be made to limit the variety of lubricants to minimum.

Bidder shall supply a quantity not less than 10 % of the full charge or one (1) year topping requirement mentioned above (whichever is higher) of each variety of lubricants, servo fluids, gases, chemicals etc (as detailed above) which is expected to be utilized during the first year of operation. The additional quantity shall be supplied in separate container.

13.02.00 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Employer alongwith lubrication requirements.

14.00.00 **LUBRICATION**

14.01.00 Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

15.00.00 **MATERIAL OF CONSTRUCTION**

15.01.00 All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilised for various components shall be those which have established themselves for use in such applications.

16.00.00 **RATING PLATES, NAME PLATES & LABELS**

16.01.00 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Employer.

16.02.00 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Employer or as detailed in appropriate section of the technical specifications.

16.03.00 Such nameplates or labels shall be of white nonhygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear side.

16.04.00 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with enamel. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

16.05.00 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support or hanger.

16.06.00 Valves, steam traps and strainers shall be identified by Employer's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

16.07.00 Safety and relief valves shall be provided with the following:

a) Manufacturer's identification.

b) Nominal inlet and outlet sizes in mm.

c) Set pressure in Kg/cm^2 (abs).

d) Blowdown and accumulation as percentage of set pressure.

e) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.

16.08.00 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

16.09.00 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system.

17.00.00 **TOOLS AND TACKLES**

The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required and other instruments for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. In case these tools and tackles are used by the Contractor during erection, commissioning or initial operation the same shall be refurbished repaired/replaced as required to the satisfaction of the Employer before handing over to the Employer. All the tools and tackles shall be of reputed make acceptable to the Employer.

18.00.00 **WELDING**

18.01.00 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be per formed by others the requirements shall be submitted to the Employer in advance of commencement of erection work.

19.00.00 **COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES**

19.01.00 All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with Employer's standard colour coding scheme, which will be furnished to the Contractor during detailed engineering stage.

20.00.00 **PROTECTION AND PRESERVATIVE SHOP COATING**

20.01.00 **PROTECTION**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or over ground environment as the case may be. The requirements for

painting specification shall be complied with as detailed out in Part-A & B of the Technical Specification.

20.02.00 **PRESERVATIVE SHOP COATING**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted as per the requirements covered in the relevant part of the Technical Specification.

Transformers and other electrical equipments, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Employer at a later date.

20.03.00 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Contractor after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Employer.

20.04.00 All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.

20.05.00 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Employer. Lube oil piping or carbon steel shall be pickled.

20.06.00 Painting for Civil structures and equipment/system covered under this package shall be done as specified under technical requirements on civil works in relevant part of this specifications.

21.00.00 **QUALITY ASSURANCE PROGRAMME**

21.01.00 To ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor’s works or at his sub-contractor’s premises or at the Employer’s site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with ISO-9001/IS-14001. A

quality assurance programme of the contractor shall generally cover the following:

a) His organisation structure for the management and implementation of the proposed quality assurance programme

b) Quality System Manual

c) Design Control System

d) Documentation Control System

e) Qualification data for Bidder's key Personnel.

f) The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

g) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.

h) Control of non-conforming items and system for corrective actions.

i) Inspection and test procedure both for manufacture and field activities.

j) Control of calibration and testing of measuring testing equipments.

k) System for Quality Audits.

l) System for indication and appraisal of inspection status.

m) System for authorising release of manufactured product to the Employer.

n) System for handling storage and delivery.

o) System for maintenance of records, and

p) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per formats enclosed as **Annexure-I** and **Annexure-II** respectively.

22.00.00 **GENERAL REQUIREMENTS - QUALITY ASSURANCE**

22.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of

inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Employer for approval. Schedule of finalisation of such quality plans will be finalised before award on enclosed format No. QS-01-QAI-P-1/F3-R0. Monthly progress reports shall be furnished.

22.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media through C-folders, a web based system of NTPC ERP in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM (As per format at Annexure-I)

22.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site (As per format at Annexure – II).

22.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

22.05.00 The contractor shall submit to the Employer Field Welding Schedule for field welding activities in the format enclosed at **Annexure-V.** The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.

22.06.00 The contractor shall have suitable Field Quality Organization with adequate manpower at Employer's site, to effectively implement the Field Quality Plan (FQP)

	and Field Quality Management System for site activities. The contractor shall submit the details of proposed FQA setup (organizational structure and manpower) for employer's approval. The FQA setup shall be in place at least one month before the start of site activities.
22.07.00	No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Employer's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).
22.08.00	All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details
22.09.00	All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Employer. All welding/brazing procedures shall be submitted to the Employer or its authorised representative for approval prior to carrying out the welding/brazing.
22.10.00	All brazers, welders and welding operators employed on any part of the contract either in Contractor's/his sub-contractor's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Employer.
22.11.00	Welding procedure qualification & Welder qualification test results shall be furnished to the Employer for approval. However, where required by the Employer, tests shall be conducted in presence of Employer/authorized representative.
22.12.00	For all IBR pressure parts and high pressure piping welding, the latest applicable requirements of the IBR (Indian Boiler Regulations) shall also be essentially complied with. However, other piping system ASME B31.1 or other relevant code as applicable shall be followed. Similarly, any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding
22.13.00	All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.
22.14.00	No welding shall be carried out on cast iron components for repair.

22.15.00 Unless otherwise proven and specifically agreed with the Employer, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

22.16.00 All non-destructive examination shall be performed in accordance with written procedures as per International Standards. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination) or equivalent. NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

In general all plates of thickness greater than 40mm & for pressure parts plates of thickness equal to or greater than 25mm shall be ultrasonically tested otherwise as specified in respective equipment specification. All bar stock/Forging of diameter equal to or greater than 40 mm shall be ultrasonically tested.

22.17.00 The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval on enclosed format No. QS-01-QAI-P-01/F3. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress reports on sub-contractor detail submission / approval shall be furnished preferably on enclosed format at **Annexure-IV.** Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

22.18.00 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc.

Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the

monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.

22.19.00 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

22.20.00 The contractor shall carry out an inspection and testing programme during manufacture in his work and that of his sub-contractor's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Contractor shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

22.21.00 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

22.22.00 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

22.23.00 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Employer/ authorised representative.

22.24.00 **Environmental Stress Screening**

Environmental stress screening test process / procedure for eliminating infant mortile components for DDCMIS / PLC based system & for other systems having substantial electronics components (as determined by employer) like Electronic transmitter, CCTV components, PA systems etc. shall be necessarily furnished for any sub vendors proposed for vendor assessment and approval for this contract. For other approved sub vendors of above mentioned systems, contractor shall furnish the test procedure for eliminating infant mortile components in case, if it is asked for by the employer before these items are offered for inspection / dispatched to site.

22.25.00 The Contractor / Sub-contractor shall carry out routine test on 100% item at contractor / sub-contractor's works. The quantum of check / test for routine & acceptance test by employer shall be generally as per criteria / sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check / test for routine / acceptance test shall be as agreed during detailed engineering stage.

22.26.00 **Software Reliability / Quality Certification**

Certification from OEM's authorized signatory that software offered with DDCMIS, PLC, CCTV, PA, Pyrometer, CEMS, AAQMS, EQMS, BHMS etc. declaring that the all the offered software(s) had gone through the established software quality test and offered software is not of β-version and offered software is also free from all known bugs as on date of approval of systems documents by NTPC as a part of quality documentation review and approval process during detail engineering.

23.00.00 **QUALITY ASSURANCE DOCUMENTS**

23.01.00 The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (✓)mark.

23.01.01 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub-supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

23.02.00 Typical contents of QA Documentation is as below:-

(a.) Quality Plan

(b.) Material mill test reports on components as specified by the specification and approved Quality Plans.

(c.) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

(d.) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

(e.) Heat Treatment Certificate/Record (Time- temperature Chart)

(f.) All the accepted Non-conformance Reports (Major/Minor)/deviation, including complete technical details / repair procedure).

(g.) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

(h.) Certificate of Conformance (COC) wherever applicable.

(i.) MDCC

23.03.00 Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

23.04.00 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

(a.) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

(b.) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

(c.) If a decision is made for despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

23.05.00 **TRANSMISSION OF QA DOCUMENTATION**

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Corporate Quality Assurance Department and other set to respective Project Site of Employer.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

24.00.00 **PROJECT MANAGER'S SUPERVISION**

24.01.00 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Project Manager and without prejudice to the provisions of 'Arbitration' clause in Section GCC, the Contractor shall proceed to comply with the Project Manager's decision.

24.02.00 The work shall be performed under the supervision of the Project Manager.

The scope of the duties of the Project Manager pursuant to the Contract, will include but not be limited to the following:

(a.) Interpretation of all the terms and conditions of these documents and specifications

(b.) Review and interpretation of all the Contractor's drawing, engineering data, etc

(c.) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract

(d.) Inspect, accept or reject any equipment, material and work under the contract

(e.) Issue certificate of acceptance and/or progressive payment and final payment certificates

(f.) Review and suggest modifications and improvement in completion schedules from time to time, and

(g.) Supervise Quality Assurance Programme implementation at all stages of the works.

25.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

25.01.00 The word 'Inspector' shall mean the Project Manager and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

25.02.00 The Project Manager or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain

for the Project Manager and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

25.03.00 The Contractor shall give the Project Manager/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector's. The Project Manager/Inspector, unless the witnessing of the tests is virtually waived and confirmed in writing, will attend such tests within fifteen (15) days of the date on which the equipment is noticed as being ready for test/inspection failing which the contractor may proceed with test which shall be deemed to have been made in the inspector's presence and he shall forthwith forward to the inspector duly certified copies of test reports in two (2) copies.

25.04.00 The Project Manager or Inspector shall within fifteen (15) days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Project Manager/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

25.05.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Project Manager /Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Project Manager /Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Project Manager /Inspector. Project Manager /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

25.06.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Project Manager /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Project Manager/Inspector or to his authorised representative to accomplish testing.

25.07.00 The inspection by Project Manager / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

25.08.00 To facilitate advance planning of inspection in addition to giving inspection notice as specified at clause no 25.03.00 of this chapter, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

25.09.00 All inspection, measuring and test equipment used by contractor shall be calibrated periodically depending on its use and criticality of the test/measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by NTPC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipment in the presence of Project Manager / Inspector.

25.10.00 **Associated document for Quality Assurance programme**

25.10.01 Manufacturing Quality Plan Format No. : QS-01-QAI-P-09/F1-R1 enclosed at **Annexure-I.**

25.10.02 Field Quality Plan Format No.: QS-01-QAI-P-09/F2-R1 enclosed at **Annexure-II.**

25.10.03 List of items requiring quality plan and sub supplier approval. Format No.: QS-01-QAI-P-01/F3-R0 **(Annexure-III).**

25.10.04 Status of items requiring Quality Plan and sub supplier approval. Format enclosed at **Annexure-IV.**

25.10.05 Field Welding Schedule Format enclosed at **Annexure-V.**

25.11.00 **Not Used**

25.12.00 **DEMONSTRATION OF APPLICATION ENGINEERING**

25.12.01 Based on NTPC inputs, the Contractor shall prepare and submit typical implemented scheme in their system (Control system & HMI) on sample basis. The typical cases to be covered shall include but not be limited to the following.

(i) Logics/Loops:

a) Drive logics implementation for each type of binary drive along with its display in HMI.

b) Sequence implementation along with its display in HMI.

c) Single non-cascade controller implementation.

d) Cascade loop implementation.

e) Master slave implementation with different slave combination.

f) Temperature & pressure compensation for flow signals & pressure compensation for level signals as applicable.

(ii) HMI Functions:

a) LVS Annunciation.

b) Graphics.

c) HSR

d) Logs/Reports.

e) Calculations (Basic & Performance Calculations).

25.12.02 The above typical cases shall be finalized with the Employer through Technical Co-ordination meetings.

After review and finalization of the typical cases, the implementation of each logic & control loop shall be carried out by the Contractor based on NTPC inputs. After implementation of these logics & loops, the Contractor shall test each logic /loop and record the observations in a format to be provided by the Employer and demonstrate to Employer at Employer premises during engineering finalization. Any modifications as a result of the demonstration shall be done and documented as part of the test report along with the final scheme. Similarly, HMI functions shall also be demonstrated by the Contractor at Employer premises & the results shall be documented as part of test report.

25.12.03 During the integrated testing at the Contractor's works, only sample checks shall be done by the Employer for the items covered in above application engineering demonstration.

26.00.00 **PRE-COMMISSIONING AND COMMISSIONING FACILITIES**

26.01.00 (a) As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included in Part-D, Section-VI and elsewhere in the Technical Specifications.

(b) The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

(c) All piping system shall be flushed, steam blown, air blown as required and cleanliness demonstrated using acceptable industry standards. Procedures to accomplish this work shall be submitted for approval to the Employer six months prior to the respective implementations. The Employer will approve final verification of cleanliness.

(d) The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

(e) The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and turned over to Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed commissioning documentation [SLs(standard check list)/TS(testing schedule)/CS(commissioning schedule)] approved by the employer.

(f) The Contractor during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

26.01.00 Contractor shall furnish the commissioning organization chart for review & acceptance of employer at least twelve months prior to the schedule date of commissioning of 1st unit. The chart should contain:

(1.) Biodata including experience of the Commissioning Engineers.

(2.) Role and responsibilities of the Commissioning Organisation members.

(3.) Expected duration of posting of the above Commissioning Engineers at site.

26.02.00 **Initial Operation**

(a) On completion of all pre-commissioning activities/ tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during

which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.

(b) The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the FGD System shall operate continuously at full load for a period not less than 72 hours.

The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

The Contractor shall intimate the Employer about the commencement of initial operation and shall furnish adequate notice to the Employer in this respect.

(c) Any operational interruption in the FGD System due to constraints attributable to the Employer shall be construed as Deemed to be in operation.

(d) An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Employer to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects which do not endanger the safe operation of the equipment, shall not be considered as reasons for with- holding the aforesaid permission.

26.03.00 **Guarantee Tests**

a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up Engineer shall make the unit ready to conduct such test before start of initial operation. Such test shall be conducted along with the Initial Operations.

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

c) For performance/ demonstration tests instrumentations, of accuracy class shall be as per specified test codes. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Employer's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Contractor, free of cost.

e) The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail elsewhere in the specifications.

27.00.00 **TAKING OVER**

Upon successful completion of Initial Operations and all the tests conducted to the Employer's satisfaction, the Employer shall issue to the Contractor a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be with held nor will the Employer delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

28.00.00 **TRAINING OF EMPLOYER'S PERSONNEL**

28.01.00 **Training for Employers O&M Personnel**

The scope of service under training of Employer's engineers shall include a training module covering upto six (6) man months in the areas of Operation & Maintenance.

Such training should enable the personnel to individually take the responsibility of operating and maintaining the FGD system in a manner acceptable to the Employer.

28.02.00 **Training for Employers Engineering Personnel**

The scope of services under training for Employer's engineering personnel shall also necessarily include three (3) man months. This shall cover all disciplines viz, Mechanical, Electrical, C&I, & QA etc. and shall include all the related areas like

Design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. An indicative module of the training requirement of Employer's Engineering personnel is attached as Annexure-VII.

28.03.00 Bidder shall furnish in his offer, details of training module(s) covering above requirements which shall be subject to Employer's approval. Consolidated training period included above (i.e. 6 man months and 3 man months respectively for O&M and Engineering) is indicative only. Employer reserves the right to re appropriate the training period between O&M and engineering depending upon the details of training module proposed by the Bidder.

28.04.00 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal within two (2) months from placement of award.

28.05.00 In all the above cases, wherever the training of Employer's personnel is arranged at the works of the manufacturer's it shall be noted that the lodging and boarding of the Employer's personnel shall be at the cost of Contractor. The Contractor shall make all necessary arrangements towards the same.

28.06.00 Take off prices (product wise) should be indicated by the Bidder in the Bid Proposal Sheets. Employer reserves the right to include or exclude these item(s) during placement of Award.

Note: For training purposes, one (1) man month implies 30 working days (excluding all intervening holidays) per person.

29.00.00 **SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION**

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

i) Working platforms should be fenced and shall have means of access.

ii) Ladders in accordance with Employer's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

30.00.00 **NOISE LEVEL**

The equivalent 'A' weighted sound pressure level measured at a height of 1.5 m above floor level in elevation and at a distance of one (1) metre horizontally from the nearest surface of any equipment/machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA . However for Ball Mills the noise levels as per following shall also be acceptable:

a) Ball Mill < 90 dBA

31.00.00 **PACKAGING AND TRANSPORTATION**

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Contractor shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting despatch of equipment. Before despatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & preassembly to bare minimum. The Employer's Inspector shall have right to insist for completion of works in shops before despatch of materials for transportation.

32.00.00 **ELECTRICAL EQUIPMENTS/ENCLOSURES**

32.01.00 All electrical equipments and devices, including insulation, heating and ventilation devices shall be designed for ambient temperature and a maximum relative humidity as specified elsewhere in the specifications.

33.00.00 **INSTRUMENTATION AND CONTROL**

All instrumentation and control systems/ equipment/ devices/ components, furnished under this contract shall be in accordance with the requirements stated herein, unless otherwise specified in the detailed specifications.

33.01.00 All instrument scales and charts shall be calibrated and printed in metric units and shall have linear graduation. The ranges shall be selected to have the normal reading at 75% of full scale.

All scales and charts shall be calibrated and printed in Metric Units as follows:

1 Temperature - Degree centigrade (deg C)

2. Pressure	-	Kilograms per square centimetre (Kg/cm^2). Pressure instrument shall have the unit suffixed with 'a' to indicate absolute pressure. If nothing is there, that will mean that the indicated pressure is gauge pressure.
3. Draught	-	Millimetres of water column (mm wc).
4. Vacuum	-	Millimeters of mercury gauge (mm Hg) or water column (mm Wcl).
5. Flow (Gas)	-	Tonnes/ hour
6. Flow (Steam)	-	Tonnes/ hour
7. Flow (Liquid)	-	Tonnes / hour
8. Flow base	-	760 mm Hg. 0 deg.C
9. Density	-	Grams per cubic centimeter.

33.02.00 All instruments and control devices provided on panels shall be of miniaturized design, suitable for modular flush mounting on panels with front draw out facility and flexible plan-in connection at rear.

33.03.00 All electronic modules shall have gold plated connector fingers and further all input and output modules shall be short circuit proof. These shall also be tropicalised & components shall be of industrial grade or better.

34.00.00 **ELECTRICAL NOISE CONTROL**

The equipment furnished by the Contractor shall incorporate necessary techniques to eliminate measurement and control problems caused by electrical noise. Areas in Contractor's equipment which are vulnerable to electrical noise shall be hardened to eliminate possible problems. Any additional equipment, services required for effectively eliminating the noise problems shall be included in the proposal. The equipment shall be protected against ESD as per IEC-61000-2. Radio Frequency interference (RFI) and Electro Magnetic Interference (EMI) protection against hardware damage and control system mal-operations/errors shall be provided for all systems as per EN-50082-2 (1995).

35.00.00 **SURGE PROTECTION FOR SOLID STATE EQUIPMENT**

All solid state systems /equipment shall be able to withstand the electrical noise and surge as encountered in actual service conditions and inherent in a power plant and shall meet the requirements of surge protection as defined in ANSI C37.90.1-1989 on its suitable equivalent class of IEC 254-4. Details of the features incorporated and relevant tests carried out. The test certificates. etc. shall be submitted by the Bidder.

36.00.00 **INSTRUMENT AIR SYSTEM**

The instrument air supply system as supplied by the Bidder for various pneumatic control & instrumentation devices like pneumatic actuators, power cylinders, E/P converters, piping / tubing etc.

Each pneumatic instrument shall have an individual air shut - off valve. The pressure regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built-in filter housing blow down valve.

37.00.00 **TAPPING POINTS FOR MEASUREMENTS**

Tapping points shall include probes, wherever applicable, for analytical measurements and sampling.

For direct temperature measurement of all working media, one stub with internal threading of approved pattern shall be provided along with suitable plug and washer. The Contractor will be intimated about thread standard to be adopted.

The following shall be provided on equipment by the Bidder. The standard which is to be adopted, will be intimated to the Contractor.

i) Temperature test pockets with stub and thermowell

ii) Pressure test pockets

38.00.00 **SYSTEM DOCUMENTATION**

The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/ commissioning procedures, instruction/ operating manuals, etc. for each of the C& I system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the C&I systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these C&I systems/ sub-systems/ equipment at site. The minimum documentation requirements for C&I systems shall be as stipulated under C&I

"Techncial Data Sheets" Part of specifications. In addition to this, system documentation for control system shall include as a minimum to that specified elsewhere in the Technical Specification.

The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

38.01.00 Bill of material (instrument list) for all C&I equipment/ devices shall be furnished by the bidder in standard formats as approved by the Employer.

39.00.00 **MAINTENANCE MANUALS OF ELECTRONIC MODULES**

The Contractor shall have to furnish two (2) sets of all maintenance manual of each and every electronic card/module as employed on the various systems and equipment including peripherals etc., offered by him. The Contractor will also have to furnish the data regarding the expected failure rate of various modules and other system components. Further , the contractor shall furnish a set of operating manuals which should include block diagrams ,make, model/type ,details wiring and external connection drawings etc as required to do the testing and maintenance of the electronic modules.

LIST OF CODES AND STANDARDS

Indian Standards	Title	International and Internationally recognised standards
IS:277	Galvanised steel sheets (plain or corrugated)	
IS:655	Specification for metal air duct	
IS:800	Code of practice for use of structural steel in general building construction	BS 449:1969 BS 5950 ASA A57, 1-1952
IS:807	Code of practice for design, manufacture, erection and testing (Structural portion) of cranes and hoists 6588 (Issued by Standards Associa-tion of Australia). DIN 120:1936 (Sheet 1) DIN 120:1936 (Sheet 2) 327 part-I, 1951 BS 466 part-II, 1960 BS 644:1960 BS 1757:1951 BS 2573:part-I:1960	Draft Revision of A.S. NO. CS.2 SAA Crane and Hoist code Doc:No. BU/4 Rev
IS:875	Code of practice for design loads (other than earthquake) for buildings and structures Leading standards (issued by Canadian Standard) DIN-1055-1955 (Issued by ASA)	National Building code of Canada (1953)-Part-IV Design section 4.1

IS:1239 Part-I	Mild steel tubes	(ISO/R 65-1957) (ISO/R-64-1958) (ISO/R-65-1958) (BS 1387 : 1957)
IS:1239 Part-II	Mild steel tubulars and other wrought steel pipe fittings	BS 1387 : 1967 BS 1387 :1967 BS 1740 :1965
IS:2825	Code for unfired vessels	
IS:1520	Horizontal centrifugal pumps for clear cold and fresh water	
IS:1600	Code for practice for performance of constant speed IC Engines for general purpose	
IS:1601	Specification for perform-ance of constant speed IC Engines for general Purpose	
IS:1893	Criteria for earthquake resistant design of structures	
IS1978-1971	Line Pipe April 1969.	API Standards 5L
IS:2254-1970	Dimensions of vertical shaft motor for pumps	IEC Pub 72-1 part I NEMA Pub MG 1 1954
IS:2266	Steel wire ropes for general engineering purposes	BS :302 : 1968
IS:2312	Propellant type Ventilation fans	
IS:2365	Steel wire suspension ropes for lifts and hoists	BS : 1957

IS:3346	Method for the determin-ation of thermal conductivity of thermal insulation materials (two slab guarded hot plate method)	DIN 52612 (Deutscher Normenausschuss) ASTM C 163-1964 (American Society of Testing and materials) ASTM C 167-1974 ASTM C 177-1963
IS:3354	Outline dimensions for electric lifts.	
IS:3401	Silica gel	
IS:3588	Specification for electrical axial flow fans	
IS:3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000 mm Nominal Diametre)	
IS:3677	Unbonded rock and slag wool for thermal insulation	
IS:3815	Point hook with shank for general engineering purposes	BS 482 - 1968 Doc.:67/3 1284 (Revision of BS 2903) (Issued BS)
IS:3895	Specification for monocry-stallines semiconductor rectifier cells and stacks	
IS:3963	Roof extractor unit	
IS:3975	Mild steel wires, strips and tapes for armouring cables	
IS:4503	Shell and tube type heat Exchanger	

IS:4540	Specification for monory-stallines rectifire assembly equipment	
IS:4671	Expanded polystyrene for thermal insulation purpose	
IS:4736	Hot dip zinc coating on steel tubes	
IS:4894	Centrifugal fans	
IS:5456	Code of practice for testing of positive displacement type air compressors and exhauster (For Test Tolerance Only)	
IS:5749	Forged ramshorn hooks	Entwurf DIN 15402 Blett 1 Entwurf DIN 15402 BS 3017-1958
IS:6392	Steel pipe flanges	BS 4504 : 1969
IS:6524 Part-I	Code of practice for design of tower cranes Static and rail mounted	BS 2799 : 1956
IS:7098	Cross linked Polyethylene insulated PVC sheathed cables	Standard No. 1 to IPCEA (USA) Pub. No. 5-66-524
IS:7373	Specification for wrought aluminium and aluminium sheet and strips	
IS:7938	Air receivers for compressed air installation	
ISO:1217	Displacement compressor-Acceplance test	
ASHRAE-33	Methods of testing for rating of forced circulation air cooling and air heating coils.	
ASHRAE-52-76	Air cleaning device used in general ventilation for removing particle matter.	

ASHRAE-22-72	Method of testing for rating of water cooled refrigerant condensers.
ASHRAE 23-67	Methods of testing for rating of positive displacement refrigerant compressors.
ARI-450-6	Standard for water cooled refrigerant condensers.
ARI-550	Standard for centrifugal water chilling packages.
ARI-410	Standard for forced circulation air cooling and air heating coils
ARI-430/435	Central station AHU/Application of Central Station AHU
BS:848 (Part-1,2)	Fans
BS:400	Low carbon steel cylinders for the storage & transport of permanent gases.
BS:401	Low carbon steel cylinders for the storage & transport of liquified gases.
CTI Code ACT-105	Acceptance test code for Water Cooling Tower.
ANSI-31.5	Refrigerant piping
ASME-PTC-23-1958	Atmospheric Water Cooling Equipment
AMCA A-21C	Test Code for air moving devices
API:618	Reciprocating Compressor for general refinary services.

HYDRAULIC INSTITUTE STANDARDS.

HYDRANT SYSTEM MANUALS OF TAC.

TAC MANUALS OF SPRAY SYSTEM

NFPA USA/ NSC UK/ UL USA/ FM USA STANDARDS.

INDIAN EXPLOSIVES ACT.

INDIAN FACTORIES ACT.

STANDARD OF TUBULAR EXCHANGER MANUFACTURER'S ASSOCIATION.

CODE AND STANDARD FOR CIVIL WORKS

Some of the applicable Standards, Codes and references are as follows:

Excavation & Filling

IS: 2720 (Part-II, IV TO VIII, XIV, XXI, XXIII, XXIV, XXVII TO XXIX, XL) Methods of test for soils-determination for water content etc.

IS: 4701 Code of practice for earth work on canals.

IS: 9758 Guide lines for Dewatering during construction.

IS: 10379 Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

Properties, Storage and Handling of Common Building Materials

IS: 269 Specification for ordinary Portland cement, 33 grade.

IS: 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS: 432 Specification for mild steel and (Parts 1&2) medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

IS: 455 Specification for Portland slag cement.

IS: 702 Specification for Industrial bitumen.

IS: 712 Specification for building limes.

IS: 808 Rolled steel Beam channel and angle sections.

IS: 1077 Specification for common burnt clay building bricks.

IS: 1161 Specification of steel tubes for structural purposes.

IS: 1363 Hexagon head Bolts, Screws and nuts of production grade C.

IS: 1364 Hexagon head Bolts, Screws and Nuts of Production grade A & B.

IS: 1367 Technical supply conditions for Threaded fasteners.

IS: 1489 Specification for Portland-pozzolana cement:

(Part-I) Fly ash based.

(Part-II)	Calcined clay based.
IS: 1542	Specification for sand for plaster.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement.
IS: 1786	Specification for high strength deformed bars for concrete reinforcement.
IS: 2062	Specification for steel for general structural purposes.
IS: 2116	Specification for sand for masonry mortars.
IS: 2386 (Parts-I to VIII)	Testing of aggregates for concrete.
IS: 3150	Hexagonal wire netting for general purpose.
IS: 3495 (Parts-I to IV)	Methods of tests of burnt clay building bricks.
IS: 3812	Specification for fly ash, for use as pozzolana and admixture.
IS: 4031	Methods of physical tests for hydraulic cement.
IS: 4032	Methods of chemical analysis of hydraulic cement.
IS: 4082	Recommendations on stacking and storage of construction materials at site.
IS: 8112	Specification for 43 grade ordinary portland cement.
IS: 8500	Medium and high strength structural steel.
IS: 12269	53 grade ordinary portland cement.
IS: 12894	Specification for Fly ash lime bricks.

Cast-In-Situ Concrete and Allied Works

IS: 280	Specification for mild steel wire for general engineering purposes.
IS: 456	Code of practice for plain and reinforced concrete.

	IS: 457	Code of practice for general construction of plain & reinforced concrete for dams & other massive structures.
	IS: 516	Method of test for strength of concrete.
	IS: 650	Specification for standard sand for testing of cement.
	IS: 1199	Methods of sampling and analysis of concrete.
	IS: 1791	General requirements for batch type concrete mixers.
	IS: 1838 (Part-I)	Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
	IS: 2204	Code of practice for construction of reinforced concrete shell roof.
	IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
	IS: 2438	Specification for roller pan mixer.
	IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
	IS: 2505	General requirements for concrete vibrators, immersion type.
	IS: 2506	General requirements for concrete vibrators, screed board type.
	IS: 2514	Specification for concrete vibrating tables.
	IS: 2645	Specification for Integral cement water proofing compounds.
	IS: 2722	Specification for portable swing weigh batches for concrete. (single and double bucket type)
	IS: 2750	Specification for Steel scaffolding.
	IS: 2751	Code of practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
	IS: 3025	Methods of sampling and test waste water.
	IS: 3366	Specification for Pan vibrators.
	IS: 3370	Code of practice for concrete structures for the storage of

(Part I to IV)	liquids.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 3550	Methods of test for routine control for water used in industry.
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 4014 (Parts I & II)	Code of practice for steel tubular scaffolding.
IS: 4326	Code of practice for earthquake resistant design and construction of buildings.
IS: 4461	Code of practice for joints in surface hydro-electric power stations.
IS: 4656	Specification for form vibrators for concrete.
IS: 4925	Specification for batching and mixing plant.
IS: 4990	Specification for plywood for concrete shuttering work.
IS: 4995 (Parts I & II)	Criteria for design of reinforced concrete bins for the storage of granular and powdery materials.
IS: 5256	Code or practice for sealing joints in concrete lining on canals.
IS: 5525	Recommendations for detailing of reinforcement in reinforced concrete work.
IS: 5624	Specification for foundation bolts.
IS: 6461	Glossary of terms relating to cement concrete.
IS: 6494	Code of practice for water proofing of underground water reservoirs and swimming pools.
IS: 6509	Code of practice for installation of joints in concrete pavements.
IS: 7861	Code of practice for extreme weather concreting. (Parts I & II)
IS: 9012	Recommended practice for shot concreting.
IS: 9103	Specification for admixtures for concrete.

IS: 9417	Recommendations for welding cold worked steel bars for reinforced concrete construction.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 11384	Code of practice for composite construction in structural steel and concrete.
IS: 11504	Criteria for structural design of reinforced concrete natural draught cooling towers.
IS: 12118	Specification for two-parts poly sulphide.
IS: 12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.
IS: 13311	Method of non-destructive testing of concrete.
Part-1	Ultrasonic pulse velocity.
Part-2	Rebound hammer.
SP:23	Handbook of concrete mixes
SP: 24	Explanatory Handbook on IS: 456-1978
SP: 34	Handbook on concrete reinforcement and detailing.

Precast Concrete Works

SP: 7(PartVI/	National Building Code- Structural design of prefabrication and Sec.7) systems building.
IS: 10297	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
IS: 10505	Code of practice for construction of floors and roofs using pre-cast reinforced concrete units.

Masonary and Allied Works

IS: 1905	Code of Practice for Structural Safety of Buildings-Masonry walls.
IS: 2212	Code of Practice for Brickwork.

IS: 2250	Code of Practice for Preparation and use of Masonry Mortar.
SP: 20	Explanatory hand book on masonry code.

Sheeting Works

IS:277	Galvanised steel sheets (plain or corrugated).
IS: 459	Unreinforced corrugated and semi-corrugated asbestos cement sheets.
IS: 513	Cold-rolled carbon steel sheets.
IS: 730	Specification for fixing accessories for corrugated sheet roofing.
IS: 1626	Specification for Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings.
IS: 2527	Code of practice for fixing rain water gutters and down pipe for roof drainage.
IS: 3007	Code of practice for laying of asbestos cement sheets.
IS: 5913	Methods of test for asbestos cement products.
IS: 7178	Technical supply conditions for tapping screw.
IS: 8183	Bonded mineral wool.
IS: 8869	Washers for corrugated sheet roofing.
IS: 12093	Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
IS: 12866	Plastic translucent sheets made from thermosetting polyster resin (glass fibre reinforced).
IS: 14246	Specification for continuously pre-painted galvanised steel sheets and coils.

Fabrication and Erection of Structural Steel Work

IS: 2016	Specification for plain washers.

	IS: 814	Specification for covered Electrodes for Metal Arc Welding for weld steel.
	IS: 1852	Specification for Rolling and Cutting Tolerances for Hot rolled steel products.
	IS: 3502	Specifications for chequered plate.
	IS: 6911	Specification for stainless steel plate, sheet and strip.
	IS: 3757	Specification for high strength structural bolts
	IS: 6623	Specification for high strength structural nuts.
	IS: 6649	High Tensile friction grip washers.
	IS: 800	Code of practice for use of structural steel in general building construction.
	IS: 816	Code of practice for use of Metal Arc Welding for General Construction.
	IS: 4000	Code of practice for assembly of structural joints using high tensile friction grip fasteners.
	IS: 9595	Code of procedure of Manual Metal Arc Welding of Mild Steel.
	IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
	IS: 1811	Qualifying tests for Metal Arc Welders (engaged in welding structures other than pipes).
	IS: 9178	Criteria for Design of steel bins for storage of Bulk Materials.
	IS: 9006	Recommended Practice for Welding of Clad Steel.
	IS: 7215	Tolerances for fabrication steel structures.
	IS: 12843	Tolerance for erection of structural steel.
	IS: 4353	Recommendations for submerged arc welding of mild steel and low alloy steels.
	SP: 6 (Part 1 to 7)	ISI Hand book for structural Engineers.

IS: 1608	Method of Tensile Testing of Steel products other than sheets, strip, wire and tube.
IS: 1599	Method of Bend Tests for Steel products other than sheet, strip, wire and tube
IS : 228	Methods of chemical Analysis of pig iron, cast iron and plain carbon and low alloy steel.
IS : 2595	Code of Practice for Radio graphic testing.
IS : 1182	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 3664	Code of practice for Ultra sonic Testing by pulse echo method.
IS : 3613	Acceptance tests for wire flux combination for submerged Arc Welding.
IS : 3658	Code of practice for Liquid penetrant Flaw Detection.
IS : 5334	Code of practice for Magnetic Particle Flaw Detection of Welds.

Plastering and Allied Works

IS : 1635	Code of practice for field slaking of Building lime and preparation of putty.
IS : 1661	Application of cement and cement lime plaster finishes.
IS : 2333	Plaster-of-paris.
IS : 2402	Code of practice for external rendered finishes.
IS : 2547	Gypsum building plaster.
IS : 3150	Hexagonal wire netting for general purpose.

Acid and Alkali Resistant Lining

IS : 158	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
IS : 412	Specification for expanded metal steel sheets for general purpose.

IS : 4441	Code of practice for use of silicate type chemical resistant mortars.
IS : 4443	Code of practice for use of resin type chemical resistant mortars.
IS : 4456	Method of test for chemical resistant tiles. (Part I & II)
IS : 4457	Specification for ceramic unglazed vitreous acid resistant tiles.
IS : 4832	Specification for chemical resistant mortars.
	Part I Silicate type
	Part II Resin type
	Part III Sulphur type
IS : 4860	Specification for acid resistant bricks.
IS : 9510	Specification for bitumasitc, Acid resisting grade.
Water Supply, Drainage and Sanitation	
IS : 458	Specification for concrete pipes.
IS : 554	Dimensions for pipe threads, where pressure tight joints are made on thread.
IS : 651	Specification for salt glazed stoneware pipes.
IS : 774	Flushing cisterns for water closets and urinals.
IS : 775	Cast iron brackets and supports for wash basins and sinks.
IS : 778	Copper alloy gate, globe and check valves for water works purposes.
IS : 781	Cast copper alloy screw down bib taps and stop valves for water services.
IS : 782	Caulking lead.
IS : 783	Code of practice for laying of concrete pipes.

	IS : 1172	Basic requirements for water supply, drainage and sanitation.
	IS : 1230	Cast iron rain water pipes and fittings.
	IS : 1239	Mild steel tubes, tubulars and other wrought steel fittings.
	IS : 1536	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
	IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
	IS : 1538	Cast iron fittings for pressure pipe for water, gas and sewage.
	IS : 1703	Ball valves (horizontal plunger type) including float for water supply purposes.
	IS : 1726	Cast iron manhole covers and frames.
	IS : 1729	Sand cast iron spigot and socket, soil, water and ventilating pipes, fittings and accessories.
	IS : 1742	Code of practice for building drainage.
	IS : 1795	Pillar taps for water supply purposes.
	IS : 1879	Malleable cast iron pipe fittings.
	IS : 2064	Code of practice for selection, installation and maintenance of sanitary appliances.
	IS : 2065	Code of practice for water supply in building.
	IS : 2326	Automatic flushing cisterns for urinals.
	IS : 2470 (Part-I & II)	Code of practice for installation of septic tanks.
	IS : 2501	Copper tubes for general engineering purposes.
	IS : 2548	Plastic seat and cover for water-closets.
	IS : 2556 (Part 1 to 15)	Vitreous sanitary appliances (vitreous china).
	IS : 2963	Non-ferrous waste fittings for wash basins and sinks.

	IS : 3114	Code of practice for laying of cast iron pipes.
	IS : 3311	Waste plug and its accessories for sinks and wash basins.
	IS : 3438	Silvered glass mirrors for general purposes.
	IS : 3486	Cast iron spigot and socket drain pipes.
	IS : 3589	Electrically welded steel pipes for water, gas and sewage (200mm to 2000mm nominal diameter).
	IS : 3989	Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
	IS : 4111 (Part I to IV)	Code of practice for ancillary structure in sewerage system.
	IS : 4127	Code of practice for laying of glazed stone-ware pipes.
	IS : 4764	Tolerance limits for sewage effluents discharged into inland-surface waters.
	IS : 4827	Electro plated coating of nickel and chromium on copper and copper alloys.
	IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
	IS : 5382	Rubber sealing rings for gas mains, water mains and sewers.
	IS : 5822	Code of practice for laying of welded steel pipes for water supply.
	IS : 5961	Cast iron grating for drainage purpose.
	IS : 7740	Code of practice for road gullies.
	IS : 8931	Cast copper alloy fancy bib taps and stop valves for water services.
	IS : 8934	Cast copper alloy fancy pillar taps for water services.
	IS : 9762	Polyethylene floats for ball valves.
	IS : 10446	Glossary of terms for water supply and sanitation.

IS : 10592	Industrial emergency showers, eye and face fountains and combination units.
IS : 12592	Specification for precast concrete manhole covers and frames.
IS : 12701	Rotational moulded polyethylene water storage tanks.
SP: 35	Hand book on water supply and drainage.
-	Manual on Sewerage and sewage treatment (Published by CPH & EEO) As updated.

Doors, Windows and Allied Works

IS : 204	Tower Bolts
Part-I	Ferrous metals.
Part-II	Nonferrous metals.
IS : 208	Door Handles.
IS : 281	Mild steel sliding door bolts for use with padlocks.
IS : 362	Parliament Hinges.
IS : 420	Specification for putty, for use on metal frames.
IS : 1003 Part-I door	Specification for timber panelled and glazed shutters- (Part-I) shutters.
IS : 1038	Steel doors, windows and ventilators.
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS : 1341	Steel butt hinges.
IS : 1361	Steel windows for industrial buildings.
IS : 1823	Floor door stoppers.
IS : 1868	Anodic coatings on Aluminium and its alloys.
IS : 2202 (Part-II)	Specification for wooden flush door shutters (solid core type); particle board face panels and hard board face panels

IS:2209	Mortice locks (vertical type).
IS:2553	Safety glass
IS:2835	Flat transparent sheet glass.
IS:3548	Code of practice for glazing in buildings.
IS:3564	Door closers (Hydraulically regulated).
IS : 3614	Fire check doors; plate, metal covered and rolling type.
IS:4351	Steel door frames.
IS:5187	Flush bolts.
IS:5437	Wired and figured glass
IS:6248	Metal rolling shutters and rolling grills.
IS:6315	Floor springs (hydraulically regulated) for heavy doors.
IS:7196	Hold fasts.
IS:7452	Hot rolled steel sections for doors, windows and ventilators.
IS:10019	Mild steel stays and fasteners.
IS:10451	Steel sliding shutters (top hung type).
IS:10521	Collapsible gates.

R oof Water Proofing and AlliedWorks

IS:1203	Methods of testing tar and bitumen.
IS:1322	Specification for bitumen felts for water proofing and damp proofing.
IS:1346	Code of practice for water proofing of roofs with bitumen felts.
IS:1580	Specification for bituminous compound for water proofing and caulking purposes.

IS:3067	Code of practice for general design details and preparatory work for damp proofing and water proofing of buildings.
IS:3384	Specification for bitumen primer for use in water proofing and damp proofing.

Floor Finishes and Allied Works

IS:1237	Specification for cement concrete flooring tiles.
IS:1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS:2114	Code of practice for laying in-situ terrazzo floor finish.
IS:2571	Code of practice for laying in-situ cement concrete flooring.
IS:3462	Specification for unbacked flexible PVC flooring.
IS:4971	Recommendations for selection of industrial floor finishes.
IS:5318	Code of practice for laying of flexible PVC sheet and tile flooring.
IS:8042	Specification for white portland cement.
IS:13801	Specification for chequered cement concrete flooring tiles.

Painting and Allied Works

IS:162	Specification for fire resisting silicate type, brushing, for use on wood, colour as required.
IS:1477	Code of practice for painting of ferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:1650	Specification for colours for building and decorative finishes.
IS:2074	Specification for red oxide-zinc chrome, priming, ready mixed paint air drying.
IS:2338	Code of practice for finishing of wood and wood based materials.
Part-I	Operations and workmanship

Part-II	Schedules
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces.
Part-I	Operations and workmanship.
Part-II	Schedule.
IS:2524	Code of practice for painting of nonferrous metals in buildings.
Part-I	Pretreatment.
Part-II	Painting.
IS:2932	Specification of synthetic enamel paint, exterior, under-coating and finishing.
IS:2933	Specification enamel paint, under coating and finishing.
IS:4759	Code of practice for hot dip zinc coating on structural steel and other allied products.
IS:5410	Specification for cement paint
IS:5411 (Part-I)	Specification for plastic emulsion paint-for exterior use
IS:6278	Code of practices for white washing and colour washing.
IS:10403	Glossary of terms relating to building finishes.
Piling and Foundation	
IS:1080	Code of practice for design and construction of simple spread foundations.
IS:1904	Code of practice for design and construction of foundations in Soils; General Requirements.
IS:2911	Code of practice for designs and construction of Pile foundations (Relevant Parts).
IS:2950 (Part-I)	Code of practice for designs and construction of Raft foundation.
IS:2974 (Part-I TO V)	Code of practice for design and construction of machine foundations.
IS:6403	Code of practice for determination of Allowable Bearing pressure on Shallow foundation.

IS:8009	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads.
Part-I	Shallow foundations.
Part-II	Deep foundations.
IS:12070	Code of practice for design and construction of shallow foundations on rocks.
DIN:4024	Flexible supporting structures for machines with rotating machines.
VDI:2056	Criteria for assessing mechanical vibrations of machines.
VDI:2060	Criteria for assessing rotating imbalances in machines.
Stop Log and Trash Rack	
IS:4622	Recommendations for fixed - wheel gates structural design.
IS:5620	Recommendations for structural design criteria for low head slide gates.
IS:11388	Recommendations for design of trash rack for intakes.
IS:11855	General requirements for rubber seals for hydraulic gates.
Roads	
IRC:5	Standard specifications and Code of practice for road bridges, section-I general Features of Design.
IRC:14	Recommended practice of 2cm thick bitumen and tar carpets.
IRC:16	Specification for priming of base course with bituminous primers.
IRC:19	Standard specifications and code of practice for water bound macadam.
IRC:21	Standard specifications and Code of practice for road bridges, section-III - Cement concrete (plain and reinforced).
IRC:34	Recommendations for road construction in waterlogged areas.
IRC:36	Recommended practice for the construction of earth embankments for road works.
IRC:37	Guidelines for the Design of flexible pavements.
IRC:56	Recommended practice for treatment of embankment slopes for erosion control.
IRC:73	Geometric design standards for rural (non-urban) highways.
IRC:86	Geometric Design standards for urban roads in plains.

IRC:SP:13	Guidelines for the design of small bridges & culverts.
IRC - Public-ation	Ministry of Surface Transport (Roads Wing), Specifications for road and bridge works.
IS:73	Specification for paving bitumen
Loadings	
IS:875 (Pt. I to V)	Code of practice for design loads other than earthquake) for buildings and structures.
IS:1893	Criteria for earthquake resistant design of structures.
IS:4091	Code of Practice for design and construction of foundation for transmission line towers & poles.
IRC:6	Standard specifications & code of practice for road bridges, Section-II Loads and stresses.
M.O.T.	Deptt. of railways Bridge Rules.
Safety	
IS:3696 (Part I & II)	Safety code for scaffolds and ladders.
IS:3764	Safety code for excavation work.
IS:4081	Safety code for blasting and related drilling operations.
IS:4130	Safety code for demolition of buildings.
IS:5121	Safety code for piling and other deep foundations.
IS:5916	Safety code for construction involving use of hot bituminous materials.
IS:7205	Safety code for erection on structural steelwork.
IS:7293	Safety code for working with construction machinery.
IS:7969	Safety code for handling and storage of building materials
IS:11769	Guidelines for safe use of products containing asbestos.

- Indian Explosives Act. 1940 as updated.

Architectural design of buildings

SP:7	National Building Code of India
SP:41	Hand book on functional requirements of buildings (other than industrial buildings)

Miscellaneous

IS:802	Code of practice for use of structural steel in
(Relevant parts)	overhead transmission line towers.
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrically welded in storage tanks.
IS:10430	Creteria for design of lined canals and liner for selection of type of lining.
IS:11592	Code of practice for selection and design of belt conveyors.
IS:12867	PVC handrails covers.
CIRIA	Design and construction of buried thin-wall pipes.
Publication	

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION

The design, manufacture, inspection, testing & installation of all equipment and system covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable VDE, IEEE, ANSI, ASME, NEC, NEMA, ISA AND Indian Standards and their equivalents.

Temperature Measurements

1. Instrument and apparatus for temperature measurement - ASME PTC 19.3 (1974).
2. Temperature measurement - Thermocouples ANSI MC 96.1 - 1982.
3. Temperature measuremnet by electrical Resistance thermometers - IS:2806.
4. Thermometer - element - Platinum resistance - IS:2848.

Pressure Measurements

1. a) Instruments and apparatus for pressure measurement - ASME PTC 19.2 (1964).

   b) Electonic transmitters BS:6447.
2. Bourdon tube pressure and vacuum gauges - IS:3624 - 1966.
3. Process operated switch devices (Pr. Switch) BS-6134.

Flow Measurements

Instruments and apparatus for flow measurements - ASME PTC 19.5 (1972) Interim supplement, Part-II.

Measurement of fluid flow in closed conduits - BS-1042.

Electronic Measuring Instrument & Control Hardware/ Software

1. Automatic null balancing electrical measuring instruments - ANSI C 39.4 (Rev. 1973): IS:9319.
2. Safety requirements for electrical and electronic measuring and controling instrument - ANSI C 39.5 - 1974.
3. Compatability of analog signals for electronic industrial process instruments - ISA - S 50.1 (1982) ANSI MC 12.1 - 1975.

4. Dynamic response testing of process control instrumentation ISA - S 26 (1968).

5. Surge Withstand Capability (SWC) tests - ANSI C 37.90 a/IEEE-472 or suitable class of IEC-255-4 equivalent to ANSI C37.90a/IEEE-472.

6. Printed circuit boards - IPC TM - 650, IEC 326 C.

7. General requirement and tests for printed wiring boards - IS 7405 (Part-I) 1973.

8. Edge socket connectors - IEC 130-11.

9. Requirements and methods of testing of wire wrap terminations DIN 41611 Part-2.

10. Dimensions of attachment plugs & receptacles - ANSI C 73 - 1973 (Supplement ANSI C 73 a - 1980).

11. Direct acting electrical indicating instrument - IS:1248 - 1968 (R).

12. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 - 1990.

13. Information Processing Systems - Local Area Networks - Part 2 : Logical Link Control - IEEE-802.2 - 1989.

14. Standard for Local Area Networks : Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1985.

15. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE-802.3 - 1988.

16. Standard for Local Area Networks : Token - Passing Bus Access Method - IEEE-802.4 - 1985.

17. Standard for Local Area Networks : Token - Ring Access Method and Physical Layer Specification - IEEE-802.5 - 1985.

18. IEEE Guide to Software Requirements Specifications - IEEE-830 - 1984.

19. Hardware Testing of Digital Process Computers - ISA RP55.1 - 1983.

20. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 - 1978.

21. Interface Between the Data Terminal Equipment and Data Circuit - Terminating Equipment Employing Serial Binary Data Interchange - EIA-232-D-1987.

22. Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment, Part 3 : Radiated Electromagnetic Field Requirements - IEC 801-3-1984.

Instrument Switches and Contact

1. Contact rating - AC services NEMA ICS 2 - 1978 (with revision through May 1983), Part - 2-125, A6000.

2. Contact rating - DC services NEMA ICS 2-1978 Part-2 125, N600.

Enclosures

1. Type of Enclosures - NEMA ICS Part - 6 - 1978 (with Rev. 1 4/80) through 110.22 (Type 4 to 13).

2. Racks, panels and associated equipment - EIA : RS - 310 C- 1983 (ANSI C 83.9 - 1972).

3. Protection class for Enclosures, cabinets, control panels & desks - IS:2147 - 1962.

Apparatus, enclosures and installation practices in hazardous area

1. Classification of hazardous area - NFPA 70 - 1984, Article 500.

2. Electrical Instruments in hazardous dust location - ISA - 512.11, 1973.

3. Instrinsically safe apparatus - NFPA 493 1978.

4. Purged and pressurised enclosure for electrical equipment in hazardous location - NFPA 496-1982.

5. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - 1977.

Sampling System

1. Stainless steel material of tubing and valves for sampling system - ASTMA 296-82, Grade 7 P 316.

2. Submerged helical coil heat exchangers for sample coolers ASTM D11 92-1977.

3. Water and steam in power cycle - ASME PTC 19.11.

4. Standard methods of sampling system - ASTM D 1066-99.

Annunciators

1. Specifications and guides for the use of general purpose annunciators - ISA S 19.1, 1979.

2. Surge withstand capability tests - ANSI C 37.90a - 1989/IEEE-472 or suitable class of IEC 255-4 equivalent to ANSI C37.90a 1989/IEEE-472

3. Damp heat cycling test - IS:2106

4. Specification for Electromagnetic Susceptibility - SAMA DMC 33, 1/78

Protections

1. Relays and relay system associated with electric power apparatus. ANSI C 37.90, 1 - 1989.

2. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS:6875 (Part-I) - 1973.

3. Turbine water damage prevention - ASME TDP-1-1980.

4. Boiler safety interlocks - NFPA 85 - 2011 or latest version.

UPS System

1. Practices and requirements for semi-conductor power rectifiers - ANSI C 34.2, 1973.

2. Relays and relays system associated with electrical power apparatus - ANSI C 3.90 - 1983.

3. Surge withstand capability test - ANSI C 37.90 1 -1989.

4. Performance testing of UPS - IEC 146.

5. Stationary cells & Batteries Lead Acid type (with tubular positive plates) specification IS-1651-1991.

6. Recommended practice for sizing large lead storage batteries for generating stations & sub-stations - IEEE-485-1985.

7. Printed Circuit Board - IPC TM 650, IEC 326C.

8. General Requirements & tests for printed wiring boards, IS:7405 (Part-I) 1973.

Control Valves

1. Control valve sizing - Compressible & Incompressible fluids - ISA S 75.01-1985.

2. Face to face dimensions of control valves - ANSI B 16.00 - 1973.

3. ISA Hand Book of Control Valves - (ISBN : B: 1047-087664-234-2).

4. Codes for pressure piping - ANSI B 31.1

5. Control Valve leak class - ISA RP 39.6

Process Connection & Piping

1. Codes for pressure piping "power piping" - ANSI B 31.1.
2. Seamless carbon steel pipe ASTM - A - 106.
3. Forged & Rolled Alloy steel pipe flanges, forged fittings and valves and parts - ASTM - A - 182.
4. Material for socket welded fittings - ASTM - A - 105.
5. Seamless ferritic alloy steep pipe - ASTM - A - 335.
6. Pipe fittings of wrought carbon steel and alloy steel - ASTM - A - 234.
7. Composition bronze of ounce metal castings - ASTM - B - 62.
8. Seamless Copper tube, bright annealed - ASTM - B - 168.
9. Seamless copper tube - ASTM - B - 75.
10. Dimension of fittings - ANSI - B - 16.11.
11. Valves flanged and butt welding ends - ANSI - B - 16.34.

Instrument Tubing

1. Seamless carbon steel pipe - ASTM - A 106.
2. Material of socketweld fittings - ASTM - A105.
3. Dimensions of fittings - ANSI - B - 16.11.
4. Code for pressure piping, welding, hydrostatic testing - ANSI B 31.1.

Cables

1. Thermocouples extension wires/cables - ANSI MC 96.1 - 1992.
2. Requirements for copper conductor-Wiring cables for telecommunications & information processing system - VDE:0815.
3. Colour coding of single or multi-pair cables - ICEA - S - 61-402 (third edition) NEMA WCS - 1979 with revisions thorugh 2/83.
4. Insulation & Sheathing compounds for cables : VDE 0207 (Part-4, 5 & 6).
5. Guide design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422-1977.
6. Rules for Testing insulated cables and flexible cables : VVDE - 0472

7. Requirements of vertical flame propagation test - IEEE 383 - 1974 (R 1980)

8. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33-81.

9. Oxygen index and temperature index test - ASTM D - 2863.

10. Smoke density measurement test - ASTMD - 2843.

11. Acid gas generation test - IEC - 754 - 1.

12. Swedish Chimney test - SEN - 4241475 (F3).

13. Teflon (FEP) insulation & sheath test - ASTMD - 2116.

14. Thermocouple compensating cables - Testing requirements & sampling plan IS:8784.

15. PVC insulated electric cables for working voltage upto and including 1100 V - IS:1554 (Part-I).

Cable Trays, Conduits

1. Guide for design and installation of cable systems in power generating staiton (Cable trays, support systems, conduits) - IEEE Std. 422, 1977, NEMA VE-1 1979, NFPA 70-1984.

2. -do- Test Standards. NEMA VE-1-1979.

3. Zinc coating "hot dip" on assembled products for galvanising of carbon steel cable trays - ASTMA - 386-78.

Public Address System

1. Specifications for loud speakers - IS:7741 (Part-I, II and III)

2. Code of safety requirement for electric mains operated audio amplifiers - IS:1301

3. Specification for Public Address Amplifiers - IS:10426.

4. Code of practice for outdoor installation of PA system - IS:1982.

5. Code of practice for installation for indoor amplifying and sound distribution system - IS:1881.

6. Basic environmental testing procedures for electronic and electrical items - IS:9000.

7. Characteristics and methods of measurements for sound system equipment - IS:9302

8. Code of practice of electrical wiring installations (System voltage not exceeding 650 volts) - IS:732

9. Rigid steel conduits for electric wiring - IS:9537 (Part-I and II)

10. Fittings for rigid steel conduits for electrical wiring - IS:2667

11. Degree of protection provided by enclosure for low voltage switchgear and control gear - IS:2147.

Vibration Monitoring System

1. API 670 - 1994

2. BS : 4675 Part-2

ANNEXURE-I

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT :
		ITEM :	QP NO.:	PACKAGE :
		SUB-SYSTEM:	REV.NO.:	CONTRACT NO. :
			DATE:	MAIN-SUPPLIER:
			PAGE: …. OF….	

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C / N					M	C	N	
1.	2.	3.	4.	5.	6.		7.	8.	9.	D*	**	10.		11.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER **C:** MAIN SUPPLIER, **N**: NTPC **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** NTPC SHALL IDENTIFY IN COLUM "N" AS 'W"	एनटीपीसी NTPC	DOC. NO.:		REV…… CAT…..
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE			
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F1-R1 1/1 ENGG. DIV./QA&I

ANNEXURE-II

SUPPLIER'S LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN		PROJECT :
		ITEM :	QP NO.:	PACKAGE :
			REV. NO.:	CONTRACT NO. :
		SUB-SYSTEM:	DATE:	MAIN-SUPPLIER:
			PAGE: …. OF….	

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS OF CHECK #	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR; 'A'** SHALL BE WITNESSED BY NTPC FQA, **'B'** SHALL BE WITNESSED BY NTPC ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE NTPC CHP STAGE)	एनटीपीसी NTPC	DOC. NO.:		REV……
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR NTPC USE			
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.: QS-01-QAI-P-09/F2-R1 1/1 ENGG. DIV./QA&I

ANNEXURE-III

एनटीपीसी NTPC	Project : Stage : Package : Supplier : Contractor No. :	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL SUB-SYSTEM :	DOC. NO.: REV. NO.: DATE : PAGE : OF

S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks

LEGENDS

SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY NTPC)

A – **For these items proposed vendor is acceptable to NTPC. To be indicated with letter "A" in the list alongwith the condition of approval, if any.**

DR – **For these items "Detailed required" for NTPC review. To be identified with letter "DR" in the list.**

NOTED – **For these items vendors are approved by Main Supplier and accepted by NTPC without specific vendor approval from NTPC. To be identified with "NOTED.'**

QP/INSPN CATEGORY:

CAT-I **: For these items the Quality Plans are approved by NTPC and the final acceptance will be on physical inspection witness by NTPC.**

CAT-II **: For these items the Quality Plans approved by NTPC. However no physical inspection shall be done by NTPC. The final acceptance by NTPC shall be on the basis review of documents as per approved QP.**

CAT-III **: For these items Main Supplier approves the Quality Plans. The final acceptance by NTPC shall be on the basis certificate of conformance by the main supplier.**

UNITS/WORKS **: Place of manufacturing Place of Main Supplier of multi units/works.**

FORMAT NO.: QS-01-QAI-P-1/F3-R0 1/1 Engg. Div. / QA&I

ANNEXURE-IV

एनटीपीसी NTPC	Project : Stage : Package : Contractor : Contractor No. :	STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL	DOC. NO.: REV. NO.: DATE : PAGE : OF

S. N.	Item / Service	QP/ Insp. Cat.	QP Sub. Schedule Approval schedule	Date of sub-missio n	Date of comm t Appl.	Status Code C/II/I	Proposed Sub-suppliers	Place of manufacturing works	Approva l Status	Sub-supplier detail submissio n schedule	Remarks

FORMAT 1/1 Engg. Div. / QA&I

ANNEXURE-V

एनटीपीसी NTPC	Project : Stage : Contractor : Contractor No. : System :	FIELD WELDING SCHEDULE (To be raised by the contractor) Welding Code: ……	DOC. NO.: REV. NO.: DATE : PAGE : OF

Sl. No.	DRG No. for Weld Location and Identification mark	Description of parts to welded	Matl. Spec.	Dimensions		Process of welding	Type of Weld	Electrode filler spec.	WPS. No.	Min. pre-heat	Heat treatment		NDT method/ Quantum	REF		Remarks
											Temp.	Holding time		Spec. No.	ACC Norm Ref.	

NOTES:

SIGNATURE

FORMAT	1/1	**Engg. Div. / QA&I**

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
1	Drawings, Data sheets, Design calculations, Purchase specifications and other documents		
	First submission and submission with major changes		
	▪ Layout (A0&A1 sizes)	4	-
	▪ Other Drawings/Documents (A0&A1 sizes)	2	-
	▪ P&ID (All sizes)	4	-
	a) Final drawings/documents (Directly to site)	6	2
	b) "As Built" Drawing/Documents (Directly to site)	6	2
	c) Analysis reports of Equipments / piping /structures components/system employing software packages as detailed in the specifications.	2	2
2	Erection Manual (Directly to site)	4 sets	2
3	Operation & Maintenance manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2
4	Plant Hand Book i) First Submission	1	1
5	Commissioning and Performance Test Procedure manual i) First Submission	1 set	--
	ii) Final Submission (Directly to site)	4 sets	2

S.No	Description of Drgs/Docs	No of Prints	No of CD ROMs/DVDs/Portable Hard Disk
6	Performance and Functional Guarantee Test Report i) First Submission	2 sets	--
	ii) Approved Copies (Direct to Site)	4 sets	2
7	Project Completion Report (Directly to site)	6 sets	2
8	QA programme including Organisation for implementation and QA system manual(with revisions)	1	--
9	Vendor details in respect of proposed vendors including contractor's evaluation report.	2	--
10	Manufacturing QPs, Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc i) For review/comment	1	--
	ii) Approved final copies of Field QPs, Field welding schedules and their reference document like test procedures, WPS, POR etc (Direct to Site)	4	2
11	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals i) For review/comment	1 set	--
	ii) Approved copies (Direct to Site)	4 sets	2
12	QA Documentation Package for items / equipment manufactured and despatched to site	2 sets	2
13	QA Documentation Package for field activities on equipment/systems at site	2 sets	2

PRODUCT	AREAS OF TRAINING REQUIEMENT			
	PRODUCT DESIGN	**Plant Visit**	**Visit to Manufacturer's Work**	**Operation & Maintenance of Plant**
FGD	Layout & model of FGD area, cable & piping trestles etc. **FGD** • Mass balance, Design, selection and sizing calculations of FGD • Training on factors affecting sizing/ efficiency of FGD system, equipments & auxiliaries • Materials for FGD & selection • Basic concepts, Design and sizing calculations on slurry systems including piping, valves, etc.. • FGD electrical system • FGD control system Erection strategies, erection procedures Performance as per applicable code and demonstration tests.	Familiarization with various system and equipment Performance, data collection analysis and review O&M feed back Operation history of various equipments and system Failure analysis	Manufacturing process of Absorber and equipments Welding process Testing facilities Product development in process Future plan for technology induction R&D work in progress	Control philosophy operation, notices, logic & protection schemes, O&M manual familiarization O&M issues. Familiarization of special maintenance techniques Special tool and tackles familiarization
MANMONTH	**2**	**0.5**	**0.5**	**6**

1.00.00 GENERAL

1.01.00 The following provisions shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract which is to be performed at site. The erection requirements and procedures not specified in these documents shall be in accordance with the recommendations of the equipment manufacturer, or as mutually agreed to between the Employer and the Contractor prior to commencement of erection work.

1.02.00 The Contractor upon signing of the Contract shall, in addition to a Project Co-ordinator, nominate another responsible officer as his representative at Site suitably designated for the purpose of overall responsibility and co-ordination of the Works to be performed at Site. Such a person shall function from the Site office of the Contractor during the pendency of Contract.

2.00.00 REGULATION OF LOCAL AUTHORITIES AND STATUTES

2.01.00 In addition to the local laws and regulations, the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract.

2.02.00 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully pay-able under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees for such inspection and/or registration shall be borne by the Contractor.

3.00.00 WELDING OF PRESSURE PARTS AND HIGH PRESSURE PIPING

The welding of all pressure parts and high pressure piping shall be in accordance with the following requirements:

3.01.00 **Qualification of Weld Procedures**

Only qualified welding procedures as per ASME Section IX shall be used by contractor at site. Procedure qualification records along with WPS shall be submitted to NTPC for review. Welding procedure shall indicate all essential and non-essential parameters as per ASME Section IX. Makes of welding consumables shall be subject to employer's approval.

3.02.00 **Welder's Qualification**

Only welders who are qualified in accordance with the latest applicable requirements of the Indian Boiler Regulations, shall be permitted to perform any welding work on the pressure parts and its attachment welding. In addition to such statutory qualification requirements, the welders shall also undergo a satisfactory

pre-production qualification test to be conducted by the Contractor at site as per ASME Sec IX in presence of employer's representative(s), prior to performing work under these specifications. The services of an independent testing laboratory shall be retained by the Contractor to perform welder qualification tests for welders.

All the welders carrying out welding at site shall carry an identification badge, which shall indicate the category and the grade of welding for which they have been tested and authorised to carry out welding.

3.03.00 **Records**

Welders performance shall be monitored regularly and record of their performance shall be maintained by contractor in a manner acceptable to the employer. Contractor shall maintain such records including record of procedure qualification & welder qualification and hand-over to the employer at the end of work.

3.04.00 **MARKING**

On completion of each welded joint, the welder shall mark his regularly assigned identification mark near the joint. The welder's identification numbers, inspection stamps or code symbol stamps and any other information shall not be directly stamped on any alloy steel piping. In alloy steel piping, all such information shall be stamped on separate marking plate which shall be tack welded on pipe near the weld.

4.00.00 HEAT TREATMENT

4.01.00 Pre-heating, post-heating and post-weld stress relief operations of all welds, shall be performed in accordance with the requirements of applicable code. Local post weld stress relieving heat treatments shall be adopted only in cases where it is normally impracticable to subject the entire assembly as such for stress relieving operations. Heating may be by means of electric induction coils or electric resistance coils. Oxy-acetylene flame heating or exothermic chemical heating methods will not be permitted. Complete recording of the temperatures through out the stress relieving cycle of the material and the weld subjected to heat treatment shall be made by means of a potentiometric recorder. Recorders other than those of potentiometric type shall not be used for such temperature recording during stress relieving operations.

The contractor & employer's representative, at start and at the end of HT Cycle shall sign the time and temperature charts for heat-treatment.

4.02.00 Not Used.

4.03.00 After setting up the weld joint for heat treatment operation, the Employer's signature shall be obtained on the strips chart of the recorder prior to starting of heat treatment cycle. The right hand corner of the strip chart at the starting point of the heat treatment cycle shall contain details like the weld number, material, diameter and thickness, method of heating adopted, prescribed ranges of heat treatment temperatures, date of heat treatment, reference to item number of the Field welding Schedule (as specified at clause no 7.00.00- of this chapter) etc.

5.00.00 **WELD EDGE PREPARATION**

Preparation at site of weld joint shall be in accordance with details acceptable to the Employer. Wherever possible, machining or automatic flame cutting shall be used for edge preparation. Hand flame cutting will be permitted only where edge preparation otherwise is impractical. All slag shall be removed from cuts and all the hand cuts shall be ground smooth to the satisfaction of the Employer. Flame cutting of alloy steel pipe shall be avoided. Wherever such cutting is done, a 200mm length at the cut face shall be removed by machining. Pneumatic hand tools such as edge preparation, tube cutting machine can be used.

6.00.00 **CLEANING AND SERVICING**

6.01.00 The inside of all tubes, pipes, valves and fittings shall be free from dirt, and loose scales before being erected. All the pipelines shall be thoroughly blown and/or flushed. Each steam and water tubes shall be blown with compressed air and shall be subjected to 'ball test' before erection to ensure that no obstructions exist. A system for recording of all such operations shall be developed and maintained in a manner to ensure that no obstructions are left inside the tubes and no tubes are left uncleaned and untested.

6.02.00 All valves and valve actuators, and dampers and damper actuators, if any, shall be thoroughly cleaned and serviced prior to pre-commissioning tests and/or Initial Operations of the plant. A system for recording of such servicing operation shall be developed and maintained in a manner acceptable to the Employer and to ensure that no valves or dampers including their actuators are left unserviced.

6.03.00 All interior surfaces of the turbine shall be thoroughly cleaned prior to boxing - up to remove all traces of oil preservations.

7.00.00 **FIELD WELDING SCHEDULE**

The Contractor shall submit to the Employer, a certified and complete field welding schedule for all the field welding activities to be carried out in respect of the pressure parts involved in the equipment furnished and erected by him, at least 90 days prior to the scheduled start of erection work at site. Such schedule will be strictly followed by the Contractor during the process of erection. The above field-welding schedule to be issued by the Contractor shall contain the following:

(a.) Drawing No (s)

(b.) Location of the weld

(c.) Size of the weld (outside diameter and thickness)

(d.) Type of joints

(e.) Material specifications

(f.) Size of fillet on backing ring, when the type of joint is with backing ring
(g.) Electrode/ filler metal specifications

(h.) Number of welds per unit

(i.) Quantity of filler metal per weld

(j.) Indication of required Non-destructive Examination (NDE) for each weld

(k.) Pre-heat temperatures for welding

(l.) Process of welding

(m.) Post-welding heat treatment temperature ranges, duration, under as specified at clause no 4.00.00 of this chapter entitled "Heat Treatment".

(n.) Qualification details of weld procedures to be adopted as specified at clause no 3.01.00 of this chapter entitled 'Qualification of Weld Procedures'.

8.00.00 SITE RUN MISCELLANEOUS PIPING

Sketches or diagrams of the proposed routings of all piping, not already indicated and routed on the shop drawings which were reviewed by the Employer, shall be submitted to the Employer for review, Employer's acceptance of such site routings shall be obtained before the piping is erected. All these site run piping shall be installed in such a manner as to present an orderly and neat installation. They shall be located as to avoid obstruction of access and passages. Valves, instruments or any other special items shall be located convenient for operation by the operating personnel. Pipe runs shall be plumb or level except where pitch for drainage is required. Pipe runs that are not parallel to the building structure, walls or column rows shall be avoided so that deflection of pipes between hangers does not exceed 6 mm. No miscellaneous pipe shall be routed and installed above or adjacent to electrical equipment.

9.00.00 THERMAL EXPANSIONS

All piping installation shall be such that no excessive or destructive expansion forces exist either in the cold condition or under condition of maximum temperature. All bends, expansion joints and any other special fittings, necessary to provide proper expansion, shall be incorporated. During installation of expansion joints and anchors, care must be taken to make sure that full design movement is available at all times for maximum to minimum temperature and vice-versa.

10.00.00 PIPING SUPPORTS

10.01.00 Hangers, supports and anchors shall be installed as required to obtain a safe, reliable and complete pipe installation. All supports shall be properly levelled and anchored when installed. The anchors shall be so placed that thermal expansion will be absorbed by bends without subjecting the valves or equipment to excessive strains.

10.02.00 The hanger assemblies shall not be used for the attachment of rigging to hoist the pipe into place. Other means shall be used to securely hold the pipe in place till the pipe support is completely assembled and attached to the pipe and building

structures and spring support is set to accommodate the pipe way. All temporary rigging shall be removed in such a way that the pipe support is not subjected to any sudden load. All piping, having variable spring type supports, shall be held securely in place by temporary means during the hydraulic test of pipe system. Constant support type spring hangers used during hydraulic test shall be pinned or blocked solid during the test. After complete installation and insulation of the piping and filling of the piping with its normal operating medium, the pipe support springs shall be adjusted to the cold positions. If necessary, the spring support shall be re-adjusted to the hot positions after the line has been placed for service at its normal maximum operating temperature conditions. Electric arc welding only shall be used to weld all pipe supports to structural steel members that form part of the building supporting structure. The structural beams shall not be heated more than necessary during welding of supports and such welds shall run parallel to the axis of the span. All lugs or any other attachments welded to the piping shall be of the same material as the pipe.

11.00.00 PRESSURE TESTING

11.01.00 On completion of erection of pressure parts, a hydraulic test in accordance with the requirements of the Indian Boiler Regulations shall be performed by the Contractor.

11.02.00 All the valves, high pressure pipes and inter-connected pipes connecting the pressure parts shall be tested along with pressure parts. All blank flanges or any removable plugs required for openings not closed by the valves, and piping provided, shall be furnished by the Contractor. The pressurization equipment including water piping from the supply, needed for the above test shall also be furnished by the Contractor. Any defects noticed during the testing are to be rectified and the unit re-tested. If any welding is done on the pressure parts after the Hydraulic test, the Hydraulic test for that portion of pressure parts shall be repeated. Water as required for such pressure testing shall be provided by the employer.

11.03.00 Thy hydraulic test shall be considered successful only on certification to that effect by the concerned inspecting Authority as per the provisions of the Indian Boiler Regulations and the Employer.

12.00.00 THERMOWELLS AND FLOW NOZZLES

12.01.00 All the thermowells and flow nozzles in the equipment furnished under the technical specifications shall be installed as a part of this work.

12.02.00 All thermowell connections incorporated in the steam service shall be plugged during the pressure testing and the blow out of steam piping systems. Upon completion of the blow out operation, all thermowells shall be installed and seam welded. Similarly, all flow nozzles in the steam lines shall also be installed only on completion of steam blowing operations unless otherwise agreed to by the Employer, depending upon the sequence of cleaning and purging operations to be adopted by the Contractor at the field.

13.00.00 **INSULATION, LAGGING AND CLADDING**

The provision of insulation, lagging and cladding of the various equipments and portion of the equipment covered under the Contract, shall be furnished by the

Contractor as specified elsewhere or agree to separately in writing. Welds required for holding insulation on pressure parts shall be carried out by IBR qualified welder.

13.01.00 **Piping, Pipe Fittings & Valves**

All piping insulation and metal cladding furnished with the equipment to be erected shall be applied as specified herein.

13.01.01 **Piping**

The insulation on piping shall be applied using wire loops on 150mm centres. These wire loops shall be thoroughly embedded into the outer insulation surface and all cracks, voids and depressions shall be filled with insulating cement suitable for the piping temperature so as to form a smooth base for application of cladding. The wires used for piping insulation shall be of 16 SWG. The surface shall be smooth and uniform before applying the outer covering. All piping insulation ends shall be terminated at a sufficient distance from flanges to facilitate removal of bolts.

13.01.02 **Flanges**

Insulation on flanges shall be by means of blocks of insulating material securely bound to the flange by wire loops. Such blocks of insulation shall be long enough to overlap the adjacent pipe insulation by an amount equal to the thickness of adjacent pipe insulation. Smooth finish shall be obtained by the application of insulating cement. Alternatively, sectional pipe insulation of proper diameter may be used. Insulation on flanges shall not be done until the pipe and equipment have been in service during the initial operation and till all the flange bolts have been retightened.

13.01.03 **Bends and Elbows**

Insulation on bends and elbows shall be cut into sections sufficiently short to form a reasonable smooth external surface. After the application of insulation material in place, it shall be smoothly coated with insulating cement. Elbows may be insulated as above or alternatively by means of specially moulded insulation enclosures.

13.01.04 **Cladding**

Cladding shall be of aluminium sheet of thickness as per details given in detail Technical Specification or will be provided during detail engineering shall be machine rolled and formed to accurately fit insulation curvatures. Cladding shall be secured using self-tapping screws. Screws shall be adequate number and so located as to produce tight joints. The spacing of screws shall be as far as possible uniform and on centres not exceeding 150 mm. For outside diameters less than 230 mm, spacing of screws shall be on centres not exceeding 100 mm. adequate number of screws shall be provided for fixing the cladding and be so placed in such locations, as to produce a smooth cladding finish without bellying'. Insulated elbows having insulated diameters less than 330 mm shall be provided with preformed smooth aluminium elbow jackets. Wherever possible, all joints should be lapped a minimum of 50 mm with joints facing downwards and so placed that they are obscured from normal points of vision. All the joints in the cladding shall be made with suitable provisions for expansions. All butt joints such as those at piping tees

shall be made using rolled seams. In addition, to prevent galvanic corrosion, suitable action, as specified at clause no 13.02.00 of this chapter, shall be taken.

13.01.05 **Valves and Fittings**

All valves and fittings (above valve size of 2 inches) installed in the steam pipelines shall also be applied with insulation and furnished with suitably shaped boxes so as to facilitate easy dismantling of the fittings. The insulation thickness for valves, valve fittings etc., shall be same as that used on the line on which they are installed. All voids shall be properly filled up with insulating material and as per the directions of the Employer.

13.02.00 **Protection of Equipment during Insulation Applications**

All equipment and structures shall be suitably protected from damage while applying insulation after completion of insulation. All equipment and structures shall be thoroughly cleaned and remove insulating materials which might have fallen on them.

14.00.00 CODE REQUIREMENTS

The erection requirements and procedures to be followed during the installation of the equipment shall be in accordance with the relevant Indian Electricity Rules & Codes, Indian Boiler Regulations, ASME codes and accepted good practices, the Employer's Drawings and other applicable Indian recognised codes and laws and regulations of the Government of India.

15.00.00 ELECTRICAL SAFETY REGULATIONS

15.01.00 In no circumstances will the Contractor interfere with fuses and electrical equipment belonging to the other Contractor or Employer.

15.02.00 Before the Contractor connects any electrical appliances to any plug or socket belonging to the other Contractor or Employer, he shall:

(a) Satisfy the Employer that the appliance is in good working condition.

(b) Inform the Employer of the maximum current rating,voltage and phase of the appliances.

(c) Obtain permission of the Employer detailing the socket to which the appliances may be connected.

The Employer will not grant permission to connect unitl he is satisfied that

(d) The appliance is in good condition and is fitted with suitable plug.

(e) The appliance is fitted with a suitable cable having two earth conductors, one of which shall be an earthened metal sheath surrounding the cores.

15.03.00 No electric cable in use by the other Contractor/Employer will be disturbed without permission. No weight of any description will be imposed on any such cable and ladder or similar equipment will rest against or to be attached with it.

15.04.00 No reapir work shall be carried out on any live equipment. The equipment must be declared safe by the Employer and a permit to work issued before any work is carried out.

15.05.00 The Contractor shall employ the necessary number of qualified, full time electricians to maintain his temporary electrical installation.

16.00.00 REMOVAL OF MATERIAL

No material brought to the Site shall be removed from the Site by the Contractor and/or his Sub-Contractors without the prior written approval of the Employer.

17.00.00 INSPECTION, TESTING AND INSPECTION CERTIFICATES

The provisions of the clause entitled Inspection, Testing and Inspection Certificates given in Part - C of the Technical Specification, shall also be applicable to the erection portion of the Works. The Employer shall have the right to re-inspect any equipment though previously inspected and approved by him at the Contractor's works, before and after the same are erected at Site. If by the above inspection, the Employer rejects any equipment, the Contractor shall make good for such rejections either by replacement or modification/ repairs as may be necessary to the satisfaction of the Employer. Such replacements will also include the replacements or re-execution of such of those works of other Contractors and/or agencies, which might have got damaged or affected by the replacements or re-work done to the Contractor's work.

18.00.00 ACCESS TO SITE AND WORKS ON SITE

18.01.00 Suitable access to site and permission to work at the Site shall be accorded to the Contractor by the Employer in reasonable time.

18.02.00 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the Employer or his representative.

19.00.00 CONTRACTOR'S SITE OFFICE ESTABLISHMENT

The Contractor shall establish a Office at the Site and keep posted an authorised representative for the purpose of the Contract. Any written order or instruction of the Employer or his duly authorised representative, shall be communicated to the said authorised resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

20.00.00 CO-OPERATION WITH OTHER CONTRACTORS

20.01.00 Employer, who may be performing other works on behalf of the Employer and the workmen who may be employed by the Employer and doing work in the vicinity of the works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the Employer, due to the Contractor's work shall promptly be made good at his own expense. The Employer shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the Employer in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the Employer on that account other than an extension of time for completing his works. Employer shall have full access to visit the contractor's site at any time for inspection and surveillance checks.

20.02.00 The Employer shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The Employer shall determine the corrective measures if any, required to rectify this situation after inspection of the works and such decisions by the Employer shall be binding on the Contractor.

21.00.00 DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the Employer in respect of his employees and workmen at Site. The Employer shall be at liberty to object to the presence of any representative or employee of the Contractor at the Site, if in the opinion of the Employer such employee has misconducted himself or is incompetent, negligent or otherwise undesirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

22.00.00 CONTRACTOR'S FIELD OPERATION

22.01.00 The Contractor shall keep the Employer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Employer shall not relieve the Contractor of any of his responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the Employer or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

22.02.00 The Contractor shall have the complete responsibility for the conditions of the Work-Site including the safety of all persons employed by him or his Sub-Contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Employer is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.

23.00.00 PHOTOGRAPHS AND PROGRESS REPORT

23.01.00 The Contractor shall furnish three (3) prints each to the Employer of progress photographs of the work done at Site. Photographs shall be taken as and when indicated by the Employer or his representative. Photographs shall be adequate in size and number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the photograph.

23.02.00 The above photographs shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and the action proposed for corrective measures, wherever necessary.

23.03.00 The Contractor shall submit the progress of work in soft and hard form (as decided by employer) quarterly highlighting the progress and constraints at site.

24.00.00 MAN-POWER REPORT

24.01.00 The Contractor shall submit to the Employer, on the first day of every month, a man hour schedule for the month, detailing the man hours scheduled for the month, skill-wise and area-wise.

24.02.00 The Contractor shall also submit to the Employer on the first day of every month, a man power report of the previous month detailing the number of persons scheduled to have been employed and actually employed, skill- wise and the areas of employment of such labour.

25.00.00 PROTECTION OF WORK

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Employer. No claim will be entertained by the Employer or the representative of the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because of other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions of the as specified at clause no 21.00.00 of this chapter entitled "Co-operation with other Contractors." The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

26.00.00 EMPLOYMENT OF LABOUR

26.01.00 In addition to all local laws and regulations pertaining to the employment of labour to be complied with by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of the

	particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.
26.02.00	All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.
26.03.00	The hours of work on the Site shall be decided by the Employer and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day - Monday through Saturday.
26.04.00	Contractor's employees shall wear identification badges while on work at Site.
26.05.00	In case the Employer becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contact Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Employer may make such payments and shall recover the same from the Contractor's Bills.
27.00.00	**FACILITIES TO BE PROVIDED BY THE EMPLOYER**
27.01.00	**Electricity** Refer clause 1.14.00 (Construction Power) Sub-Section III-B, Part-A, Section VI of Technical Specification.
27.02.00	**Water** Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite/colony. However, drawl of construction/potable water from bore-well shall be permitted if found suitable. Any statutory clearance required shall be obtained by the contractor. Assistance, if required shall be provided by the owner.
27.03.00	**Communication** The Employer will extend the telephone facilities, if available at Site, for purposes of Contract. The Contractor shall be charged at actuals for such facilities.
27.04.00	**Railway Siding** Railway siding shall be provided by owner (up to plant entry point) for coal transportation to site. However the same may not be available to the bidder for material/supplies transport etc. Bidder has to plan its own arrangement for movement of ODC consignment to plant site.

28.00.00 FACILITIES TO BE PROVIDED BY THE CONTRACTOR

28.01.00 **Contractor's site office Establishment**

The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC. The site office will include one conference meeting room for site meetings between the Contractor and the Employer.

28.02.00 **Tools, tackles and scaffoldings**

The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, installation, testing, commissioning and conducting Guarantee tests of the equipments covered under the Contract. He shall submit a list of all such materials to the Employer before the commencement of pre-assembly at Site. These tools and tackles shall not be removed from the Site without the written permission of the Employer. The Contractor shall arrange Dozer, Hydra, Cranes, Trailer, etc. for the purpose of fabrication, erection and commissioning.

28.03.00 **Testing Equipment and Facilities:**

The contractor shall provide the necessary testing, equipment and facilities.

28.04.00 **Site laboratory for civil works:**

Contractor shall provide and maintain a site laboratory for the testing of construction material under the direction and general supervision of employer.

28.05.00 **First-aid**

28.05.01 The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.

28.05.02 The Employer will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.

28.06.00 **Cleanliness**

28.06.01 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the Employer. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.

28.06.02 Similarly the offices shall be kept clean and neat to the entire satisfaction of the Employer. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas and office areas of the Contractor.

29.00.00 **LINES AND GRADES**

All the Works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate and layout the Works. Basic horizontal and vertical control points will be established and marked by the Employer at Site at suitable points. These points shall be used as datum for the works under the Contract. The Contractor shall inform the Employer well in advance of the times and places at which he wishes to do work in the area allotted to him so that suitable datum points may be established and checked by the Employer to enable the Contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Employer at Contractor's expense.

30.00.00 **FIRE PROTECTION**

30.01.00 The work procedures that are to be used during the erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the Site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipment and materials storage areas in safe containers. Untreated canvas, paper, plastic or other flammable flexible materials shall not at all be used at Site for any other purpose unless otherwise specified. If any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable material before moving into the construction or storage area.

30.02.00 Similarly corrugated paper fabricated cartons etc. will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistant type. All the other materials such as working drawings, plans etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.

30.03.00 All the Contractor's supervisory personnel and sufficient number of workers shall be trained for fire-fighting and shall be assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.

30.04.00 The Contractor shall provide enough fire protection equipment of the types and number for the warehouses, office, temporary structures, labour colony area etc. Access to such fire protection equipment, shall be easy and kept open at all time.

31.00.00 **SECURITY**

The Contractor shall have total responsibility for all equipment and materials in his custody stores, loose, semi-assembled and/or erected by him at Site. The Contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipment and works from theft, fire, pilferage and any other damages and loss. All materials of the Contractor shall enter and leave the Employer Site only with the written permission of the Employer in the prescribed manner.

32.00.00 **CONTRACTOR'S AREA LIMITS**

The Employer will mark-out the boundary limits of access roads, parking spaces, storage and construction areas for the Contractor and the Contractor shall not trespass the areas not so marked out for him. The Contractor shall be responsible to ensure that none of his personnel move out of the areas marked out for his operations. In case of such a need for the Contactor's personnel to work out of the areas marked out for him the same shall be done only with the written permission of the Employer.

33.00.00 **CONTRACTOR'S CO-OPERATION WITH THE EMPLOYER**

In case where the performance of the erection work by the Contractor affects the operation of the system facilities of the Employer, such erection work of the Contractor shall be scheduled to be performed only in the manner stipulated by the Employer and the same shall be acceptable at all times to the Contractor. The Employer may impose such restrictions on the facilities provided to the Contractor such as electricity, etc. as he may think fit in the interest of the Employer and the Contractor shall strictly adhere to such restrictions and co-operate with the Employer. It will be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and operation of the equipment systems which are erected by him. The Contractor shall also be responsible for flushing and initial filling of all the oil and lubricants required for the equipment furnished and installed by him, so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in documents and specifications.

34.00.00 **PRE-COMMISSIONING AND COMMISSIONING ACTIVITIES**

34.01.00 **GENERAL**

34.01.01 The Contractor upon completion of installation of equipments and systems, shall conduct pre-commissioning and commissioning activities, to make the equipment/systems ready for safe, reliable and efficient operation on sustained basis. All pre-commissioning/commissioning activities considered essential for such readiness of the equipment/systems including those mutually agreed and included in the Contractor’s quality assurance programme as well as those indicated in clauses elsewhere in the technical specifications shall be performed by the contractor.

34.01.02 The pre-commissioning and commissioning activities including Guarantee/ demonstration/ acceptability tests, checks and trial operations of the equipment/systems furnished and installed by the contractor shall be the responsibility of the Contractor as detailed in relevant clauses in Technical Specification. The Contractor shall provide, in addition, test instruments, calibrating devices etc. and labour required for successful performance of these operations. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such operations.

34.01.03 The following activities shall be carried out by the contractor, 18 month prior to schedule date of commissioning of the equipment/systems installed by him.

(a.) The contractor shall furnish the organization chart of his operation and commissioning engineers for the acceptance of employer. Adequate number of operation and commissioning engineers shall be deployed by the contractor to effectively meet the requirement of round the clock operation in shifts also, till the plant is taken over by the employer.

(b.) The contractor shall submit the bio-data containing the details of experience of his operation and commissioning engineers for the acceptance of employer.

(c.) The contractor shall furnish the deployment schedule of his operation and commissioning engineers for the acceptance of the employer.

(d.) Apart from above, contractor shall ensure deployment of sufficient skilled/semi-skilled/unskilled manpower during pre-commissioning and commissioning activities.

34.01.04 It shall be the responsibility of the Contractor to provide all necessary temporary instrumentation and other measuring devices required during start-up and initial operation of the equipment/systems which are installed by him.

34.01.05 The Contractor shall also be responsible for flushing and initial filling of all oils and lubricants required for the equipment furnished and installed by him so as to make such equipment ready for operation. The Contractor shall be responsible for supplying such flushing oil and other lubricants unless otherwise specified elsewhere in these specifications and documents.

34.02.00 **COMMISSIONING DOCUMENTATION**

34.02.01 The contractor shall submit the commissioning documentation, comprising of Standard checklists, pre-commissioning procedures, testing schedules, commissioning schedules and commissioning networks for various equipment/systems covered under the contract, for the approval of employer.

34.02.02 Standard checklist, as the name suggests, shall be a fairly general documents, containing the list of all checks required to be carried out for similar and repetitive type of equipment to ensure consistent and thorough checking. An indicative list of such equipment is enclosed as Annexure I.

34.02.03 The testing schedule is a document, designed for safe and systematic commissioning of individual equipment/sub-system (for example compressor etc.) Commissioning schedule is a document envisaged for commissioning of a system (for example Compressed Air system, Unit commissioning etc.). The testing/Commissioning schedule shall have a standard format in order to maintain consistency of presentation, content and reporting. A brief write up on the contents of the Testing Schedule/Commissioning Schedule is enclosed as Annexure-II.

34.02.04 The contractor shall submit the list of commissioning documentation to be submitted by him, along with their submission schedule for various equipment/systems covered under the contract, with in 6(six) month from the date of award of contract, for the acceptance of employer.

34.02.05 The Contractor shall submit the commissioning documentation, for various equipment/covered under the contract, for the approval of employer, at least 18 months before the scheduled date of commissioning of the equipment/systems.

34.03.00 **COMMISSIONING ACTIVITIES**

34.03.01 Upon completion of pre-commissioning activities/tests, the contractor shall initiate commissioning of facilities. During commissioning the Contractor shall carry out system checking and reliability trials on various parts of the facilities.

34.03.02 Contractor shall carry out the checks/tests at site to prove to the Employer that each equipment of the supply complies with requirements stipulated and is installed in accordance with requirements specified.

34.03.03 Before the plant is put into initial operation the Contractor shall be required to conduct test to demonstrate to the Employer that each item of the plant is capable of correctly performing the functions for which it was specified and its performance, parameters etc. are as per the specified/approved values. These tests may be conducted concurrently with those required under commissioning sequence.

34.03.04 The Contractor shall also demonstrate the performance of all C&I equipment, the tests on main equipment of prior to that as the case may be.

34.03.05 Other tests shall be conducted, if required by the Employer, to establish that the plant equipment are in accordance with requirements of the specifications.

34.03.06 The Contractor shall conduct all the commissioning tests and undertake commissioning activities pertaining to all other auxiliaries and equipments including all electrical and C&I equipment/systems not specifically brought out above but are within the scope of work and facilities being supplied and installed by the Contractor and follow the guidelines indicated above or elsewhere in these technical specifications.

34.05.00 **Initial Operation**

Upon completion of system checking/Tests as above and as a part of commissioning of facilities, complete plant/facilities shall be put on initial operation as stipulated in General Technical Requirements.

35.00.00 MATERIALS HANDLING AND STORAGE

35.01.00 All the equipments furnished under the Contract and arriving at Site shall be promptly received, unloaded and transported and stored in the storage spaces by the Contractor.