TENDER SPECIFICATION
BHEL: PSSR: SCT: 1915

FOR

Civil, structural & Architectural works of FLUE GAS DESULPHURISATION PLANTS (FGD) in existing 2 x 500 MW Tuticorin Thermal power station at Tuticorin, Tamilnadu, India for NLC TAMILNADU POWER LIMITED (NTPL).

TECHNOCOMMERCIAL BID - Consists of Book- I & Book- II

Book- I Consists of

- **Notice Inviting Tender**
- **Volume-IA: Technical Conditions of Contract**

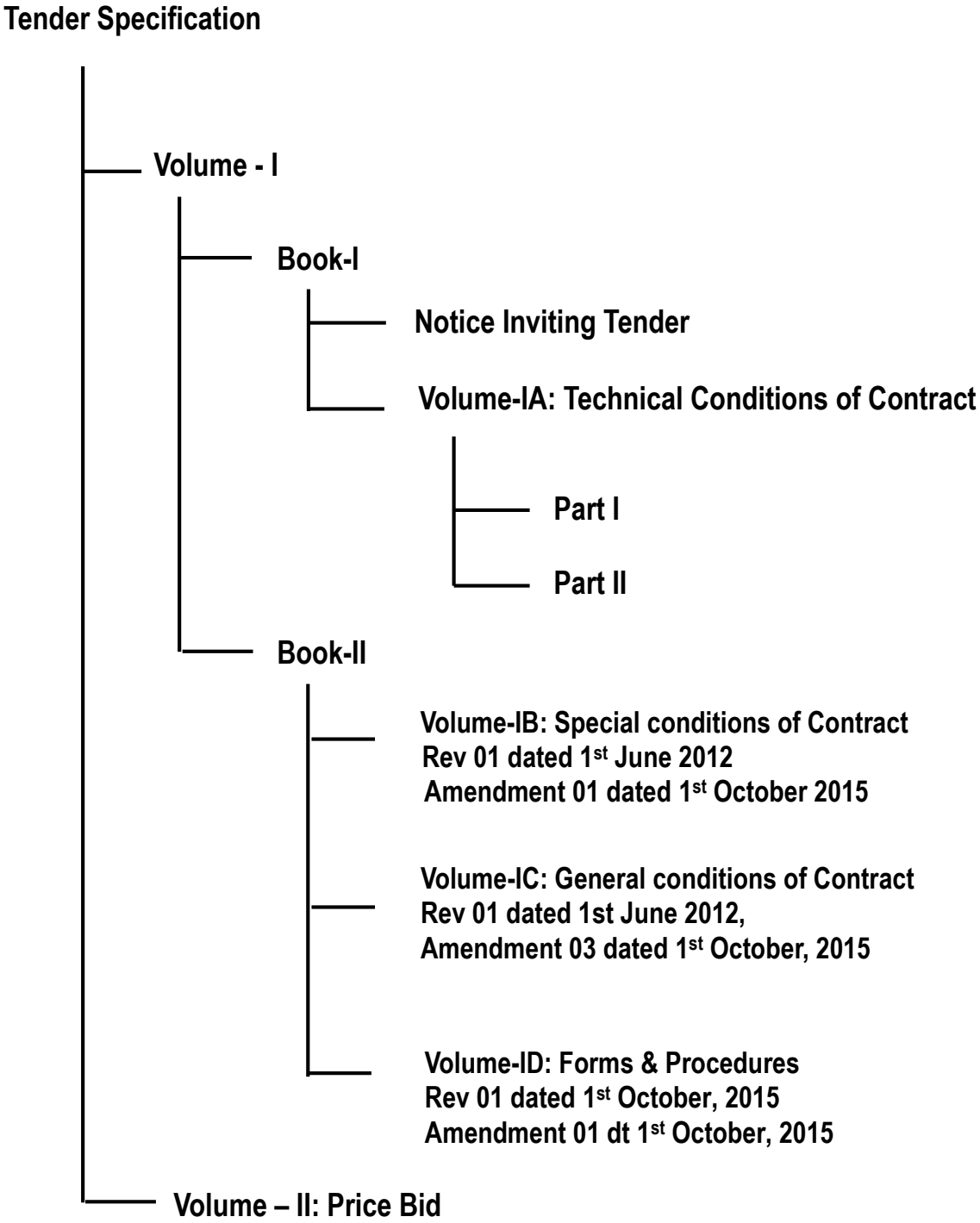
Book-II consists of

- **Volume-IB: Special conditions of Contract,**
  Rev 01 dated 1st June 2012
  Amendment 01 dated 1st October, 2015
- **Volume-IC: General conditions of Contract**
  Rev 01 dated 1st June 2012,
  Amendment 03 dated 1st October, 2015
- **Volume-ID: Forms & Procedures**
  Rev 01 dated 1st June 2012
  Amendment 01 dt 1st October, 2015

VOLUME –I BOOK – I

BHARAT HEAVY ELECTRICALS LIMITED
(A Government of India Undertaking)
Power Sector – Southern Region
Tek Towers, No.11, Old Mahabalipuram Road,
Okkiyam Thoraipakkam, Chennai - 600097.

TENDER SPECIFICATION CONSISTS OF



NOTICE INVITING TENDER

Bharat Heavy Electricals Limited

Ref: BHEL: PSSR: SCT: 1915 **Date: 15.09.2020**

NOTICE INVITING TENDER (NIT)

Submission only through E-Procurement Portal

https://bhel.abcprocure.com

Note: Bidder may download Tender Document from web sites

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To
Dear Sir/Madam

Sub: NOTICE INVITING TENDER

Online Sealed offers in two part bid system (National competitive bidding (NCB)) are invited from reputed & experienced bidders (meeting as mentioned in Annexure-I) **through E-Procurement Portal** https://bhel.abcprocure.com only, for the subject job by the undersigned on the behalf of BHARAT HEAVY ELECTRICALS LIMITED as per the tender document. Following points relevant to the tender may please be noted and complied with.

1.0 Salient Features of NIT

Sl. No	ISSUE	DESCRIPTION	
i)	**TENDER NUMBER**	**BHEL: PSSR: SCT: 1915**	
ii)	**Broad Scope of job**	Civil, structural & Architectural works of FLUE GAS DESULPHURISATION PLANTS (FGD) in existing 2 x 500 MW Tuticorin Thermal power station at Tuticorin, Tamilnadu, India for NLC TAMILNADU POWER LIMITED (NTPL).	
iii)	**DETAILS OF TENDER DOCUMENT**		
A	Volume-IA	Technical Conditions of Contract (TCC) consisting of Scope of work, Technical Specification, Drawings, Procedures, Bill of Quantities, Terms of payment, etc.,	Applicable
B	Volume-IB	Special conditions of Contract, Rev 01 dated 1st June 2012, Amendment 01 dated October 01, 2015	Applicable
C	Volume-IC	General conditions of Contract Rev 01 dated 1st June 2012, Amendment 03 dated October 01, 2015	Applicable
D	Volume-ID	Forms & Procedures Rev 01 dated 1st June 2012 Amendment 01 dated October 01,2015	Applicable
E	Volume-II	Price Schedule (Absolute value).	Applicable

iv)	Issue of Tender Documents	1. **This is an E-tender floated online through our E-Procurement Portal** https://bhel.abcprocure.com 2. **Sale** **Start: 16.09.2020** **Close:** Tender documents can be downloaded till closing time for offer submission. 3. **From**: BHEL website (www.bhel.com -> Tender Notifications). Tender documents for bidder's reference can be downloaded from this website till due date of submission.	Applicable
v)	Due Date & Time of Offer Submission	**Date:07.10.2020, Time :15.00 Hrs** The bidder should submit their offer online in e-Procurement portal at https://bhel.abcprocure.com. ***Bidders are requested to upload their offer well in advance in order to avoid last minute congestion at this website.*** **Hard copy bid or bids through E-mail / fax shall not be accepted.**	Applicable
vi)	Opening of Tender	**Date: 07.10.2020, Time :15.30 Hrs** Notes: (1) In case the due date of opening of tender becomes a non-working day, tenders shall be opened on next working day at the same time. (2) Bidder may record their presence online, during tender opening. However, this being an e-tender it shall be opened online.	Applicable
vii)	EMD Amount	**Rs.1,09,70,000/- (Rupees One Crore Nine Lakhs and Seventy Thousand only)** - Refer Vol-1A Part-II Chapter-1 of Technical Conditions of Contract (Volume-I, Book-I) for mode of payment of EMD. - Exemption of EMD for MSEs is not applicable for this tender. - One time EMD is not applicable for this tender.	Applicable
viii)	Cost of Tender	**Rs. 2,000/-** (Rupees Two Thousand Only) - Cost of tender shall be remitted through, Electronic Fund Transfer credited in BHEL account or Banker's cheque or Pay order or Demand draft, in favour of BHEL.	Applicable

		- Exemption of Cost of Tender for MSEs is not applicable for this tender. - **Originals shall be sent to "Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097".**	
ix)	Last Date For Seeking Clarification	Bidders may submit their queries in https://bhel.abcprocure.com at least 7 days before the due date of offer submission or two days before the scheduled date of pre-bid meeting whichever is earlier along with soft version also, addressing to undersigned & to others as per contact address given above.	Applicable
x)	Schedule of Pre Bid Discussion (PBD)	Date**:25.09.2020** Time **11.00AM** At BHEL: PSSR: Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097.	Applicable
xi)	Integrity Pact & Details of Independent External Monitor (IEM)	a. Integrity Pact (IP) is a tool to ensure that activities and transactions between the company and its Bidders / Contractors are handled in a fair, transparent and corruption free manner. Following Independent External Monitors (IEMs) on the present panel have been appointed by BHEL.: 1. Shri. Arun Chandra Verma, IPS(Retd.) E Mail: acverma1@gmail.com 2. Shri. Virendra Bahadur Singh, IPS (Retd.), E Mail: vbsinghips@gmail.com b. The IP as per format given at Volume IA Part II of this tender is to be submitted (duly signed by the authorized signatory) along with Techno Commercial Bid (Part-1, in case of two/ three part bid). Only those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding. In other words, entering into this pact would be a preliminary qualification. c. Please refer section- 8 of the IP (refer the format given at Volume IA Part II of this tender) for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to any of the above IEMs. All	**Applicable**

		correspondence with the IEMs shall be done through E-mail only. Note: No routine correspondence shall be addressed to the IEM (Phone / Post / E mail) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarification / issues shall be addressed directly to the tender issuing department's officials whose contact details are provided below:	
	Contact Details	For all clarifications /issues related to the tender, please contact: Mr. Anil Kumar, DGM/ SCT BHEL-PSSR Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097. anil.kr@bhel.in Ph: +91-9490165953	
xii	Latest updates	Latest updates on the important dates, Amendments, Correspondences, Corrigenda, Clarifications, Changes, Errata, Modifications, Revisions, etc to Tender Specifications will be hosted in BHEL webpage (www.bhel.com → Tender Notifications), CPP Portal (https://eprocure.gov.in) & portal **https://bhel.abcprocure.com.** Bidders to keep themselves updated with all such information. This also form part of tender hence the same shall be enclosed with their offer.	

2.0 The offer shall be submitted as per the instructions of tender document and as detailed in this NIT. Bidders to note specifically that all pages of tender document, including these NIT pages of this particular tender together with subsequent correspondences shall be submitted by them, **duly signed & stamped on each page, as part of offer**. **Rates / Price including discounts / rebates, if any, mentioned anywhere / in any form in the techno-commercial offer other than the Price Bid, shall not be entertained.**

3.0 Unless specifically stated otherwise, Bidder shall remit cost of tender through, Electronic Fund Transfer credited in BHEL account or Banker's cheque or Pay order or Demand draft, in favour of BHEL.

4.0 Unless specifically stated otherwise, bidder shall deposit **Earnest Money Deposit (EMD) as mentioned in Volume IA, Part-II, Chapter-1** of Technical Conditions of Contract (Volume-I Book-I) under the heading 'Modes of Deposit of EMD'. Please note that 'One Time EMD' shall not be considered. **It is to be noted that proof of remittance for EMD shall be made available at BHEL PSSR Office prior to tender opening.**

5.0 **Procedure for Submission of Tenders**: This is an E-tender floated online through our E-Procurement portal https://bhel.abcprocure.com . The bidder should respond by submitting their offer online only in our e-Procurement portal at https://bhel.abcprocure.com . Hard copy bid or bids through email/ fax shall not be accepted.

I. Pre-requisite for Offer Submission: -

Digital Certificate: To participate in an e-Tender, you need to have a Class-II/III Digital Signature Certificate (DSC) for Signing & Encryption (Required both digital signature certificate: Signing & Encryption) of bids issued by any of the valid Certifying Authorities (approved by Controller of Certifying Authorities) in India. Valid Digital Signature Certificate (DSC) must be installed in a computer system from where you want to access the website.

MINIMUM REQUIREMENT: (Mandatory)

- Computer with good Internet Connection.
- Operating System should be Windows Vista / Windows 7 and above.
- Web Browsers: Internet Explorer 9.0 (32-bit Browser only) & above.
- System Access with Administrator Rights.

At first time login, to verity and approve your login profile & DSC, you are requested to contact e-Procurement Service Provider.
Also please Refer "Bidder Manual for BHEL Bidders" and "Minimum System Requirements and Settings Document for BHEL user & Bidders" available at https://bhel.abcprocure.com .

II. Digital Signing of e-Tender

Tenders shall be uploaded with all relevant documents in PDF/zip format. The relevant tender documents should be uploaded by an authorized person having Class-II/III Digital Signature Certificate (DSC) for Signing & Encryption.

i) The Requirement:

a. A PC with Internet connectivity &
b. DSC (Digital Signature Certificate) Class-II/III Digital Signature Certificate (DSC) for Signing & Encryption)

Vendors are also requested to go through bidder manual available on https://bhel.abcprocure.com

III. E-procurement service Provider-:

Address:

e-Procurement Technologies Limited (abcProcure),

Head Office: B-704/705, Wall Street - II, Opp. Orient Club,

Nr. Gujarat College, Ellis Bridge, Ahmedabad - 380 006, Gujarat (India)

Timing:

Indian Standard Time (+5:30 GMT): 10:00 AM - 07:00 PM (Monday to Friday)

Indian Standard Time (+5:30 GMT): 10:00 AM - 04:00 PM (Saturday)

The contact details of the service provider are given below:

Contact: +91-79-68136819/809/862/867/823/872/842

E-Mail: Bhel.Support@abcProcure.com

Further contact details can be obtained by visiting the following webpage:

https://bhel.abcprocure.com/EPROC/contactus

IV. Documents Comprising the e-Tender

The tender shall be submitted online – only except tender fee & EMD (in physical form) as mentioned below:

i) Technical Tender (UN priced Tender)

Bidders shall furnish the following information along with technical tender (preferably in pdf format):

i). Tender Cost and Earnest Money Deposit (EMD) furnished in accordance with **NIT Clause 3.0 & 4.0.**

ii). All Technical details (eg. Eligibility Criteria requested, Technical Conditions of Contract) should be attached in e-tendering module **(As detailed in Clause 6.0 below),** failing which the tender stands invalid & may be REJECTED.

ii) Price Bid:

a. Prices are to be quoted as per the Price Bid Form available on e-tender portal.
b. The price should be quoted for the accounting unit indicated in the e-tender document.

c. The item description, Quantity and Unit of measurement, as mentioned in Price bid uploaded by BHEL and subsequent revisions issued by BHEL, shall be binding on the bidder.

Note:

i). It is the responsibility of tenderer to go through the Tender document to ensure furnishing all required documents in addition to above, if any. Any deviation would result in REJECTION of tender and would not be considered at a later stage at any cost by BHEL.

ii). A person signing (manually or digitally) the tender form or any documents forming part of the contract on behalf of another shall be deemed to warrantee that he has authority to bind such other persons and if, on enquiry, it appears that the persons so signing had no authority to do so, the purchaser may, without prejudice to other civil and criminal remedies, cancel the contract and hold the signatory liable for all cost and damages.

iii). A tender, which does not fulfil any of the above requirements and/or gives evasive information/reply against any such requirement, shall be liable to be ignored and rejected.

iv). In case offer is sent through hard copy/fax/telex/cable/electronically in place of e-tender, same shall not be considered.

V. DO NOT'S

Bidders are requested NOT to submit the hard copy of the Bid. In case offer is sent through hard copy/fax/telex/cable/electronically in place of e-tender, the same shall not be considered.

Vendors are also requested to go through bidder manual available on https://bhel.abcprocure.com

6.0 DOCUMENTS TO BE UPLOADED & MODALITY OF UPLOADING in E-PROCUREMENT PORTAL https://bhel.abcprocure.com SHALL BE AS DETAILED BELOW

Sl No	Description	Remarks
	Techno-Commercial Bid CONTAINING THE FOLLOWING:-	
i.	Covering letter / Offer forwarding letter of Tenderer.	Refer "Bidder Manual for BHEL Bidders" available

		at https://bhel.abcprocure.com
ii.	Duly filled-in `No Deviation Certificate' as per prescribed format to be placed after document under sl no (i) above. **Note:** 1. In case of any deviation, the same should be submitted separately for technical & commercial parts, indicating respective clauses of tender against which deviation is taken by bidder. The list of such deviation shall be attached along with document under sl no (i) above. It shall be specifically noted that deviation recorded elsewhere shall not be entertained. 2. BHEL reserves the right to accept / reject the deviations without assigning any reasons, and BHEL decision is final and binding. (i) In case of acceptance of the deviations, appropriate loading shall be done by BHEL (ii) In case of unacceptable deviations, BHEL reserves the right to reject the tender.	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
iii.	Supporting documents / annexure / schedules / drawing etc as required in line with Pre-Qualification criteria. (Technical & Financial) As detailed in Clause No. 25 of NIT, It shall be specifically noted that all documents as per above shall be indexed properly and credential certificates issued by clients shall distinctly bear the name of organization, contact phone no, FAX no, E-mail ID, etc.	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
iv.	All Amendments / Correspondences / Corrigenda / Clarifications / Changes / Errata etc pertinent to this NIT.	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
v.	Integrity Pact Agreement (Duly signed by the authorized signatory)	Refer "Bidder Manual for BHEL Bidders" available at

		https://bhel.abcprocure.com
vi.	Duly filled-in annexures, formats etc as required under this Tender Specification / NIT	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
vii.	Notice inviting Tender (NIT)	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
viii.	Volume – I A : Technical Conditions of Contract (TCC) consisting of Scope of work, Technical Specification, Drawings, Procedures, Bill of Quantities, Terms of payment, etc	
ix.	Volume – I B : Special Conditions of Contract (SCC)	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
x.	Volume – I C : General Conditions of Contract (GCC)	
xi.	Volume – I D : Forms & Procedures	
xii.	Volume – II (UNPRICED – without disclosing rates/price, but mentioning only 'QUOTED' or 'UNQUOTED' against each item	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
xiii.	Any other details preferred by bidder with proper indexing.	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com
Caution to Bidders: - The duly signed & stamped copies of Volume – 1 Book I & Volume 1 Book II are to be attached as a part of your offer, under the form Techno-commercial Bid. Also for any further queries, please refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com		

	PRICE BID consisting of the following shall be attached as mentioned below	

i	**Price/ Total Amount corresponding to the total works as specified in "Part C: Bill of Quantities" available in "Volume II – PRICE BID (latest Revision) shall be quoted in the Price Bid Form available in e-Procurement portal.** **Bidders to note that total amount quoted by the bidder in Price Bid - "Bidding Forms" of eProcurement Portal shall be considered for evaluation of offer.**	Refer "Bidder Manual for BHEL Bidders" available at https://bhel.abcprocure.com

SPECIAL NOTE:

i. All documents / annexures submitted with the **offer shall be properly attached / entered / uploaded in the respective sections**. BHEL shall not be responsible for any missing documents.

ii. **Your offer & documents submitted along with offer shall be signed & stamped in each page by your authorized representative**.

7.0 Deviation with respect to tender clauses and additional clauses / suggestions / in Techno-commercial bid / Price bid shall NOT be considered by BHEL. Bidders are requested to positively comply with the same.

8.0 BHEL reserves the right to accept or reject any or all Offers without assigning any reasons thereof. BHEL also reserves the right to cancel the Tender wholly or partly without assigning any reason thereof. Also BHEL shall not entertain any correspondence from bidders in this matter (except for the refund of EMD).

9.0 **ASSESSMENT OF CAPACITY OF BIDDERS:**

Bidder's capacity for executing the job under tender shall be assessed 'LOAD' wise and 'PERFORMANCE' wise as per the following:

I. LOAD: Load takes into consideration ALL the contracts of the Bidder under execution with BHEL Regions, irrespective of whether they are similar to the tendered scope or not. The cut off month for reckoning 'Load' shall be the 3rd month preceding the month corresponding to the 'latest date of bid submission', in the following manner –

(**Note**: For example, if latest bid submission is in Jan 2017, then the 'load' shall be calculated up to and inclusive of Oct 2016)

Total number of Packages in hand = Load (P)

Where 'P' is the sum of all unit wise identified packages (refer table-1) under execution with BHEL Regions as of the cut off month defined above, including packages yet to be commenced, excepting packages which are on Long HOLD.

II. PERFORMANCE: Here 'Monthly Performance' of the bidder for all the packages (under execution/ executed during the 'Period of Assessment' in all Power Sector Regions of BHEL) **SIMILAR** to the packages covered under the tendered scope, excepting packages not commenced shall be taken into consideration. The 'Period of Assessment' shall be 6 months preceding and including the cut off month. The cut off month for reckoning 'Period of Assessment' shall be the 3rd month preceding the month corresponding to 'latest date of bid submission', in the following manner:

(Note: For example, if 'latest date of bid submission' is in Jan 2017, then the 'performance' shall be assessed for a 'six months' period up to and inclusive of Oct 2016 (i.e. from May 2016 to Oct 2016), for all the unit wise identified packages (refer Table I)

i). Calculation of Overall 'Performance Rating' for 'Similar Package / Packages' for the tendered scope under execution at Power Sector Regions for the 'Period of Assessment

This shall be obtained by summing up the 'Monthly Performance Evaluation' scores obtained by the bidder in all Regions for all the similar Package / packages', divided by the total number of Package months for which evaluation should have been done, as per procedure below:

a) P_1, P_2, P_3, P_4, P_5 , …. P_N etc. be the packages (under execution / executed during the 'Period of Assessment' in all Regions of BHEL) **SIMILAR** to the packages covered under the tendered scope, excepting packages not commenced. Total number of similar packages for all Regions = $\mathbf{P_T}$ (i.e. $P_T = P_1 + P_2 + P_3 + P_4 + \ldots P_N$)

b) Number of Months 'T_1' for which 'Monthly Performance Evaluation' as per relevant formats, should have been done in the 'Period of Assessment' for the corresponding similar package P_1. Similarly T_2 for package P_2, T_3 for package P_3, etc. for the tendered scope. Now calculate cumulative total months '$\mathbf{T_T}$' for total similar Packages '$\mathbf{P_T}$' for all Regions (i.e. $\mathbf{T_T} = T_1 + T_2 + T_3 + T_4 + .. T_N$)

c) Sum 'S_1 'of 'Monthly Performance Evaluation' Scores ($S_{1\text{-}1}$, $S_{1\text{-}2}$, $S_{1\text{-}3}$, $S_{1\text{-}4}$, $S_{1\text{-}5}$…. $S_{1\text{-}T1}$) for similar package P1, for the 'period of

assessment' 'T_1' (i.e. S_1**=** S_{1-1}+ S_{1-2}+ S_{1-3}+ S_{1-4}+ S_{1-5}+…S_{1-T1}). Similarly, S_2 for package P_2 for period T_2, S_3 for package P_3 for period T_3 etc. for the tendered scope for all Regions. Now calculate cumulative sum 'S_T' of 'Monthly Performance Evaluation' Scores for total similar Packages '$\mathbf{P_T}$' for all Regions (i.e. 'S_T' = S_1+ S_2+ S_3+ S_4+ S_5+…. S_N.)

d) **Overall Performance Rating 'R_{BHEL}' for the Similar Package / Packages** (under execution / executed during the 'Period of Assessment') in all the Power Sector Regions of BHEL

$$= \frac{\text{Aggregate of Performance scores for all similar packages in all the Regions}}{\text{Aggregate of months for each of the similar packages for which performance should have been evaluated in all the Regions.}}$$

$$= \frac{S_T}{T_T}$$

e) **Bidders to note that the risk of non-evaluation or non-availability of the 'Monthly Performance Evaluation' reports as per relevant formats is to be borne by the Bidder.**

f) **Table showing methodology for calculating 'a', 'b' and 'c' above**

Sl no	Item Description	Details for all Regions							Total
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
1	Similar Packages for all Regions → (under execution/ executed during period of assessment)	P_1	P_2	P_3	P_4	P_5	…	P_N	Total No of similar packages for all Regions = $\mathbf{P_T}$ ie Sum (Σ) of columns (iii) to (ix)

Sl no	Item Description	Details for all Regions							Total
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
2	Number of Months for which 'Monthly Performance Evaluation' as per relevant formats should have been done in the 'period of assessment for corresponding similar Package (as in row 1)	T_1	T_2	T_3	T_4	T_5	…	T_N	Sum (Σ) of columns (iii) to (ix) = $\mathbf{T_T}$
3	Monthly performance scores for the corresponding period (as in Row 2)	$S_{1\text{-}1}$, $S_{1\text{-}2}$, $S_{1\text{-}3}$, $S_{1\text{-}4}$, … $S_{1\text{-}T1}$	$S_{2\text{-}1}$, $S_{2\text{-}2}$, $S_{2\text{-}3}$, $S_{2\text{-}4}$, … $S_{2\text{-}T2}$	$S_{3\text{-}1}$, $S_{3\text{-}2}$, $S_{3\text{-}3}$, $S_{3\text{-}4}$, … $S_{3\text{-}T3}$	$S_{4\text{-}1}$, $S_{4\text{-}2}$, $S_{4\text{-}3}$, $S_{4\text{-}4}$, … $S_{4\text{-}T4}$	$S_{5\text{-}1}$, $S_{5\text{-}2}$, $S_{5\text{-}3}$, $S_{5\text{-}4}$, … $S_{5\text{-}T5}$	.. … … … …	$S_{N\text{-}1}$, $S_{N\text{-}2}$, $S_{N\text{-}3}$, $S_{N\text{-}4}$, … $S_{N\text{-}TN}$	---
4	Sum of Monthly Performance scores of the corresponding Package for the corresponding period (as in row-3)	S_1	S_2	S_3	S_4	S_5	…	S_N	Sum (Σ) of columns (iii) to (ix) = $\mathbf{S_T}$

ii.) <u>Calculation of Overall 'Performance Rating' (R_{BHEL}) in case at least 6 evaluation scores for 'similar Package / Packages' for the tendered scope ARE NOT AVAILABLE during the 'Period of Assessment'.</u>

This shall be obtained by summing up the 'Monthly Performance Evaluation' scores obtained by the bidder in all Regions for ALL the packages, divided by the total number of Package months for which evaluation should have been done. '$\mathbf{R_{BHEL}}$' shall be calculated subject to availability of 'performance scores' for at least 6 'package months' in the order of precedence below:

a) 'Period of Assessment' i.e. six months preceding and including the cut-off month
b) 12 months preceding and including the cut-off month
c) 24 months preceding and including the cut-off month

In case, '$\mathbf{R_{BHEL}}$' cannot be calculated as above, then Bidder shall be treated as 'NEW VENDOR'. Further eligibility and qualification of this

bidder shall be as per definition of 'NEW VENDOR' described in 'Explanatory Notes'.

iii) Factor "L" assigned based on Overall Performance Rating (R_{BHEL}) at Power Sector Regions,:

Sl. No.	Overall Performance Rating (R_{BHEL})	Corresponding value of 'L'
1	=60	NA
2	> 60 and ≤ 65	0.4
3	> 65 and ≤ 70	0.35
4	> 70 and ≤ 75	0.25
5	> 75 and < 80	0.2
6	≥ 80	NA

III. Assessment of Capacity of Bidder':

'Assessment of Capacity of Bidder' is based on the Maximum number of packages for which a vendor is eligible, considering the performance scores of similar packages, as below:

Max number of packages P_{Max}= (R_{BHEL}- 60) divided by corresponding value of 'L' i.e. (R_{BHEL}- 60)/L

Note:

i. In case the value of P_{Max} results in a fraction, the value of PMax is to be rounded off to next whole number
ii. For R_{BHEL} = 60, P_{Max} = '1'
iii. For R_{BHEL} ≥ 80, there will be no upper limit on P_{Max}

The Bidder shall be considered 'Qualified' as per 'Assessment of Capacity of Bidder' for the subject Tender if P ≤ P_{Max}

(Where P is calculated as per clause 'I' above.)

IV. Explanatory note:

i). Similar package means Boiler or ESP or Piping or Turbine or Civil or Structure or Electrical or C&I etc. at the individual level irrespective of rating of Plant and irrespective of whether the subject tender is a single package or as part of combined / composite packages. Normally Boiler, ESP, Piping, Turbine, Electrical, C&I, Civil, Structure etc. is considered individual level of package. For example, in case the tendered scope is a Boiler Vertical Package comprising of Boiler, ESP and Power Cycle Piping (i.e. the 'identified packages as per Table-1 below), the 'PERFORMANCE' part against sl.no. II above, needs to

be evaluated considering all the identified packages (i.e. Boiler, ESP and Power Cycle Piping) and finally the Bidder's capacity to execute the tendered scope is assessed in line with III above.

ii). Identified Packages (Unit wise)

Table-1

Civil	Electrical & CI	Mechanical
i). Enabling works ii). Pile and Pile Caps iii). Civil Works including foundations iv). Structural Steel Fabrication & Erection v). Chimney vi). Cooling Tower vii). Others (Civil)	i). Electrical ii). CI iii). Others (Elec & CI)	i). Boiler & Aux (All types including CW Piping if applicable) ii). Power Cycle Piping / Critical Piping iii). ESP iv). LP Piping v). Steam Turbine Generator set & Aux vi). Gas Turbine Generator set & Aux vii). Hydro Turbine Generator set & Aux viii). Turbo Blower (including Steam Turbine) ix). Material Management x). Others (Mechanical)

iii). Bidders who have not been evaluated for at least six package months in the last 24 months preceding and including the Cut-off month in the online BHEL system for contractor performance evaluation in BHEL PS Regions, shall be considered "NEW VENDOR".

A 'NEW VENDOR' shall be considered qualified subject to satisfying all other tender conditions

A 'NEW VENDOR' if awarded a job (of package / packages identified under this clause) shall be tagged as "FIRST TIMER" on the date of first LOI from BHEL.

The "FIRST TIMER" tag shall remain till completion of all the contracts against which vendor has been tagged as First Timer or availability of 6 evaluation scores within last 24 months preceding and including the Cut-off month in the online BHEL system for contractor performance evaluation in BHEL PS Regions.

A Bidder shall not be eligible for the next job as long as the Bidder is tagged as "FIRST TIMER" excepting for the Tenders which have been opened on or before the date of the bidder being tagged as 'FIRST TIMER'.

After removal of 'FIRST TIMER' tag, the Bidder shall be considered 'QUALIFIED' for the future tenders subject to satisfying all other tender conditions including 'Assessment of Capacity of Bidders'.

iv). Consequent upon applying the criteria of 'Assessment of Capacity of Bidders' detailed above on all the bidders qualified against Technical and Financial Qualification criteria, if the number of qualified bidders reduces to less than four, then for further processing of the Tender, BHEL at its discretion reserves the right to also consider the bidders who are "not qualified" as per criteria of 'Assessment of Capacity of Bidders' and for this, procedure described in following three options shall be followed:

a) All the bidders having Overall Performance Rating ('R_{BHEL}') ≥60 shall be considered qualified against criteria of 'Assessment of Capacity of Bidders'.

b) If even after using option "a", the number of qualified bidders remains less than four, then in addition to bidders considered as per option "a", "First timer" bidders having average of available performance scores ≥60 upto and including the Cut Off month shall also be considered qualified against criteria of 'Assessment of Capacity of Bidders'.

c) If even after using option "a" and "b", the number of qualified bidders remains less than four, then in addition to bidders considered as per option "a" and "b", "First timer" bidders for whom no performance score is available in the system upto and including the Cut Off month, shall also be considered qualified against criteria of 'Assessment of Capacity of Bidders'.

Note:- In case, the number of bidders qualified against Technical and Financial Qualification criteria itself is less than four, then all bidders (a)- having Overall Performance Rating ('R_{BHEL}') ≥60, (b)- First timer" bidders having average of available performance scores ≥60 upto and including the Cut Off month, (c)- "First timer" bidders for whom no performance score is available in the system upto and including the Cut Off month, shall be considered qualified against criteria of 'Assessment of Capacity of Bidders' for further processing of tender.

v). 'Under execution' shall mean works in progress as per the following:

a. Up to execution of 90% of anticipated Contract Value in case of Civil, MM, Structural and Turbo Blower Packages

b. Up to Steam Blowing in case of Boiler/ESP/Piping Packages

c. Up to Synchronization in all Balance Packages

Note: BHEL at its discretion can extend (or reduce in exceptional cases in line with Contract conditions) the period defined against (a), (b) and (c) above, depending upon the balance scope of work to be completed.

vi). Contractor shall provide the latest contact details i.e. mail-ID and Correspondence Address to SCT Department, so that same can be entered in the Contractor Performance Evaluation System, and in case of any change/discrepancy same shall be informed immediately. Login Details for viewing scores in Contractor Performance Evaluation System shall be provided to the Contractor by SCT Department.

vii). Performance Evaluation for Activity Month shall be completed in Evaluation Month (i.e. month next to Activity Month) or in rare cases in Post Evaluation Month (i.e. month next to Evaluation Month) after approval from Competent Authority. In case scores are not acceptable, Contractor can submit Review Request to GM Site / GM Project latest by 25th of Evaluation Month or 3 days after approval of score, whichever is later. However, acceptance / rejection of 'Review Request' solely depends on the discretion of GM Site / GM Project. After acceptance of Review Request, evaluation score shall be reviewed at site and the score after completion of review process shall be acceptable and binding on the contractor.

viii. Project on Hold due to reasons not attributable to bidder -

a. **Short hold:** Evaluation shall not be applicable for this period; however, loading will be considered.

b. **Long hold:** Short hold for continuous six months and beyond or hold on account of Force Majeure shall be considered as Long Hold. Evaluation as well as Loading shall not be considered for this period.

10.0 Performance evaluation in Clause 9 above is applicable to Prime bidder and consortium partner (or Technical tie up partner) for their respective scope of work.

11.0 Since the job shall be executed at site**,** bidders must visit site/ work area and study the job content, facilities available, availability of materials, prevailing site conditions including law & order situation, applicable wage structure, wage rules, etc before quoting for this tender. They may also consult this office before submitting their offers, for any clarifications regarding scope of work, facilities available at sites or on terms and conditions.

12.0 For any clarification on the tender document, the bidder may seek the same in clarification provision available in procurement portal https://bhel.abcprocure.com or writing or through e-mail, as per specified format, within the scheduled date for seeking clarification, from the office of the undersigned. BHEL shall not be responsible for receipt of queries after due date of seeking clarification due to postal delay or any other delays. Any clarification / query received after last date for seeking clarification may not be normally entertained by BHEL and no time extension will be given.

13.0 BHEL may decide holding pre-bid discussion [PBD] with all intending bidders as per date indicated in the NIT. The bidder shall ensure participation for the same at the appointed time, date and place as may be decided by BHEL. Bidders shall plan their visit accordingly. The outcome of pre-bid discussion (PBD) shall also form part of tender.

14.0 In the event of any conflict between requirement of any clause of this specification / documents / drawings / data sheets etc or requirements of different codes / standards specified, the same to be brought to the knowledge of BHEL in writing for clarification before due date of seeking clarification (whichever is applicable), otherwise, interpretation by BHEL shall prevail. Any typing error/missing pages / other clerical errors in the tender documents, noticed must be pointed out before pre-bid meeting / submission of offer, else BHEL's interpretation shall prevail.

15.0 Unless specifically mentioned otherwise, bidder's quoted price shall deem to be in compliance with tender including PBD.

16.0 Bidders shall submit Integrity Pact Agreement, (Duly signed by authorized signatory who signs in the offer), along with techno-commercial bid. This pact shall be considered as a preliminary qualification for further participation**. The Integrity pact is to be submitted by Prime Bidder & Consortium / Technical Tie up partner jointly in case Consortium bidding is permitted, otherwise by the sole bidder. The names and other details of Independent External Monitor (IEM) for the subject tender is as given at point (1) above.**

17.0 The Bidder has to satisfy the Pre-Qualifying Requirements stipulated for this Tender in order to be qualified. The Price Bids of only those bidders will be opened who will be qualified for the subject job on the basis of satisfying the pre-qualification criteria specified in this NIT as per Annexure-1(as applicable)

past performance etc. and date of opening of price bids shall be intimated to only such bidders. BHEL reserves the right NOT to consider offers of parties under HOLD.

18.0 In case BHEL decides on a 'Public Opening', the date & time of opening of the sealed PRICE BID shall be intimated to the qualified bidders and in such a case, bidder may depute one authorized representative to witness the price bid opening. BHEL reserves the right to open 'in-camera' the 'PRICE BID' of any or all Unsuccessful / Disqualified bidders under intimation to the respective bidders.

19.0 Validity of the offer shall be for **six months** from the latest due date of offer submission (including extension, if any) unless specified otherwise.

20.0 BHEL shall be resorting to Reverse Auction (RA) (Revised Guidelines for Reverse Auction 2020 as available on www.bhel.com) for this tender. RA shall be conducted among all the techno-commercially qualified bidders.

Price bids of all techno-commercially qualified bidders shall be opened and same shall be considered as initial bids of bidders in RA. In case any bidder(s) do(es) not participate in online Reverse Auction, their sealed envelope price bid along with applicable loading, if any, shall be considered for ranking.

21.0 On submission of offer, further consideration will be subject to compliance to tender & qualifying requirement and customer's acceptance, as applicable.

22.0 In case the bidder is an "Indian Agent of Foreign Principals", 'Agency agreement has to be submitted along with Bid, detailing the role of the agent along with the terms of payment for agency commission in INR, along with supporting documents.

23.0 Consortium bidding (or technical tie up) shall be allowed only if specified in Pre-Qualifying Requirement (PQR) criteria, and in such a case, the following shall be complied with:

23.1 Prime bidder and consortium partner or partners are required to enter into a consortium agreement with a validity period of six months initially. In case the consortium is awarded in the contract, then the consortium agreement between the prime bidder and consortium partner or partners shall be extended till contractual completion period including extension periods, if any applicable.

23.2 'Stand alone bidder' cannot become a **'Prime bidder' or a 'consortium partner' or 'technical tie-up bidder' in a consortium (or technical tie up bidding)**. Prime bidder shall neither be a consortium partner to other prime bidder nor take any other consortium partners. However, consortium partner may enter into consortium agreement with other prime bidders. In case of noncompliance, consortium bids of such Prime bidders will be rejected.

23.3 Prime Bidder and Consortium partners shall be approved by Customer for being considered for the tender.

23.4 Number of partners including prime Bidder shall be NOT more than 3 (three).

23.5 Prime Bidder alone shall necessarily comply with "B1 Technical Criteria" mentioned in Pre-Qualification Requirements.

23.6 Prime Bidder and Consortium Partner shall together comply with the 'Pre-Qualification Requirements' specified for the respective category of technical requirement as per "B2 technical criteria".

23.7 Prime Bidder shall comply with all other Pre Qualifying criteria for the Tender unless otherwise specified.

23.8 Prime Bidder shall be the Bidder who qualifies against the conditions specified under clause B.1 & B2.2 of the Pre-Qualification Requirements.

23.9 Prime Bidder shall be responsible for the overall execution of the Contract.

23.10 Performance shall be evaluated for Prime Bidder and the Consortium partner for their respective scope of work.

23.11 In case Prime Bidder withdraws or insolvency/ liquidation/ winding up proceedings have been initiated/ admitted against the prime bidder. BHEL reserves right to cancel, terminate or short close the contract or take any other action to safeguard BHEL's interest in the project/ contract. This action will be without prejudice to any other action that BHEL can take under law and the contract to safeguard interests of BHEL.

23.12 After successful execution of one work with a consortium partner under direct orders of BHEL, the Prime Bidder shall be eligible for becoming a 'standalone' bidder for works similar to that for which consortium partner was engaged, for subsequent tenders.

23.13 The Consortium partner shall submit SD equivalent to 1% of the total contract value in addition to the SD to be submitted by the Prime Bidder for the total contract value. In case consortium partner backs out, their SD shall be encashed by BHEL. In such a case other consortium partner or partners meeting the PQR have to be engaged by the Prime bidder, and if not, the respective work will be withdrawn and executed in risk and cost basis of the prime bidder. The new consortium partner or partners shall submit fresh SDs as applicable.

24.0 The bidders shall not enter into any undisclosed M.O.U. or any understanding amongst themselves with respect to tender.

25.0 The bidder shall submit documents in support of possession of 'Qualifying Requirements' duly self-certified and stamped by the authorized signatory,

indexed and properly linked in the format for PQR. In case BHEL requires any other documents / proofs, these shall be submitted immediately.

26.0 The bidder may have to produce original document for verification if so decided by BHEL.

27.0 The offers of the bidders who are under suspension as also the offer of the bidders, who engage the services of the banned firms, shall be rejected. The list of banned firms is available on BHEL web site "www.bhel.com → tender notification".

28.0 It may be noted that guidelines / rules in respect of 'Suspension of Business dealings' available on BHEL web site "www.bhel.com → Supplier Registration", 'Vendor evaluation format', Quality, Safety & HSE guidelines', etc may undergo change from time to time and the latest one shall be followed.

29.0 The Bidder along with its associate/ collaborators/ sub-contractors/ sub-vendors/ consultants/ service providers shall strictly adhere to BHEL Fraud Prevention Policy displayed on BHEL website **http://www.bhel.com** and shall immediately bring to the notice of BHEL Management about any fraud or suspected fraud as soon as it comes to their notice.

30.0 Bid should be free from correction, overwriting, using corrective fluid, etc. Any interlineation, cutting, erasure or overwriting shall be valid only if they are attested under full signature(s) of person(s) signing the bid else bid shall be liable for rejection. All overwriting/cutting, etc., will be numbered by bid opening officials and announced during bid opening.

31.0 Integrity commitment, performance of the contract and punitive action thereof:

31.1 Commitment by BHEL:

BHEL commits to take all measures necessary to prevent corruption in connection with the tender process and execution of the contract. BHEL will during the tender process treat all Bidder(s) in a transparent and fair manner, and with equity.

31.2 Commitment by Bidder / Supplier / Contractor:

31.2.1 The bidder / supplier / contractor commit to take all measures to prevent corruption and will not directly or indirectly influence any decision or benefit which he is not legally entitled to nor will act or omit in any manner which tantamount to an offence punishable under any provision of the Indian Penal Code, 1915 or any other law in force in India.

31.2.2 The bidder / supplier / contractor will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with

the award of the contract and shall adhere to relevant guidelines issued from time to time by Govt. of India/ BHEL.

31.2.3 The bidder / supplier / contractor will perform / execute the contract as per the contract terms & conditions and will not default without any reasonable cause, which causes loss of business / money / reputation, to BHEL.

31.3 If any bidder / supplier / contractor during pre-tendering / tendering / post tendering / award / execution / post-execution stage indulges in mal-practices, cheating, bribery, fraud or and other misconduct or formation of cartel so as to influence the bidding process or influence the price or acts or omits in any manner which tantamount to an offence punishable under any provision of the Indian Penal Code, 1915 or any other law in force in India, then, action may be taken against such bidder / supplier / contractor as per extant guidelines of the company available on www.bhel.com and / or under applicable legal provisions.

32.0 For this procurement, the local content to categorize a supplier as a Class I local supplier/ Class II local supplier/ Non- Local supplier and purchase preference to Class I local supplier, is as defined in Public Procurement (Preference to Make in India), Order 2017 dated 04.06.2020 issued by DPIT. In case of subsequent Orders issued by the Nodal Ministry, changing the definition of local content for the items of the NIT, the same shall be applicable even if issued after issue of this NIT, but before opening of Part-II bids against this NIT.

33.0 In the course of evaluation, if more than one bidder happens to occupy L-1 status, effective L-1 will be decided by soliciting discounts from the respective L-1 bidders.

In case more than one bidder happens to occupy the L-1 status even after soliciting discounts, the L-1 bidder shall be decided by a toss/ draw of lots, in the presence of the respective L-1 bidder(s) or their representative(s).

Ranking will be done accordingly. BHEL's decision in such situations shall be final and binding.

34.0 Order of Precedence:

In the event of any ambiguity or conflict between the Tender Documents, the order of precedence shall be in the order below:

a. Amendments / Clarifications / Corrigenda / Errata etc. issued in respect of the tender documents by BHEL

b. Notice Inviting Tender (NIT)
c. Price Bid
d. Technical Conditions of Contract (TCC)—Volume-1A
e. Special Conditions of Contract (SCC) —Volume-1B
   Rev. 01 Dt. 01 Jun 2012; Amendment: 01 Dt. 1st October 2015
f. General Conditions of Contract (GCC) —Volume-1C
   Rev. 01 Dt. 01 Jun 2012; Amendment: 03 Dt. 1st October 2015
g. Forms and Procedures —Volume-1D
   Rev. 01 Dt. 01 Jun 2012; Amendment: 01 Dt. 1st October 2015

For and on behalf of BHARAT HEAVY ELECTRICALS LTD

General Manager / SCT, Purchase & Debtor

Enclosure

1. Annexure-1: Pre Qualifying criteria.
2. Annexure-2: Check List.
3. Annexure-3 Technical Pre qualifying criteria.
4. Annexure-4 Annexure to Pre-Qualifying Criteria.
5. Annexure-5 Tender Schedule.
6. Other documents as per this NIT.

ANNEXURE - 1
PRE QUALIFYING CRITERIA

JOB	Civil, structural & Architectural works of FLUE GAS DESULPHURISATION PLANTS (FGD) in existing 2 x 500 MW Tuticorin Thermal power station at Tuticorin, Tamilnadu, India for NLC TAMILNADU POWER LIMITED (NTPL).		
Tender No.	**BHEL: PSSR: SCT: 1915**		
Sl. No.	**PRE QUALIFICATION CRITERIA**	**Bidders claim in respect of fulfilling the PQR Criteria**	
		Name and Description of qualifying criteria	**Page no of supporting document. Bidder must fill up this column as per applicability**
A	**Submission of Integrity Pact duly signed (if applicable)** (**Note**: To be submitted by Prime Bidder & Consortium / Technical Tie up partner jointly in case Consortium bidding is permitted, otherwise by the sole bidder)	Applicable	
B	**Technical**		
	Refer Annexure 3	Applicable	To be filled in Annexure-4
C C-1	**FINANCIAL** **Turnover** Bidders must have achieved an average annual financial turnover (Audited) of Rs.29,89,00,000/- (Rupees Twenty-Nine Crores and Eighty-Nine Lakhs only) or more over last three Financial Years (FY) i.e., 2016-17, 2017-18 and 2018-19.	Applicable	To be filled in Annexure-4
C-2	**Net worth** (only in case of Companies) Net worth of the Bidder based on the latest Audited Accounts as furnished for 'C-1' above should be positive	Applicable	To be filled in Annexure-4
C-3	**Profit** Bidder must have earned profit in any one of the three Financial Years as applicable	Applicable	To be filled in Annexure-4

	in the last three Financial Years as furnished for 'C-1 above.		
C-4	Bidder must not be under Bankruptcy Code Proceedings (IBC) by NCLT or under Liquidation / BIFR, which will render him ineligible for participation in this tender, and shall submit undertaking to this effect.	Applicable	To be filled in Annexure-4
D	Assessment of Capacity of Bidder to execute the work as per Sl. No 9 of NIT (if applicable)	Applicable	By BHEL
E	**Approval of Customer (if applicable)** **Note:** Names of bidders (including consortium / Technical Tie up partners in case consortium bidding is permitted) who stand qualified after compliance of criteria A to D shall be forwarded to customer for their approval.	Applicable	
F	**Price Bid Opening** **Note:** Price Bids of only those bidders shall be opened who stand qualified after compliance of criteria A to E	Applicable	BY BHEL
G	**Consortium criteria (if applicable)**	Applicable	
	Explanatory Notes for the PQR (unless otherwise specified in the PQR): 1. Bidder to submit Audited Balance Sheet and Profit and Loss Account for the respective years as indicated against C-1 above along with all annexures. 2. In case audited financial statements have not been submitted for all the three years as indicated against C-1 above, then the applicable audited statements submitted by the bidders against the requisite three years, will be averaged for three years. 3. If Financial Statements are not required to be audited statutorily, then instead of audited financial statements, financial statements are required to be certified by Chartered Accountant. 4. C-2:-NETWORTH: Shall be calculated based on the latest Audited Accounts as furnished for C-1 above. Net worth =Paid up share capital + reserves 5. C-3:- PROFIT : shall be PBT earned during any one year of the three financial years as in C-1 above 6. Completion date for achievement of the technical criteria specified in the Common QR should be in the last 7 years ending on the 'latest date of Bid Submission' of Tender irrespective of date of the start of work.		

	7. Boiler means HRSG or WHRB or any other types of Steam Generator 8. Power Cycle piping means Main Steam, Hot Reheat, Cold Reheat, HP Bypass. 9. For the purpose of evaluation of the PQR, one MW shall be considered equivalent to 3.5TPH where ever rating of HRSG/BOILER is mentioned in MW. Similarly, where ever rating of Gas Turbine is mentioned in terms of Frame size, ISO rating in terms of MW shall be considered for evaluation. 10. In case the experience/PO/WO certificate enclosed by bidders do not have separate break up prices for the E&C portion of Electrical and CI Works, (i.e. the certificates enclosed are for composite order for supply and erection of Electrical & CI and other works if any), then value of Erection and Commissioning for the Electrical & CI portion shall be considered as 15% of the supply & erection of Electrical & CI.

Note:

(i) BIDDER SHALL SUBMIT PRE-QUALIFICATION CRITERIA FORMAT (Refer Annexure-4), DULY FILLED-IN, SPECIFYING RESPECTIVE ANNEXURE NUMBER AGAINST EACH CRITERIA AND FURNISH RELEVANT DOCUMENT INCLUSIVE OF WORK ORDER AND WORK COMPLETION CERTIFICATE ETC. IN THE RESPECTIVE ANNEXURES IN THEIR OFFER.

(ii) Authenticity of Credentials submitted by the Bidder against 'Pre-Qualifying Criteria' shall be verified from the Issuing Authority, by BHEL. In case, any credential(s) is/are found to be unauthentic, offer of the bidder is liable to be rejected. BHEL reserves the Right to Initiate any further action as per the "Guidelines for Suspension of Business Dealings with Suppliers/Contractors" (Published in http://www.bhel.com/vender_registration/vender.php) and "Fraud Prevention Policy" (Published in http://www.bhel.com/home.php) as applicable.

ANNEXURE - 2

CHECK LIST

NOTE: - Tenderers are required to either fill in or submit separately the following details. No column should be left blank.

1	Name of the Tenderer			
	Address of the Tenderer			
2	Details about type of the Firm / Company			
3a	Details of Contact person for this Tender: Name : Mr. / Ms. Designation: Telephone No/ Mobile No: E-mail ID:			
3b	Details of alternate Contact person for this Tender: Name: Mr. / Ms. Designation: Telephone No/ Mobile No: E-mail ID:			
4	EMD DETAILS *(Remittance of EMD should be in line with Mode of Deposit as detailed in Vol 1A, Part-2, Chapter-1)* a. Cash portion of EMD – online payment/ DD/ Cheque (Minimum Rs 2 Lakhs) b. Balance portion of EMD (Over and above Rs. 2 Lakhs) (Applicable only for BG/FD)	a. Mode of Remittance: Ref No: Date : Amount: b. Mode of Remittance: Ref No : Date :		
5	Validity of Offer	To be valid for six months from due date		
			Applicability (By BHEL)	**Bidder Reply**
6	Whether the format for compliance with **PRE QUALIFICATION CRITERIA (ANNEXURE-I & ANNEXURE-IV)** is understood and filled with proper supporting documents referenced in the specified format		Applicable	Yes/ No
7	Submission of Copy of Balance sheet and Profit and Loss Account for the last three years (Refer "Explanatory Note for the PQR" in Annexure 1 of NIT)		Applicable	Yes/ No
8	Submission of Copy of PAN Card		Applicable	Yes/ No

9	Whether all pages of the Offer Documents are signed by the person authorized to sign this offer	Applicable	Yes/ No
10	Whether all pages of the Tender documents including annexures, appendices etc are read understood and signed	Applicable	Yes/ No
11	Submission of Integrity Pact	Applicable	Yes/ No
12	Submission of Declaration by Authorized Signatory	Applicable	Yes/ No
13	Submission of No Deviation Certificate	Applicable	Yes/ No
14	Submission of Declaration confirming knowledge about Site Conditions	Applicable	Yes/ No
15	Submission of Declaration for relation in BHEL	Applicable	Yes/ No
16	Submission of Non-Disclosure Certificate	Applicable	Yes/ No
17	Submission of Copy Bank Account Details for E-Payment	Applicable	Yes/ No
18	Submission of Capacity Evaluation of Bidder for current Tender	Applicable	Yes/ No
19	Submission of Tie Ups / Consortium Agreement as per format	Applicable	Yes/ No
20	Submission of Power of Attorney for Submission of Tender / Signing Contract Agreement	Applicable	Yes/ No
21	Submission of Analysis of Unit rates	Applicable	Yes/ No
22	Submission of Unquoted Price Bid	Applicable	Yes/ No
23	Tabular column showing Category- wise, month wise, man power deployment sub package wise planned for the execution of the scope of works.	Applicable	Yes/ No
24	Copy of Organization Chart	Applicable	Yes/ No
25	Copy of Registration / Incorporation certificate, Partnership Deed (Certified by Notary Public) as applicable for firm.	Applicable	Yes/ No
26	Undertaking as per Financial C 4 Criteria of Annexure 1 of NIT regarding Bankruptcy Code Proceedings (IBC)	Applicable	Yes/ No

NOTE:

1. STRIKE OFF 'YES' OR 'NO', AS APPLICABLE.
2. TENDER NOT ACCOMPANIED BY THE PRESCRIBED **ABOVE APPLICABLE DOCUMENTS** ARE LIABLE TO BE SUMMARILY REJECTED.
3. For Sl. No.11 to 21 above, the formats are available in "Volume ID of Volume I Book-II – Forms and Procedures" of this tender specification.

DATE:

AUTHORISED SIGNATORY
(With Name, Designation and Company seal)

Annexure-3

B Technical Pre-Qualification Criteria

B 1 Technical Qualification Criteria: Bidder should have executed Similar works for any one of the following in the last seven years from latest date of bid submission.

B.1.1 One (1) work of value not less than Rs. 79.70 Crores

(OR)

B.1.2 Two (2) works each of value not less than Rs. 49.82 Crores

(OR)

B.1.3 Three (3) works each of value not less than Rs. 39.86 Crores

Note for B.1.1 to B.1.3

- 'Similar works' shall be as per following:

  Piling or Civil or Structure or 'Civil and Structural works' or RCC Chimney or RCC Cooling Tower or RCC Silo or Mill Bunker or any combination of these shall be considered similar works.

1) Value of work is to be updated with indices for "All India Avg. Consumer Price index for industrial workers" and "Monthly Whole Sale Price Index for All Commodities" with base month as per last month of work execution and indexed up to three (3) months prior to the month of latest due date of bid submission as per following formula-

$$P = R + 0.425 \times R \times \frac{(X_N - X_0)}{X_0} + 0.425 \times R \times \frac{(Y_N - Y_0)}{Y_0}$$

Where

P = Updated value of work

R = Value of executed work

$\mathbf{X_N}$ = All India Avg. Consumer Price index for industrial workers for three months prior to the month of latest due date of bid submission (e.g. If latest bid submission date is 02-Mar-17, then bid submission month shall be reckoned as March'17 and index for Dec'2016 shall be considered).

X_0 = All India Avg. Consumer Price index for industrial workers for last month of work execution

Y_N = Monthly Whole Sale Price Index for All Commodities for three months prior to the month of latest due date of bid submission (e.g. If latest bid submission date is

02-Mar-17, then bid submission month shall be reckoned as March'17 and index for Dec'2016 shall be considered).

Y_0 = Monthly Whole Sale Price Index for All Commodities for last month of work execution

AND

B.2 The bidder should have executed the following in the last seven years from the latest date of bid submission.

B.2.1 Piling works

Executed 'RCC cast in-situ driven piles' OR 'RCC cast in-situ Bored piles' OR 'Pre-cast piles and its installation at site' OR any combination of these with quantity in each case

1) At least **19,130 RM** in cumulative of two running/ completed contracts within a common period of twelve consecutive months.

Or

2) At least **12,750 RM** within a period of twelve consecutive months in one running/completed contract.

AND

B.2.2 RCC Works,

Bidder shall comply with following requirements:

A.

a. Bidder shall have experience in carrying out civil engineering works for industrial building/ equipment foundations/ high-rise building (3 storeys or more) etc.,

b. Bidder should have executed not less than 10000 Cu. M of RCC work in a single agreement.

c. The work in note no. a) & b) should have been completed within past 7 years, as on the original scheduled date of tender opening.

(AND)

B.

Executed

1) At least **15,630 cum** of RCC quantities within a common period of twelve consecutive months in cumulative of two running/ completed contract.

OR

2) Executed at least **10,420 cum** of RCC quantities within a period of twelve consecutive months in one running/ completed contract.

AND

B.2.3 Structural works

Bidder shall comply with following requirements:

A.

a. Bidder shall have experience in carrying out structural engineering works for industrial building/ power plant structures/ high- rise buildings etc.

b. Any structural steel works of quantity not less than 2000MT in a single agreement.

c. The work in note a) & b) should have been completed within past 7 years, as on the original scheduled date of tender opening.

(AND)

B.

1) Executed the Structure work for

a) At least **1,600 MT** of Structure Fabrication work, completed within a common period of twelve consecutive months in cumulative of two running/completed contracts.

And

At least **1,600 MT** of Structure Erection work, completed within a common period of twelve consecutive months in cumulative of two running/completed contracts.

OR

b) At least **1,060 MT** of Structure Fabrication work, completed within a period of twelve consecutive months in one running/completed contract.

And

At least **1,060** MT of Structure Erection work, completed within a period of twelve consecutive months in one running/completed contract.

Or

c) Mill bunker for at least one unit of rating **≥ 190 MW**

OR

2) Executed Boiler for at least on unit of rating **≥ 190 MW**

Note-1: The term **"Executed"** in PQR B.1, B.2.1, B2.2 & B2.3 above means: the bidder should have achieved the criteria specified in the PQR even if the contract has not been completed or closed.

Note 2: Completion date for achievement of the technical criteria specified in this PQR should be in the last 7 (Seven) years ending on the 'latest date of bid submission' of Tender irrespective of date of start of work. This note is applicable for PQR B.1, B.2.1, B2.2 & B2.3.

Note 3: For evaluation of PQR, in case bidder alone does not meet the pre- qualifying technical criteria B1 above, bidder may utilize the experience of its parent/ subsidiary company along with its own experience, subject to following:

a. The parent shall have a controlling stake of ≥ 50% in the subsidiary company (as per format provided in Vol IA Part II).
b. The parent company/ subsidiary company of which experience is being utilized for bidding shall submit security deposit (SD) equivalent to 1% of the total contract value.
c. The parent/ subsidiary company and bidder shall provide an undertaking that they are jointly and severally responsible for successful performance of the contract (as per format provided in Vol IA Part II).
d. In case bidder is submitting bid as a consortium partner, option of utilizing experience of parent/ subsidiary company can be availed by prime bidder only.
e. Parent company/ subsidiary company of which experience is being used for bidding, cannot participate as a 'Standalone bidder' or as a 'Consortium bidder'.

Note 4: Bidders not satisfying the conditions above can have consortium for the area of work as mentioned below.

Definition:-

Standalone bidder: -The bidder who fulfils all the conditions stipulated above on their own without any consortium partner.

Prime bidder: The Prime Bidder shall be one, who qualifies against the conditions specified under Clause B.1 & B.2.2 on his own without any consortium Partners.

Consortium partner: - Consortium partner is the one who qualifies against one or more of the conditions specified under Clause B.2.1 & B.2.3.

Following shall be complied with in case of consortium:

A. The Prime Bidder and Consortium Partner(s) are required to enter in to a consortium agreement and certify to BHEL regarding existence and validity of their consortium agreement in line with validity period mentioned in NIT.

B. Prime Bidder and Consortium partners shall be approved by Customer for being considered for the tender (applicable if customer approval is required).
C. Number of partners including prime Bidder shall be NOT more than 3 (three).
D. Prime Bidder alone shall necessarily comply with “B1 Technical Criteria”.
E. Prime Bidder and Consortium Partner shall together comply with the ‘Pre-Qualification Requirements’ specified for the respective category of technical requirement as per “B2 technical criteria”.
F. Prime Bidder shall comply with all other Pre Qualifying criteria for the Tender unless otherwise specified.
G. All other conditions shall be read in conjunction with clause no 23.0 of NIT.
H. Prime Bidder shall be the Bidder who qualifies against the conditions specified under clause B.1 & B2.2.
I. Prime Bidder shall be responsible for the overall execution of the Contract.
J. Performance shall be evaluated for Prime Bidder and the Consortium partner for their respective scope of work.
K. In case the Consortium partner backs out, another consortium partner meeting the QRs, has to be engaged by Prime Bidder and if not, the respective work will be withdrawn and executed on risk and cost basis of the prime bidder.
L. In case Prime Bidder withdraws or insolvency/ liquidation/ winding up proceedings have been initiated/ admitted against the prime bidder. BHEL reserves right to cancel, terminate or short close the contract or take any other action to safeguard BHEL’s interest in the project/ contract. This action will be without prejudice to any other action that BHEL can take under law and the contract to safeguard interests of BHEL.
M. After successful execution of one work with a consortium partner under direct orders of BHEL, the Prime Bidder shall be eligible for becoming a ‘standalone’ bidder for works similar to that for which consortium partner was engaged, for subsequent tenders.
N. The Consortium partner shall submit SD equivalent to 1% of the total contract value in addition to the SD to be submitted by the Prime Bidder for the total contract value.

ANNEXURE - 4

Additional Format to be submitted by Bidders in an additional separate cover superscribed "Annexure to Pre-Qualifying Criteria".

Name of the Bidder: M/s……...

Sl. No.	PQR Ref	PQR (Reproduced from Annexure – 1)	Qualifying Experience	Work order Ref with page no in Offer for supporting documents	Completion certificate ref for the referred Work with page no in Offer for supporting documents	Details of work with Project, Unit, Quantity / rating & Period	Rem-arks
1	**Technical B:**	**B 1 Technical Qualification Criteria:** Bidder should have executed Similar works for any one of the following in the last seven years from latest date of bid submission. B.1.1 One (1) work of value not less than Rs. 79.70 Crores (OR) B.1.2 Two (2) works each of value not less than Rs. 49.82 Crores (OR) B.1.3 Three (3) works each of value not less than Rs 39.86 Crores					

		AND **2** The bidder should have executed the following in the last seven years from the latest date of bid submission. **B.2.1 Piling works** Executed 'RCC cast in-situ driven piles' OR 'RCC cast in-situ Bored piles' OR 'Pre-cast piles and its installation at site' OR any combination of these with quantity in each case 3) At least **19,130 RM** in cumulative of two running/ completed contracts within a common period of twelve consecutive months. Or 4) At least **12,750 RM** within a period of twelve consecutive months in one running/completed contract. **AND** **B.2.2 RCC Works,**					

		Bidder shall comply with following requirements: **A.** a. Bidder shall have experience in carrying out civil engineering works for industrial building/ equipment foundations/ high-rise building (3 storeys or more) etc., b. Bidder should have executed not less than 10000 Cu. M of RCC work in a single agreement. c. The work in note no. a) & b) should have been completed within past 7 years, as on the original scheduled date of tender opening. (AND) **B.** Executed 1) At least **15,630 cum** of RCC quantities within a common period of twelve consecutive months in cumulative of two running/ completed contract. OR					

		2) Executed at least **10,420 cum** of RCC quantities within a period of twelve consecutive months in one running/ completed contract. **AND** **B.2.3 <u>Structural works</u>** Bidder shall comply with following requirements: **A.** a. Bidder shall have experience in carrying out structural engineering works for industrial building/ power plant structures/ high- rise buildings etc. b. Any structural steel works of quantity not less than 2000MT in a single agreement. c. The work in note a) & b) should have been completed within past 7 years, as on the original scheduled date of tender opening. (AND)					

		B. 1) Executed the Structure work for a) At least **1,600 MT** of Structure Fabrication work, completed within a common period of twelve consecutive months in cumulative of two running/completed contracts. And At least **1,600 MT** of Structure Erection work, completed within a common period of twelve consecutive months in cumulative of two running/completed contracts. OR b) At least **1,060 MT** of Structure Fabrication work, completed within a period of twelve consecutive months in one running/completed contract. And At least **1,060 MT** of Structure Erection work, completed within a period of					

		twelve consecutive months in one running/completed contract. Or c) Mill bunker for at least one unit of rating **≥ 190 MW** OR 2) Executed Boiler for at least on unit of rating **≥ 190 MW** Notes and other details are as per Annexure -3.					
2	**Financial C1**	**TURNOVER** Bidders must have achieved an average annual financial turnover (Audited) of Rs.29,89,00,000/- (Rupees Twenty-Nine Crores and Eighty-Nine Lakhs only) or more over last three Financial Years (FY) i.e. 2016-17, 2017-18 and 2018-19.					
3	**Financial C2**	**NETWORTH** (only in case of Companies) Net worth of the Bidder based on the latest Audited Accounts as furnished for 'C-1' above should be positive					

4	**Financial C3**	**PROFIT** Bidder must have earned profit in any one of the three Financial Years as applicable in the last three Financial Years as furnished for 'C-1 above.					
5	**Financial C 4**	Bidder must not be under Bankruptcy Code Proceedings (IBC) by NCLT or under Liquidation / BIFR, which will render him ineligible for participation in this tender, and shall submit undertaking to this effect.					

Note: Indicate the page nos in the respective columns for the enclosed PQR supporting documents in the offer

ANNEXURE-5

Tender Schedule

Description	Schedule	Remarks
Technical Bid Opening	As mentioned in Notice Inviting Tender.	
Communication from BHEL for Clarifications, if any, required by BHEL	Within Three days from tender opening date	
Last date for Bidders to submit the clarifications / documents required	Within Six days from tender opening date	Bidders to note that their competent representative to be readily available in this week for offering clarifications / submitting the further documents, if any, required.
If Reverse Auction is applicable, then the tentative date for conducting Reverse Auction	Within Fifteen days from tender opening date	Exact date and time of Reverse Auction shall be informed to the bidders

Note:

1. Bidders to note that the above schedule should be adhered to and no further extension will be given. To adhere to the schedule indicated below, Bidders should ensure the adequacy of the documents submitted in their offer, with proper validation.

VOLUME – IA
Part I & II

TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED

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VOLUME - IA PART – I CHAPTER – I

1.1 PROJECT INFORMATION

1.1.1 BHEL is going to set up FLUE GAS DESULPHURISATION PLANTS (FGD) in existing 2 x 500 MW Tuticorin Thermal power station at Tuticorin, Tamilnadu, India for NLC TAMILNADU POWER LIMITED (NTPL). The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on BHEL/Owner. All relevant site data /information as may be necessary shall have to be obtained /collected by the Bidder.

A. PROJECT INFORMATION

1	Name of the Project	FLUE GAS DESULPHURISATION PLANTS (FGD) in existing 2 x 500 MW Tuticorin Thermal power station
2	Station Capacity	2X500 MW (Coal based)
3	Owner	NLC TAMILNADU POWER LIMITED (NTPL)
4	Site Location	At Tuticorin taluk in Tuticorin district in the southern part of Tamilnadu along the Bay of Munnar, India The site is accessed by National highway no. 7A adjacent to plant. Due south connecting Madurai. Tuticorin sea port is located adjacent to the plant. Nearest town Tuticorin is located 5.5 km away from the plant and nearest city Pallayamkottai is 60km away from the plant.
5	Latitude	*8° 45'*38.09 N
6	Longitude	79° 10'15.85 E
7	Nearest Town	5.5 Km Tuticorin
8	Nearest Railway Station	1.0 Km Port trust railway yard
9	Nearest Airstrip	16.5 Kms (Pudukottai)

10	Site Conditions	
	Ambient Temperature	
	Daily minimum (average)	20.8°C
	Daily maximum (average)	36.5°C
	Design Ambient Temperature	50°C
	Ambient temperature (performance)	27°C
	Relative Humidity for design / efficiency	35-82 %
	Annual rainfall, mm	437 mm
	Plant Elevation above MSL	1.46 m above MSL
	Mean Wind Speed	50 m/s
	Wind Pressure	As per the latest revision of IS 875/1987
	Seismic co-efficient	Zone-II as per IS- 1893 (Part-IV)

VOLUME-IA PART-I CHAPTER – II

1.2 SCOPE OF WORKS

1.2.1 The scope of works covers Civil, structural & Architectural works of FLUE GAS DESULPHURISATION PLANTS (FGD) in existing 2 x 500 MW Tuticorin Thermal power station at Tuticorin, Tamilnadu, India for NLC TAMILNADU POWER LIMITED (NTPL) as mentioned below, including supply of all materials (excluding Cement, MS round for earthing & Reinforcement steel), labour, tools and plants. The scope of work is indicative but not limited to the given below.

1.2.2 Major structures covered under FGD system is as mentioned below:

1. Absorber
2. Duct foundations
3. FGD control room
4. Booster fan
5. Pipe rack
6. Lime stone handling system
7. Gypsum handling system
8. Ball mill building
9. Gypsum dewatering building
10. ACW/ DMCW pump house
11. DG set
12. Compressor house
13. Paving, roads & drains
14. Filling and micro grading as per site requirement
15. Pile and pile cap for all structures
16. Test piles installation and testing & report submission
17. Truck hopper
18. Any other structures as per scope of works required for system completion

1.2.3 Note: The above provided list is indicative only for the bidder's guideline. **Any other building / structure / foundation not mentioned above, but required for completion of the package in total, deemed to have been included in the bidder's scope under this contract.** Such work will be executed under this contract by bidder as per the direction of Engineer in charge. If any item of work not available in the rate schedule of this contract, the rate will be fixed in line with clause 2.15.7 of GCC.

1.2.4 Cement & Reinforcement steel for civil works & MS round for below ground earthing shall be provided by BHEL free of cost only for incorporation in the permanent work. Embedments /inserts required for the works in general shall be supplied by the bidder and payment shall be made as per corresponding item in BOQ. If BHEL provides

Structural Steel for embedments/inserts from scraps (if available), payment shall be made as per corresponding item in BOQ.

1.2.5 The works to be performed under this contract consist of providing all labour, supervision, material, scaffolding, construction equipment's, tools and plants, temporary works, supplies including POL (Petroleum, oil & lubricants), transportation and all incidental items not shown or specified but reasonably implied or necessary for the proper completion of work in all respects. Testing of all materials, concrete, earthwork other allied works, preparation of bar bending schedules on the basis of construction drawings, etc. are included in the rates of items of work.

1.2.6 The area of work shall be cleared of all vegetation, rubbish and other objectionable matter and materials removed shall be burnt or otherwise disposed of as directed by the Engineer-in-Charge. No separate payment for these operations shall be made. The cost of all these operations shall be deemed to have been included in the unit rates rendered for the different items under bill of quantities.

1.2.7 All the works areas shall be adequately flood lighted to the satisfaction of the Engineer-in-Charge when the work is in progress during the night shifts.

1.2.8 The unit rates shall include all material equipment, fixtures, labour construction plant, temporary works and everything whether of permanent or temporary nature necessary for the completion of job in all respects.

1.2.9 The unit rates for various items of B.O.Q shall include all the stipulations mentioned in technical specifications and nothing extra over B.O.Q rates shall be payable.

1.2.10 Drawings showing enough details for the construction as per the specification shall be furnished to the contractor in a phased manner.

1.2.11 The bidder should fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, local conditions, soil strata and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may have not been specifically brought out in the specifications.

1.2.12 Test piles work shall be started within 7 days of handing over of fronts and drawings.

1.2.13 Special arrangements to be made for tackling pandemic – Contractor shall make arrangements for stay of workers within their premises as far as possible and/ or adjacent building and for implementation of STANDARD OPERATING PROTOCOL (SOP) as per government order. The transportation of workers to work place shall be arranged by the contractor in dedicated transport by ensuring social distance. Any person violating the pandemic measures published vide government order time to time will be liable to be proceeded for legal action as per the government order. Following shall be observed in work place:

1.2.14 All work places shall have adequate arrangements for temperature screening and provide sanitizers at convenient places.

1.2.15 Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.

1.2.16 Use of AROGYA SETU will be encouraged for all employees both private and public.

1.2.17 Contractor shall sanitize their work place between shifts.

1.2.18 Large meetings to be prohibited. Spitting shall be strictly prohibited. Wearing of face cover is compulsory.

1.2.19 Government order (state/ center) being issued time to time for protective measures of pandemic shall be complied with strictly untill government (state/ center) declares end of pandemic.

1.2.20 Standard operating procedure for social distancing for workplace and offices

The following measures shall be implemented by contractor for their office and workplaces:

1. All areas in the work premises including the following shall be disinfected completely using user friendly disinfectant mediums:

a. Entrance gate of work place, office, if any
b. Cafeteria and canteens, if any
c. Meeting room, conference halls/ open area available/ verandah/ entrance gate of site, bunkers, porta cabins, buildings, etc.
d. Equipments and lifts
e. Washroom, toilet, sink, water points, etc
f. Wall/ all other surfaces.

2. For workers coming from outside, special transportation facility shall be arranged without any dependency on the public transport system. These vehicles should be allowed to work only with 30-40% passenger capacity.
3. All vehicles and machinery entering the premise should be disinfected by spray mandatorily.
4. Mandatory thermal scanning of everyone entering and exiting the work place to be done.
5. Medical insurance for the workers to be made mandatory.
6. Provision for hand wash & sanitizer preferably with touch free mechanism shall be made at all entry and exit points and common areas. Sufficient quantities of all the items should be available.

7. Work places shall have a gap of one hour between shifts and will stagger the lunch breaks of staff, to ensure social distancing.
8. Large gatherings or meetings of 10 or more people to discouraged. Seating at least 6 feet away from others on job sites and in gatherings, meetings and training sessions.
9. Not more than 2/4 persons (depending on size) will be allowed to travel in lifts or hoists.
10. Use of staircase for climbing should be encourages.
11. There should be strict ban of gutka, tobacco, etc. and spitting should be strictly prohibited.
12. There should be total ban on non-essential visitors at sites.
13. Hospitals/ clinics in the nearby areas, which are authorized to treat pandemic patients, should be identified and list should be available at work place all the times.

VOLUME IA PART – I CHAPTER – III

1.3 FACILITIES & CONSUMABLES IN THE SCOPE OF CONTRACTOR / BHEL

(SCOPE MATRIX)

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
	ESTABLISHMENT			
1.3.1.1.1	FOR CONSTRUCTION PURPOSE:			
A	Open space for office	Yes		Free of charges as provided by NTPL
B	Open space for storage	Yes		Free of charges as provided by NTPL
C	Construction of bidder's office, canteen and storage building, cement storage shed including supply of materials and other services		Yes	At bidder's own cost
D	Bidder's all office equipment's, office / store / canteen consumables		Yes	At bidder's own cost
E	Canteen facilities for the bidder's staff, supervisors and engineers etc.		Yes	At bidder's own cost
F	Firefighting equipment's like buckets, extinguishers etc.		Yes	At bidder's own cost
G	Fencing of storage area, office, canteen etc. of the bidder		Yes	At bidder's own cost
1.3.1.1.2	FOR LIVING PURPOSES OF THE SUCCESSFUL BIDDER'S PERSONNEL			

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
A	Open space for labour colony	Yes		As provided by NTPL on chargeable basis as per the prevailing rate of NTPL
B	Living accommodation		Yes	At bidder's own cost
1.3.1.2.0	**ELECTRICITY**			
1.3.1.2.1	Electricity For construction purposes	Yes		Free of charges as provided by NTPL
1.3.1.2.1.1	Single point source (In general) For detail, refer clause no. 1.3.4.1	Yes		
1.3.1.2.1.2	Further distribution for the work to be done which include supply of materials and execution		Yes	At bidder's own cost
1.3.1.2.2	Electricity for the office, stores, canteen, labour colony, etc of the bidder which include:		Yes	At bidder's own cost
1.3.1.2.2.1	Distribution from single point including supply of materials and service		Yes	At bidder's own cost
1.3.1.2.2.2	Supply, installation and connection of material of energy meter including operation and maintenance		Yes	At bidder's own cost
1.3.1.2.2.3	Duties and deposits including statutory clearances for the above		Yes	At bidder's own cost

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.2.2.4	Demobilization of the facilities after completion of works		Yes	At bidder's own cost
1.3.1.2.3	Electricity for living accommodation of the bidder's staff, engineers, supervisors etc on the above lines. (in case BHEL provides this facility, the scope should be given without ambiguity)		Yes	
1.3.1.3.0	**WATER SUPPLY**			
1.3.1.3.1	For construction purposes:	Yes		Free of charges as provided by NTPL
1.3.1.3.1.1	Making the water available at single point	Yes		As provided by NTPL
1.3.1.3.1.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At bidder's own cost
1.3.1.3.2	Water supply for bidder's office, stores, canteen, labour colony, etc.		Yes	At bidder's own cost
1.3.1.3.2.1	Making the water available at single point		Yes	At bidder's own cost
1.3.1.3.2.2	Further distribution as per the requirement of work including supply of materials and execution		Yes	At bidder's own cost
1.3.1.4.0	**LIGHTING**			

Sl.No	Description PART I	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.1.4.1	For construction work (supply of all the necessary materials) At office storage area At the preassembly area At the construction site / area		Yes	At bidder's own cost
1.3.1.4.2	For construction work (Execution of the lighting work / arrangements) At office storage area At the preassembly area At the construction site /area At the labour hutment		Yes	At bidder's own cost
1.3.1.5.0	**COMMUNICATION FACILITIES for site operations of the bidder**	**-**		
1.3.1.5.1	Telephone, Fax, internet, intranet, email etc		Yes	At bidder's own cost

Sl.No	Description PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
	CONSTRUCTION FACILITIES			
1.3.2.1.0	**Engineering works for construction**			
1.3.2.1.1	Providing the construction drawings for all the equipment covered under this scope	Yes		Progressively

Sl.No	Description PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.2.1.2	Detailing of drawings for construction		Yes	In consultation with BHEL
1.3.2.1.3	As-built drawings – wherever deviations observed and executed and also based on the decisions taken at site- example – routing of small-bore pipes	Yes	Yes	”
1.3.2.1.4	Shipping lists etc for reference and planning the activities	Yes	Yes	”
1.3.2.1.5	Preparation of site construction schedules and other input requirements		Yes	In consultation with BHEL, As per requirement of BHEL targets
1.3.2.1.6	Review of performance (Form-14) and revision of site construction schedules in order to achieve the end dates and other commitments		Yes	
1.3.2.1.7	Weekly construction schedules based on Sl No 1.3.2.1.5		Yes	
1.3.2.1.8	Daily construction / work plan based on Sl No 1.3. 2.1.7		Yes	For daily monitoring meeting at site
1.3.2.1.9	Periodic visit of the senior official of the bidder to site to review the progress so that works are completed as per schedule. It is suggested this review by the senior official of the bidder should be done once in every two months.		Yes	At bidder’s own cost
1.3.2.1.10	Preparation of preassembly bay, if any required		Yes	At bidder’s own cost

Sl.No	Description PART II	Scope to be taken care by		Remarks
		BHEL	Bidder	
1.3.2.1.11	Laying of racks for gantry crane if provided by BHEL or brought by the contractor / bidder himself			Applicable, if required at site

1.3.3 OPEN SPACE:

Open space, as provided by NTPL, will be provided to the bidder free of cost. Availability of land within plant boundary is very limited and the contractor has to plan and use the existing land considering the use of land by other Civil /mechanical/ electrical contractors and the storage of plant machineries and materials. The existing land shall be shared by all erection agencies. Land will be allocated with certain time frame and to the extent available/ considered necessary, and will be reviewed by BHEL depending upon the area availability. Area within plant premises for batching plant, office, storage area etc. for construction purpose shall be provided as per availability free of cost. The contractor will be responsible for handing back all lands, as handed over to him by BHEL.

Land for labour colony shall be provided by BHEL approximately nearer to site (outside plant boundary approximate distance 4km), on chargeable basis, as provided by NTPL. The contractor shall provide adequate water arrangement for drinking/washing/bathing with required toilets, drainage system, and electrification etc. in labour colony at his own cost. Suitable paved area, as & if directed by customer based on hygiene requirement of labour, to be provided in the labour colony at the cost of contractor.

1.3.4 **ELECTRICITY:**

1.3.4.1 In general, Construction power will be provided to the contractor free of cost at one single point within the plant area by BHEL as provided by NTPL. The contractor has to provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc. However, based on request of Contractor and requirement of project, BHEL Site in charge, at his discretion, may provide construction power at multiple point (as close to work area as possible), free of cost, for smooth execution of the work at site. If, BHEL provides electricity at more than one point (as close to work area as possible), it will be responsibility of the contractor to provide all the support necessary for enabling BHEL for extending such provision to contractor. The contractor has to Provide necessary meter for measuring the power consumption. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc.

1.3.4.2 Necessary "Capacitor Banks" to improve the Power factor to a minimum of 0.9 shall be provided by the contractor at his cost. Penalty if any levied by customer on this account will be recovered from contractor's bills.

1.3.4.3 Any duty, deposit involved in getting the Electricity shall be borne by the bidder. As regards contractor's office shed also all such expenditure shall be borne by the contractor.

1.3.4.4 Provision for distribution of electrical power from the given single central common point to the required places with proper distribution boards, approved cables and cable laying including supply of all materials like cables, switch boards, pipes etc., observing the safety rules laid down by electrical authority of the State / BHEL / their customer with appropriate statutory requirements shall be the responsibility of the tenderer / contractor.

1.3.4.5 BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply.

1.3.4.6 Contractor has to make their own arrangements for electricity requirement for labour colony at his own cost.

1.3.4.7 As there are bound to be interruptions in regular power supply, power cut/ load shedding in any construction sites, contractor should make his own arrangement for alternative source of power supply through deployment of adequate number of DG sets at their cost during the power breakdown / failure to get urgent and important work to go on without interruptions. No separate payment shall be made for this contingency.

1.3.5 WATER:

1.3.5.1 Water (Raw water) required for construction purposes will be provided at one single point within the plant area free of cost as provided by NTPL. The contractor has to construct sump, at their own cost, for storage of water in the area allocated to contractor (preferably in working area), of adequate size (BHEL approval, for the size, shall be taken prior to construction). Water shall be filled in the sump by NTPL tankers. The required pumps & accessories, pipes for drawing water from the given point and further distribution will be arranged by the contractor at their cost to go on without interruptions. Water from sump thus constructed, shall also be utilized among various contractors deployed by BHEL viz. mechanical, electrical, C&I, BOPs, etc.

1.3.5.2 In case of non-availability of water, the contractor shall make his own arrangements of **water suitable for construction purpose** to have uninterrupted work. No separate payment shall be made for any contingency arrangement made by contractor, due to delay / failure for providing water supply.

1.3.6 MATERIAL SUPPLY:

1.3.6.1 Supply / providing coarse aggregate, fine aggregate and all other materials required (except free supply materials i.e. cement, reinforcement steel, structural steel for structural works, structural steel for embedments/inserts from scraps (if available), foundation bolts & inserts/embedments supplied by manufacturing units of BHEL) for the work are in the scope of the contractor. BHEL shall provide Cement, reinforcement steel for civil works, structural steel for structural works and MS rounds for below ground earthing only for incorporation in the permanent work AS FREE SUPPLY. Embedments /inserts required for the works in general shall be supplied by the bidder and payment shall be made as per corresponding item in BOQ. If BHEL provides Structural Steel from scraps (if available), payment shall be made as per corresponding item in BOQ.

- Regarding supply of cement, the cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos minimum 100MT each per 30 Cum batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the number of cement silos shall be increased based on the site requirement. Making arrangement for unloading of cement into the silo and provision of necessary manpower support is in the scope of successful bidder within the quoted price. On advance request of the bidder, the cement shall be supplied in Bags for other than RCC works like masonry, flooring works etc. Advance request for supply of cement in bags shall be minimum two months. Provision of necessary storage arrangement for cement received in bags is in the scope of successful bidder within the quoted price.
- The steel material will be issued from BHEL stores, within the plant premises. Collection and transporting to the place of work is in contractor's scope without any extra cost to BHEL. The steel will be issued to the agency in standard lengths. In some instances, for 8mm, 10mm &12mm dia reinforcement steel will be supplied in coil form. No extra claims will be entertained against issue of Non-standard lengths of steel and de coiling of 8mm, 10mm &12mm dia. steel.

1.3.6.2 If any matching sections of steel are not available with BHEL, contractor may arrange these sections on certification of BHEL and the landing cost of sections to site will be reimbursed based on the prevailing rate at SAIL at the time of procurement at the nearest SAIL outlet with the freight charges against supporting document.

1.3.6.3 AGGREGATES: Aggregates shall be natural or crushed stone or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and

coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Owner/Consultant.

a) **Coarse Aggregate** Aggregate of sizes ranging between 4.75 mm and 150 mm shall be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS: 383 shall be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary. The grading of coarse aggregates by sieve analysis shall be as per IS: 383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Owner/Consultant may ask the Successful Bidder to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) **Fine Aggregate** Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 (latest revision) is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification shall be allowed to be used on works. Normally river sand shall be used as fine aggregates. In case of unavailability of normal specified river sand, the M sand or Crushed stone sand shall be used with the approval of the Owner /Consultant as per given criteria/specifications below.

i) As per Cl. 3.1.4 , of IS-383 (latest revision) the terminology of M-sand (manufactured sand) as defined as fine aggregate manufactured from other than natural sources, by processing materials using thermal or other processes such as separation, washing, crushing and scrubbing. Generally the M-sand or Crushed stone sand for the fine aggregate is produced by crushing the hard stone. The Crushed stone sand or M-sand conforming to the following shall only be used as fine aggregate in making concrete for sub and superstructures. The Crushed stone sand is to be manufactured using VSI crushers only and not with HSI crushers. In order to remove the fines, Crushed stone sand manufacturer should have mechanized washing facility unit. Crushed sand stone conforming to Grading zone –II as per IS-383 (latest rev.) shall only be used. The M-sand shall comply all the parameters and recommendations of IS: 383 (latest rev.)

ii) The M-sand shall be used only after the following tests are to be conducted by the bidders at the NABL accredited laboratories with proven track records of performing such type of tests by sending sealed samples of the materials –

a) Gradation Test.

b) Petrography.

c) Silt content.

d) Permeability test.

e) Adulteration test.

f) Design Mix Report.

g) Chemical Analysis Report

Using of M-Sand/Crushed Stone Sand based on the Test reports shall only be done after written approval of Engineer– In-Charge.

iii) The Crushed stone sand in general shall not be used for the following structures/facilities :-

a) Structures constructed using slip form technology.

b) All internal & external plastering works.

The structures where the slip form construction is envisaged the M-sand or Crushed stone sand may be used for casting its foundations only as they are not constructed using slip form Technology.

iv) Special care for design mix, cement content and necessary curing in the initial stage shall be taken care of while using M-sand / Crushed stone sand. However, if the results are not satisfactory, the use of crushed stone sand shall not be allowed for all RCC floor slab up to and including 150 mm thickness, which are directly exposed to the atmosphere immediately after casting. In such cases the ordinary river sand shall be used.

v) The M-sand/Crushed stone sand manufacturing locations shall be inspected by the Owner before giving approval for supply. The bidder shall ensure that the manufacturing process is done using only VSI crushers & shall have mechanized water washing unit for removal of fines in the Crushed stone sand manufactured. Aggregates smaller than 4.75 mm and within the grading limits and other requirements set in IS-383 (latest rev.) as termed as fine aggregate. Only fine aggregate from approved sources and conforming to IS: 383 (latest rev.) shall be used for execution. The bidder shall have well developed site laboratory and quality control team to take extra care while manufacturing and casting concrete using M-sand/ Crushed stone sand. Normally, any particular structure shall be constructed by using any one type of sand (fine aggregate) only as per the direction / approval

of engineer-in-charge. In general, it is not permitted to use different types of sand in any particular structure.

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Owner/Consultant.

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt or other deleterious materials. Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials. However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

1.3.6.4 CONSUMABLE

a. All consumables, like gas, electrodes, chemicals, lubricants etc. required for the scope of work, shall be arranged by the contractor at his own cost unless otherwise specifically mentioned in the contract. Prior approval from Engineer In-Charge shall be obtained for all the consumable to be used in permanent work.

b. In the event of failure of contractor to bring necessary and sufficient consumables, BHEL may arrange for the same at the risk and cost of the contractor. The entire cost towards this along-with overhead shall be paid by the contractor or deducted from the contractor's bills.

c. All welding electrodes shall be of Low Hydrogen type conforming to IS: 814 (Latest Revision) and shall be EB5426H3JX type. All electrodes, flux, wire etc. shall be of ADOR Welding Ltd., ESAB India Ltd., D & H Secheron Electrodes Pvt. Ltd. Or any other equivalent manufacturer accepted by Owner.

d. Alternatively, flux coated arc welding (FCAW) conforming to AWSE70T-5 which is a modified procedure of MIG/CO2 (solid wire) can be used. If submerged arc welding is used, the bare wire electrodes shall be as follows :

e. Filler wire : AWS-A-5.17-EH14

f. Flux : agglomerated type of classification AWS-A-5.17-F7A2EH14

g. Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE – I		
Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30

1.3.7 **LIGHTING FACILITY:**

Adequate lighting facilities such as flood lamps, hand lamps and area lighting shall be arranged by the contractor at the site of construction, and contractor's material storage area etc. at his own cost.

1.3.8 **CONTRACTOR'S OBLIGATION ON COMPLETION**:

On completion of work, all the temporary buildings, structures, pipe lines, cables etc. shall be dismantled and leveled and debris shall be removed as per instructions of BHEL by the contractor at his own cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

1.3.9 Blasting

Hard rock requiring blasting for excavation has to be carried out by chiselling, wedging or any other agreed method since blasting is prohibited within the plant premises. In case of any dispute regarding classification, the decision of the Engineer shall be final.

1.3.10 DEWATERING

Contractor shall ensure at all times that his work area & approach/ access roads are free from accumulation of water, so that the materials are safe and the erection/ progress schedule are not affected. No separate claim in this regard shall be admitted by BHEL. No separate payments for dewatering of subsoil, surface water or catchments water, if required, at any time during execution of the work including monsoon period shall be considered by BHEL. Dewatering required for control of sub-soil water for construction of various foundations for the package shall be paid under relevant item(s) available in the price schedule. Situation of flood shall be dealt separately and situation of flood shall be accounted upon certification of Engineer In-Charge or as per announcement of local administrative body.

Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of owner to the nearby sump/drain i.e. Korappallum back water channel located at western side of plant boundary. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

1.3.11 BID DRAWINGS

Bid drawings enclosed for information and this may get revised during execution.

VOLUME-IA PART-I CHAPTER – IV

1.4 T&Ps TO BE DEPLOYED BY CONTRACTOR

1.4.1 All the tools and plants required for satisfactory completion of the work have to be arranged by the contractor.

1.4.2 The contractor is required to arrange the following tentative Major T&Ps and other T&Ps for the satisfactory completion of the work

A. Structural works		
Sr No	**Major T&Ps**	**Mobilizing time from the date of start of work**
A1	1 Nos. 150 T capacity crawler crane for erection.	As per BHEL requirement at site.
A2	1 Nos. 100 T/ 75 T capacity crawler crane for erection.	As per BHEL requirement at site.
A3	1 Nos. 75 T capacity crawler crane for Fabrication	As per BHEL requirement at site.
A4	1 Nos. 45 T capacity Tyre mounted crane	As per BHEL requirement at site.
Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
A5	2 nos. hydra (10/ 12 T cap)	1 no. – Within 90 days. Balance progressively as per site requirement
A6	1 Nos. Radial drill machine	As per BHEL requirement at site.
A7	1 no. magnetic base drill machine	As per BHEL requirement at site.
A8	2 nos. submerged arch welding machine	As per BHEL requirement at site.
A9	4 nos. flux coated arc welding (FCAW) machine	As per BHEL requirement at site.

A10	10 nos. welding rectifier	6 Nos. within 120 days and balance as per site requirement.
A11	1 no. trailor – 15T	1 no. Within 120 days. Balance as per site requirement.
A12	2 no. power driven HSFG bolt tightening m/c	As per BHEL requirement at site.
A13	1 no. torque tightening m/c. (2 no. Capacity up to 30 dia HSFG bolt tightening)	As per BHEL requirement at site.
A14	Sufficient quantity of steel ladders for approach up to the top of each erected column to be required during erection of columns.	As per BHEL requirement at site.
A15	Power winch – 3T - 2 no's for structural erection	As per BHEL requirement at site.
A16	Power winch – 5T - 1 no's for structural erection	As per BHEL requirement at site.
A17	1 no ultra-sonography testing machine with printing facility for structural work.	As per BHEL requirement at site.
A18	1 nos. Painting equipment sets complete with compressor, hopper, screen, blasting hose pipe, nozzle airless/conventional spray (within CGI temporary cover shed)	As per BHEL requirement at site.
A19	1 no. Plate Bending Machine	As per BHEL requirement at site.
B. Civil works		
Sr No	**Major T&P**	Mobilizing time from the date of start of work
B1	Bored cast in situ hydraulic rig – 4 nos	2 nos within 75 days and balance as per BHEL requirement in site

B2	2 No. Poclain CK90 excavator	1 no. within 90 days and balance in a progressive manner depending up on the requirement.
B3	1 no. automatic concrete batching plant with printing facility (30 Cum/Hr) – and DG backup. With minimum 2 Nos of silo (100MT each)	1 nos to be commissioned within within 90 days.
B4	2 Nos Truck mounted concrete mixer cum pump along with placing boom minimum 36 m high Concrete boom placer (36m)	1 No within 120 days and balance as per BHEL requirement at site
B5	2 nos. concrete pump (60 cum/ hr min capacity & lift 90M)	1 No within 90 days and balance as per BHEL requirement at site
B6	4 nos. transit mixer (5/6 M3 capacity) with standby 1 no.	2 nos within 90 days. Balance progressively as per site requirement.
Sr No	**Other T&Ps**	**Mobilizing time from the date of start of work**
B7	4 No. JCB	2 no. within 90 days and balance as per site requirement.
B8	6 nos. dumper (Min 15 cum each)	2 nos. Within 90 days. 2 nos. within 120 days. Balance as per site requirement.
B9	2 nos. diesel Mixer machine of 0.5 cum capacity	As per BHEL requirement at site.
B10	3 nos. self-priming dewatering pump 5 HP (diesel)	Within 90 days.
B11	3 nos. self-priming dewatering pump 5 HP (electric)	Within 90 days
B12	4 nos. curing pump – 1.5 /2 HP (pump for curing at heights)	Within 90 days.
B13	4 nos. reinforcement bending machine	3 nos. within 90 days and balance progressively as per requirement

B14	1 no. Vibromax (earth compactor)	as per BHEL site requirement.
B15	6 nos. reinforcement cutting machine	2 nos. within 90 days, 2 nos. within 120 days and balance progressively as per requirement
B16	Vacuum dewatered flooring machine – 2nos	As per BHEL requirement at site
B17	MS scaffolding pipe / ACROW PIPE	As per BHEL requirement at site
B18	MS scaffolding pipe cup lock system /Doka D3 load bearing tower system.	As per BHEL requirement at site for various decks
B19	1 nos. power driven earth rammer (Roller Type 1/2 T)	As per BHEL requirement at site
B20	Civil laboratory equipment's as per list IN Sl 1.4.4.2 with temporary building one AC lab size 4.5mtrx6mtr and 1 non AC lab 4.5 mtrx4.5 mtr.	Within 90 days.
B21	2 nos. building hoist	As per BHEL requirement at site
B22	2 no total station with adequate arrangement for Surveyors.	1 no. Within 75 days. and balance progressively as per requirement
B23	2 no theodolite 1 second accuracy	1 no. within 75 days. and balance progressively as per requirement
B24	5 no's auto level & staff + 2 no's as required	2 nos. Within 75 days. And balance as per requirement.
B25	120 no's concrete cube moulds	60 nos with in 90 days and balance progressively as per requirement
B26	Various decks (fan decks, pump decks,etc.) scaffolding materials / structural steel	At the time of raft casting.
B27	Adequate no. of small trucks 2T/5T for shifting of reinforcement/cement/shuttering etc. within site	As per BHEL requirement at site

B28	3 nos. drinking water tank – 5000 lit.	1 nos. Within 90 days. Balance as per site requirement.
B29	4 nos. mobile toilet blocks for labour use.	1 no's within 90 days balance within 120 days.
B30	2 nos. truck mounted 125 KVA DG set	1 no. within 90 days and balance as per requirement at site.
B31	Construction power cable	As per Requirement
B32	Construction water Pipeline	As per Requirement
B33	1 no. Concrete Paver machine	As per Requirement
B34	1 no. trailor for shifting of crawler mounted equipment's like Poclain, Dozer	As per site requirement.
B35	2 nos. Motorized External Platforms (sky climber)	As per site requirement.
B36	Concrete vibrator with adequate needle (Minimum 20 nos diesel/power nos.)	6Nos (at least 3nos. diesel driven) within 90 Days. Balance as per site requirement.
B37	Portable fire extinguishers as below: Soda acid – 10 sets. Dry chemical powder – 10 sets CO2 – 10 sets. Water & sand bucket (4 buckets in one stand) – 10 sets. Fire hose with nozzle (50 M length) – 5 sets.	25% within 90 days and balance progressively within 120 days.
B38	2 no. compression testing machine (200 T cap)	1 Nos. within 90 days and balance as per requirement.

Note:

1. T&P shown in the above-mentioned list and the mobilization schedule is tentative requirement considering parallel working. However, mobilization schedule modification as well as no. of T&Ps as mutually agreed at site for major T&Ps, have to be adhered to. Numbers/ time of requirement will be reviewed time to time at site and contractor will provide required T&P/ equipment's to ensure completion of entire work within schedule/target date of completion without any additional financial implication to BHEL. Vendor shall give advance

intimation & certification regarding capacity etc. prior to dispatch of heavy equipment's. Also on completion of the respective activity, demobilization of T&P in total or in part can be done with the due approval of engineer in charge. Retaining of the T&P's during the contract period will be mutually agreed in line with construction requirement.
2. All T&P and all IMTEs, which are required for successful and timely execution of the work covered within the scope of this tender, shall be arranged and provided by the contractor at his own cost in working condition.
3.In the event of contractor failing to arrange the required tools, plants, machineries, equipment, material or non-availability of the same owing to breakdown, BHEL will make alternative arrangement at the risk and cost of the contractor.
Case 1: BHEL provides its own Capital T&P.
In case the BHEL provides any T&P which is owned by BHEL, hire charges (as per BHEL norms) will be recovered from the contractor as per the prevailing BHEL corporate hire charges. In case, the T&P is specifically listed in "T&Ps to be deployed by Contractor", "Hire charges applicable to outside agencies other than contractors working for BHEL" will apply. If not listed, "hire charges applicable to contractor working for BHEL" will apply. The hire charges of Capital tools & plants are exclusive of operating expenses e.g. operator, fuel & consumables and the same shall be arranged by the contractor at his cost.
Case 2: In all cases other than that specified in case 1 above, actual expenses incurred by BHEL along with applicable overheads will be back-charges to the contractor.
4. In the event of need of change of type of any of major T&Ps, approval shall be taken from BHEL Engineer in-charge prior to mobilization. The decision of Number of T&P required due to replacing the enlisted T&P as per above table, shall be taken after analyzing the production capacity and suitability of both the T&Ps.
5. Clause no. 1.6.1.1 of this specification may please be referred for date of start of work.

1.4.3 In addition to the above, any other tools and plants required for execution of the above work are in contractor's scope.

1.4.4 The Bidder shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time for testing. Successful bidder shall submit scheme for lab arrangement within 7 days from date of commencement of work at site for approval of BHEL engineer in-charge.

1.4.5 The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can carried out in compliance with the standards.

1.4.6 Field and laboratory testing procedures for materials follow Indian Standard Specifications with necessary equipment's like as given in table below:

	CONCRETE TESTING EQUIPMENT			
SL NO.	**NAME OF TEST**	**NAME OF EQUIPMENT**	**SIZE OF EQIPMENT**	**IS REF.**
1	Initial & final setting time, Consistency of cement	Vicat Apparatus with desk pot	Standard	IS 5513
2	Shrinkage of cement, Auto Clave Test	Le Chatelier's appratus Auto Clave Equipment	Standard	IS 5514
3	Abrasion value test	Los Angles Abrasion testing machine	Standard	IS 2386
4	Aggregate Impact value test	Aggregate Impact value testing machine with blow counter	Standard	IS 9377
5	Aggregate crushing value test	Crushing value apparatus	Standard	IS 2386
6	Flakiness index	Thickness gauge for measuring flakiness index	Standard	IS 2386
7	Elongation Index	Elongation guage	Standard	IS 2386
8	Bulk density, voids and bulking apparatus	Measuring cylinders	3, 5,10 & 15 liters cylinders	
9	Workability of concrete	Slump cone	Standard, at least 04 no's	IS 456
10	Specific gravity of aggregates	Pycnometer	Standard, at least 02 no's	IS 383
11	Cement mortar cube vibrating	Motorised vibration machine for cement testing	Standard	IS 4031
12	Course aggregate Sieve analysis (Concrete & Road Works)	Sieve set	450mm dia GI Frames Size: 125 mm, 90 mm, 75 mm, 63 mm, 53 mm, 40 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 4.75 mm, Pan and cover	IS 383
13	Fine aggregate sieve analysis	Sieve set	200 mm dia Brass sieves; Size 4.75	IS 383

			mm, 2.36 mm, 1.18 mm 600 micron, 300 micron, 150 micron, 75 micron, 75 micron, Pan and cover	
14	Sieve Shaker	Motorized Sieve shaker	Mfg. Catalogue	
15	Silt content check	Sand silt content beaker	Standard	

	Soil Testing Equipment			
1	Liquid limit test	Liquid limit apparatus	Standard	IS 2720
2	Core Cutter test	core cutter apparatus	Rammer, 6 no's of std. core cutter mould, dolly	IS 2720
3	Proctor density test	Std proctor Compaction apparatus	Standard	IS 2720
4	Moisture Content	Rapid moisture meter	Standard, at least 04 no's	IS 2720

1.4.7 Contractor shall have at all times experienced operators and technicians for routine and breakdown maintenance of the equipment. Any delay in rectification of defects will warrant BHEL rectifying the defect and charging the cost to the contractor.

1.4.8 The area and infrastructure development of the work area are to be carried out by the customer. However, in construction projects of this magnitude it is possible that all the areas / approaches may not be ready. In such cases consolidation of ground and arrangement of sleepers / sand bag filling etc for safe operation / movement of equipment including cranes / trailers etc shall be the responsibility of the contractor at his cost. No compensation on this account shall be payable.

1.4.9 In general, crane upto capacity of 150 tonne SWL for the tendered package will not be provided by BHEL. However, if requirement of crane of higher capacity arises (i.e. more than 150MT), bidder may request BHEL to provide crane on shareable basis, free of hire charges but BHEL reserves right of provision of crane. Crane operators deployed by the contractor shall be tested by BHEL before they are allowed to operate the cranes.

1.4.10 The age of the contractor deployed cranes upto 150 T should be within 15 years as on date of deployment. Contractor has to provide documentary proof for the age of the crane at the time of deployment to the BHEL Engineer.

1.4.11 In case, cement is issued through bulkers being supplied from manufacturer /stockiest, the same shall be emptied in cement silos of batching plant and necessary assistance shall be provided by contractor without any additional financial implication to BHEL. Contractor to note that batching plant being established at site shall have cement silos of 100 MT capacities (minimum 2 nos.) each as mentioned in clause 1.4.2.B- list of Tools & Plants to be deployed by the contractor.

VOLUME-IA PART-I CHAPTER – V

1.5 T&Ps provided by BHEL

1.5.1 BHEL will provide suitable higher capacity cranes above 150T capacity to the contractors as per the requirement at the discretion of BHEL on free of hire charges on shareable basis.

1.5.2 Besides the T & P mentioned above, which is being made available to the contractor on free of hire charges, any additional crane and other T & P which may be required for successful and timely execution of the work covered within the scope of this tender shall be arranged and provided at site by the contractor at his cost. In case if the contractor fails to provide such equipment's, BHEL will arrange for the same and the cost will be recovered from the contractor's bill with BHEL overheads, as applicable from time to time which may vary even during contract period.

1.5.3 BHEL's Crane is only for erection purpose and shall not be available for material handling or transportation purpose. Contractor shall make their own arrangements for material transportation to erection site.

1.5.4 BHEL may provide either BHEL owned cranes or hired cranes at the discretion of BHEL. Operator for the BHEL supplied cranes will be provided by BHEL on free of charges.

1.5.5 Bidder to note the following: -

In the event of providing BHEL owned cranes or Hired cranes:

Fuel has to be arranged by the contractor at his cost.

1.5.6 For all BHEL's crane BHEL shall provide crane operators free of charges, all consumables for BHEL crane maintenance shall be provided by the contractor within the quoted rates.

1.5.7 Tentative List of consumables required to be provided by contractor is as below:

a. Engine Oil 15 W 40
b. Fuel Filters
c. Air Filters
d. Hydraulic Filters
e. Hydraulic Oil –Servo 68
f. Gear Oil- Servo 90
g. Engine oil Filter
h. Oil Separator Filter

i. Rope- CRG 100 Grease

j. Grease- Servo Multi-Purpose Grease

1.5.8 Maintenance for the BHEL crane shall be carried out by BHEL. Bidder shall extend support (if required) for routine maintenance works.

VOLUME-IA PART-I CHAPTER – VI

1.6 TIME SCHEDULE

1.6.1 The date of commencement of work at site shall be mutually agreed between bidder and BHEL site in-charge.

1.6.2 The entire work of Civil, structural and Architectural works as detailed in the Tender Specification shall be completed within **17 (Seventeen) months** from the date of commencement of work with intermediate milestones as mentioned below,

1.6.2.1 Milestones

1.6.2.1.1 Completion of all foundations of raw water pump house job pile installation – 7th month

1.6.2.1.2 Completion of FGD control room superstructure – 11th month

1.6.3 During the total period of contract, the contractor has to carry out the activities in a phased manner as required by BHEL and the program of milestone events.

1.6.4 The contractor is required to refer Form 15 in Volume 1- BOOK 2 for all the instructions to be taken immediately after receipt of LOI.

1.6.5 MOBILISATION

The Contractor has to subsequently augment his resources in such a manner to achieve the COMPLETION SCHEDULES:

The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the tenderer taking in to consideration of the COMPLETION SCHEDULES /site decision on drawings flow (latest) and submitted for BHEL's approval.

1.6.6 In order to meet above schedule in general, and any other intermediate targets set, to meet customer / project schedule requirements, contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL.

1.6.7 In case the project is to be advanced, the civil works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

1.6.8 SUBMISSION OF L3 SCHEDULE

The contractor shall submit a detailed area/structure wise L3 schedule within 15 days from date of issue of LOI, in consultation with BHEL based on the tentative schedule provided as per the clause 1.6.10. The detailed L3 schedule shall be approved by BHEL and same shall be implemented. Bidder shall submit L3 schedule in MS Projects (or any suitable format as agreed between contractor and BHEL engineer in-charge) to meet the agreed project schedule covering various mile stone activities and their split up details such as construction, procurement of materials, fabrication & erection

activities, etc. This schedule shall also clearly indicate the interface facilities/inputs to be provided by BHEL/Customer and the dates by which such facilities/inputs are required. The schedule shall be acceptable to BHEL for meeting their mile stone targets/schedule.

1.6.9 GUARANTEE PERIOD FOR THE PACKAGE

Guarantee period of 12 months shall commence from the date of completion of the whole work certified by the BHEL Engineer.

1.6.10 CONSTRUCTION SCHEDULE

Tentative construction schedule for civil works is as mentioned below. Overall completion period for the completion of works and submission of final bill is 17 months.

Sl.No	Area	Completion from the date of commencement of civil work
1.	Test piles installation	Progressively by 1st Month
2.	Load testing on test piles and report submission	Progressively by 2nd month
3.	Job pile installation	Progressively by 6th month
4.	Absorber	Progressively by 7th month
5.	Duct support	Progressively by 7th month
6.	Booster fan	Progressively upto 8th month
7.	DG set	Progressively by 8th months
8.	Compressor house	Progressively by 12th months
9.	Ball mill foundation	Progressively by 8th months
10.	Tank foundations	Progressively by 9th months
11.	Lime stone silo foundations	Progressively by 9th months
12.	FGD control room foundation	Progressively by 7th months
13.	FGD control room superstructure	Progressively by 11th months
14.	FGD control room finishing works	Progressively by 13th Month

Sl.No	Area	Completion from the date of commencement of civil work
15.	ACW/ DMCW pump house	Progressively by 7th month
16.	Gypsum dewatering building	Progressively by 12th Month
17.	Lime stone handling system foundations	Progressively by 8th month
18.	Lime stone crusher deck	Progressively by 12th month
19.	Superstructure works of lime stone handling system	Progressively by 12th month
20.	Ball mill building superstructure	Progressively by 12th month
21.	Lime stone slurry pump house	Progressively by 10th month
22.	Lime stone silo foundation	Progressively by 8th months
23.	Oxidation blower foundation	Progressively by 9th months
24.	Gypsum shed	Progressively by 12th month
25.	Junction houses, trestles, conveyor galleries	Progressively by 12th month
26.	Truck hopper	Progressively by 12th month
27.	Switchyard	Progressively upto 13th month
28.	Paving, roads & drains	Progressively upto 15th month
29.	Other miscellaneous foundations	Progressively upto 13th month
30.	Micro levelling and grading works in plant area as per site directions	Progressively upto 15th month
31.	Documentation, final reconciliation, final bill submission and contract closing	Progressively upto 17th month

1.6.11 The above schedule is tentative. In case the project is to be advanced, the civil works in the scope of the contractor is to be advanced to meet the project requirement. No extra payment whatsoever shall be paid on this account.

1.6.12 The above schedule is for entire completion and handing over the structure/ Building to BHEL. Date of commencement of work shall be as mutually agreed at site between BHEL & contractor.

1.6.13 Commencement of test pile installation work and completion of all initial pile load test is very critical for this package. Hence, contractor has to mobilise minimum necessary T & Ps required for completion of test pile work, within 15 days of placement of LOI or 7 days of handing over of drawings for test pile work, whichever is later.

1.6.14 The foundations, pedestals, floors, etc, required for the mechanical equipment erection/ structural erection shall be handed over to BHEL progressively within the scheduled period given in the above table, as per the BHEL site requirement.

1.6.15 The left out minor finishing works shall also be completed and handed over to BHEL within the contract period.

1.6.16 The above time allowed for completion of work including Sundays and Holidays is from the date of commencement of work. Detailed program to be prepared by the bidder taking in to consideration of the COMPLETION SCHEDULES / site decision on drawings flow (latest) and submitted for BHEL's approval.

1.6.17 In order to meet the above schedule in general, and any other intermediate targets set, to meet customer/ project schedule requirements, Contractor shall arrange & augment all necessary resources from time to time on the instructions of BHEL Engineer.

1.6.18 The bidder must submit a detail schedule (area wise) for completion of work to meet civil work schedule given in CLAUSE 1.6.10 within 15 days from the date of issue of LOI.

1.6.19 The major activities as mentioned against the work schedule given in clause No.1.6.10 are to be indicated in detailed schedule which shall be prepared by the bidder.

1.6.20 RECORDS TO BE MAINTAINED AT SITE:

Record of Quantity of FREE/Chargeable items issued by BHEL must be maintained during contract execution. Also reconciliation statement to be prepared at regular intervals.

- The under mentioned Records/ Log-books/ Registers applicable to be maintained.
- Hindrance Register.
- Site Order Book.
- Test Check of measurements.

- Steel & Cement Supply and Consumption Daily Register
- Records of Test reports of Field tests.
- Records of manufacture's test certificates.
- Records of disposal of scraps generated during and after the work completion.

VOLUME-IA PART-I CHAPTER – VII

1.7 TERMS OF PAYMENT

1.7.1 Secured Advance

Not applicable

1.7.2 Advance for Mobilization

1.7.2.1 Interest bearing advance for Mobilization, limited to 5% of the contract value will be paid against submission of bank guarantee of at least 110% of the advance valid for the contract period, which will be recovered from the first running bill onwards. The advance for mobilization shall be paid as under.

1.7.2.2 2% of contract value after receipt of initial Security Deposit, security deposit for consortium and additional security deposit as applicable if any, as per relevant clauses in the GCC/TCC along with unqualified acceptance of detailed letter of intent.

1.7.2.3 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below and on certification by site in-charge for compliance provided clause no. 1.7.2.2 as mentioned above is also complied with.

i) Back hoe loader like JCB – 1 No.

ii) Excavator equivalent to capacity of Poclain CK90 or higher to suit the requirement of work at site – 1 No

iii) Dumper (Min 15 CUM each)– 3 nos.

iv) Concrete pump (60 CUM/ hr min capacity & lift 90M) – 1 No

Note: Concrete pump can be replaced by concrete boom placer in addition to those mentioned above in sl. No. (v) with due approval of Engineer In- Charge

1.7.2.4 1.5% of contract value on completion of site Mobilization of Machinery & T&P as given below in addition to the above, and on certification by site in-charge for compliance.

i) Automatic concrete batching plant with printing facility (minimum capacity of 30 CUM/Hr each) with DG backup with minimum 2 Nos. of silo per batching plant (100MT each)-1 no Self-priming dewatering pump 5 HP (diesel/electric)- 5 nos.

ii) Transit mixer (5/6 M3 capacity) – 2 Nos.

iii) Truck mounted concrete mixer cum pump along with placing boom minimum 36 m high i.e. Concrete boom placer (36m) – 1 No.

1.7.2.5 Payment of the advance as specified herein and recovery of the advance will be as per clause 2.13 of GCC. Option of availing the interest-bearing mobilization advance is left with the bidder.

1.7.3 Interim Payment

1.7.3.1 Interim bills in the form of monthly running bills prepared by the contractor in soft as well as Hard copies shall be based on the quantities executed and measured.

1.7.3.2 95% item rate shall be released after completion of works certification by Engineer in charge.

1.7.3.3 5% of the item rate shall be released after submission of the quality check formats as per the quality plan for the quantum of work billed and duly certified by engineer.

1.7.3.4 Retention amount as per GCC as reproduced below:

2.22.1 After award of work, vendor shall submit 5% of the contract value towards Performance security deposit, in the form of (a) or (b)

a) CASH, 5% of the contract value towards performance security deposit before commencing the contract

(or)

b) Recovery 5% from each running bill towards performance security deposit (note-subcontractor has to choose either option (a) or (b) before issue of DLOI)

c) However, performance security deposit on part of PVC will be recovered at the rate of 5% from every running bill towards performance security deposit.

2.22.2 Refund of performance security deposit shall be as follows:

a) 50% of performance security deposit shall be released along with the final bill (and)

b) Balance 50% will be released after completion of performance guarantee period (i.e. after expiry of guarantee period), provided all the defects noticed during the guarantee period have been rectified to the satisfaction of BHEL site engineer/ BHEL construction manager, and after deducting all expenses/ other amounts due to BHEL under the contract/ other contracts entered into by BHEL with them. T his portion of performance security deposit, amount can be released on commencement of the guarantee period, on submission of equivalent bank guarantee.

1.7.4 Royalty/seigniorage charges (if any) for excavation inside plant premises as applicable as per Govt of Tamilnadu shall be reimbursable to the bidder by BHEL for the quantum of earth work done on submission of necessary proof of payments as required by M/s NTPL for reimbursement.

1.7.5 Royalty for construction materials:

Payment of royalty for construction materials viz. coarse aggregates, fine aggregates, borrowed earth, etc. is to be made by contractor and challan of deposit of royalty/ seigniorage fee shall be submitted to BHEL along with RA bill.

In absence of production of challan following methodology shall be adopted:

Sl. No.	**Construction Material**	**Rate of seigniorage/ royalty per cum (In rupees) to be withheld in RA bill**	**Volume to be considered for calculation**	**Remarks**
1	Coarse aggregate	45.00	A. For RCC: (As per approved design mix proportion + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill) 'B. For PCC: (As per DSR recommendation + wastage as specified in IS 383) x (Total volume of concrete claimed in RA bill)	Rate mentioned herein is indicative and for information. Actual prevailing rate for seigniorage fee / royalty fee shall be considered for operation in RA bills/ Final bill. The amount so calculated shall be withheld from RA bill and on production of challan, payment of relevant portion will be released.
2	Fine aggregate	45.00		
3	Borrowed earth	20.00	Actual volume of filling shall be considered	

1.7.6 BHEL Site Engineer, at discretion, may operate the part rate of the items in line with GCC clause no. 2.23.1 (v). Payment for supply portion (subjected to approval of Engineer In-Charge) shall be made only after receipt of material at site.

1.7.7 METHOD OF MEASUREMENT

Mode of measurement shall be as per relevant IS 1200 in conjunction of IS code 3385. In case the same is also not available, the standard procedure adopted in CPWD shall be adopted. In case, the same is also not available in CPWD, the measurement of the work done will be based on the mutual agreement between BHEL and contractor. In all the above cases, the interpretation of BHEL will be final and binding to the contractor. Measurement guidelines as a ready reference is also available in the technical specification.

1.7.8 INO CLAIM WHAT SO EVER MAY BE, WILL BE ENTERTAINED UNDER THIS CONTRACT, AFTER DULY SIGNING THE FINAL BILL ALONG WITH MEASURMENT BOOKS AND ACCEPTED BY BHEL.

VOLUME-IA PART-I CHAPTER - VIII

TAXES AND OTHER DUTIES

1.8.1 Goods and service Tax (GST) & Cess

1.8.1.1 The successful bidder shall furnish proof of GST registration with GSTN Portal in the State in which the Project is being executed, covering the services under this contract. Registration should also bear endorsement for the premises from where the billing shall be done by the successful bidder on BHEL for this project/ work.

1.8.1.2 Contractor's price/rates shall be exclusive of GST & Cess (if applicable) (herein after termed as GST). Contractor shall submit to BHEL the GST compliant tax invoice/debit note/revised tax invoice on the basis of which BHEL will claim the input tax credit in its return. Since this is a works contract, the applicable rate shall be @ 18% GST, as applicable presently

1.8.1.3 Bidder shall note that the GST Tax Invoice complying with GST Invoice Rules wherein the 'Bill To' details will as below:

BHEL GSTN - 33AAACB4146P2ZL
NAME - BHARAT HEAVY ELECTRICALS LIMITED
ADDRESS - BHEL SITE OFFICE, 2X500 MW NTPL PROJECT, HARBOUR ESTATE, TUTICORIN, PINCODE 628004, TAMILNADU

1.8.1.4 GST charged in the tax invoice/debit note/revised tax invoice by the contractor shall be released separately to the contractor only after contractor files the outward supply details in GSTR-1 on GSTN portal and input tax credit of such invoice is matched with corresponding details of outward supply of the contractor and has paid the GST at the time of filing the monthly return.

1.8.1.5 In case BHEL has to incur any liability (like interest / penalty etc.) due to denial/reversal / delay of input tax credit in respect of the invoice submitted by the contractor, for the reasons attributable to the contractor, the same shall be recovered from the contractor.

1.8.1.6 Further, in case BHEL is deprived of the Input tax credit due to any reason attributable to contractor, the same shall not be paid or Recovered if already paid to the contractor.

1.8.1.7 Tax invoice/debit Note/revised tax invoice shall contain all such particulars as prescribed in GST law and comply to the timelines for issue of the same. Invoices shall be submitted on time to the concerned BHEL Engineer In Charge.

1.8.1.8 TDS under GST (if/ as & when applicable) shall be deducted at prevailing rates on gross invoice value from the running bills.

1.8.1.9 E-way bills / Transit passes / Road Permits, if required for materials / T&P etc., bought into the project site is to be arranged by the Contractor only.

1.8.1.10 BHEL shall not reimburse any amounts towards any interest / penalty etc., incurred by contractor. Any additional claim at a later date due to issues such as wrong rates / wrong classification by contractor shall not be paid by BHEL.

1.8.2 All taxes and duty other than GST & Cess

The contractor shall pay all (except the specific exclusion viz GST & Cess) taxes, fees, license charges, deposits, duties, tools, royalty, commissions, Stamp Duties, or other charges / levies, which may be levied on the input goods & services consumed and output goods & services delivered in course of his operations in executing the contract and the same shall not be reimbursed by BHEL. In case BHEL is forced to pay any of such taxes, BHEL shall have the right to recover the same from his bills or otherwise as deemed fit.

1.8.3 Statutory Variations

Statutory variations are applicable under the GST Acts, against production of proof. The changes implemented by the Central / State Government during the tenure of the contract viz. increase / decrease in the rate of taxes, applicability, etc. and its impact on upward revision / downward revision are to be suitably paid/ adjusted from the date of respective variation. The bidder shall give the benefit of downward revision in favour of BHEL. No other variations shall be allowed during the tenure of the contract.

1.8.4 New Taxes/Levies

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

1.8.5 Direct Tax

BHEL shall not be liable towards Income Tax of whatever nature including variations thereof arising out of this contract as well as tax liability of the bidder and their personnel. Deduction of tax at source at the prevailing rates shall be effected by BHEL before release of payment as a statutory obligation, unless exemption certificate is produced by the bidder. TDS certificate will be issued by BHEL as per the provisions of Income Tax Act.

VOLUME-IA PART-I CHAPTER -IX

1.9.0 BILL OF QUANTITY

As mentioned in the Volume II, Price Bid, Part-C

NOTE TO BOQ:

A) The Price bid contains the consolidated list of BOQ with brief description of items. The quantity indicated in the BOQ / Price bid is approximate only and is liable for variation. Payment will be as per actual quantity executed as certified by BHEL Engineer.

B) Before filling the Rates in the Price bid, the bidder shall go through the detailed specification of all items of BOQ as well as Scope of Work as specified in relevant Clause of this document

C) Bidders shall refer Volume II, Price Bid, Part –A for Instructions.

D) Bidders shall quote 'Total Amount' in the "Price Bid Form" available in eProcurement portal.

E) Any other entry elsewhere in the price bid shall be treated as Null and Void. Quoting of rates in any other form/formats will not be entertained.

F) The above mentioned 'Total amount' is for the entire Bill of Quantity (BOQ) given in Part -C of the Price Bid.

G) BHEL has pre-fixed the weightages for the amount of individual items of Bill of Quantity with respect to the 'Total Amount' in Part-C.

H) Based on the pre-fixed weightages, the amount for the individual items of the Bill of Quantity shall be arrived at. This amount shall be rounded off to the nearest rupee.

I) Based on the quantities of individual item and the amount arrived in Sl.No.: H) above, unit rate of individual items shall be derived. This unit rate shall be rounded off to four decimal places.

J) Bidders to note that this is an item rate contract. Payment shall be made for the actual quantities of work executed at the unit rate arrived at as per Sl.No. I) above.

VOLUME-IA PART-I CHAPTER -X
GENERAL

1.10.0 **In addition to the clause 2.8 of General Conditions of Contract (Volume-1C of Book-II) the contractor shall comply with the following:**

1.10.1 Payment Bidders are requested to furnish the following at PSSR-HQ, Chennai immediately after release of Letter of Intent (LOI)

I. Security Deposit and Additional Security Deposit (As applicable).
II. Unqualified Acceptance for Detailed LOI/ Work Order.
III. Rs.100/- Stamp Paper for preparation of Contract Agreement.
IV. Option (whether a or b of said clause) exercised towards Performance Security Deposit for the subject contract as per Sl. No. 16 of Volume IA Part II Chapter 1 of TCC.

1.10.2 Bidders are requested to furnish the proof of documents for the following at PSSR- Site.

I. PF Regn No.
II. Labour License No.
III. Workmen Insurance Policy No.

1.10.3 In addition to the clause 2.8 of General Conditions of Contract (Volume-1C of Book-II) the contractor shall comply with the following.

1.10.4 BOCW Act & BOCW Welfare Cess Act

1.10.4.1 The Contractor Should Register their Establishment under BOCW Act 1996 read with rules 1998 by submitting Form I (Application for Registration of Establishment) and Form IV (Notice of Commencement /Completion of Building Other Construction Work) to the respective Labour Authorities i.e.,

a) Assistant Labour Commissioner (Central) in respect of the project premises which is under the purview of Central Govt.–NTPC, NTPL etc.

b) Appropriate State authorities in respect of the project premises which is under the purview of State Govt.

1.10.4.2 The Contractor should comply with the provisions of BOCW Welfare Cess Act 1996 in respect of the work awarded to them by BHEL

1.10.4.3 The contractor should ensure compliance regarding Registration of Building Workers as Beneficiaries, Hours of work, welfare measures and other conditions of service with particular reference to Safety and Health measures like Safety Officers, safety committee, issue of Personal protective equipments, canteen, rest room, drinking water, Toilets, ambulance, first aid centre etc.,

1.10.4.4 The contractor irrespective of their nature of work and manpower (Civil, Mechanical, Electrical works etc) should register their establishment under BOCW Act 1996 and comply with BOCW Welfare Cess Act 1996.

1.10.4.5 Contractor shall make remittance of the BOCW cess as per Act in consultation with BHEL as per the rates in force (presently 1%). BHEL shall reimburse the same upon production of documentary evidence. However, BHEL shall not reimburse the Fee paid towards the registration of establishment, fess paid towards registration of beneficiaries and contribution of beneficiaries remitted.

1.10.4.6 Non-compliance to provisions of the BOCW act and BOCW welfare Cess act is not acceptable. In case of any non-compliance, BHEL reserves the right to withhold any sum it deems fit. Only upon total compliance to the BOCW act and also discharge of total payment of Cess under the BOCW Cess act by the contractor, BHEL shall consider refund of the amounts.

1.10.5 PROVIDENT FUND

1.10.5.1 The contractor is required to extend the benefit of Provident Fund to the labour employed by the contractor in connection with this contract as per the Employees Provident Fund and Miscellaneous Provisions Act 1952. For due implementation of the same, the contractor is hereby required to get themselves registered with the Provident Fund authorities for the purpose of reconciliation of PF dues and furnish to us the code number allotted to them by the Provident Fund authorities within one month from the date of issue of this letter of intent. In case the contractor is exempted from such remittance an attested copy of authority for such exemption is to be furnished. Please note that in the event of contractor's failure to comply with the provisions of said Act, if recoveries therefore are enforced from payments due to BHEL by the customer or paid to statutory authorities by BHEL, such amount will be recovered from payments due to the contractor.

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

1.10.6 OTHER STATUTORY REQUIREMENTS

1.10.6.1 The Contractor shall submit a copy of Labour License obtained from the Licensing Officer (Form VI) u/r25 read with u/s 12 of Contract Labour (R&A) Act 1970 & rules

and Valid WC Insurance copy or ESI Code (if applicable) and PF code no along with the first running bill.

1.10.6.2 The contactor shall submit monthly running bills along with the copies of monthly wages (of the preceding month) u/r78(1)(a)(1) of Contract Labour Rules, copies of monthly return of PF contribution with remittance Challans under Employees Provident Fund Act 1952 and copy of renewed WC Insurance policy or copies of monthly return of ESI contribution with Challans under ESI Act 1948 (if applicable) in respect of the workmen engaged by them.

1.10.6.3 The Contractor should ensure compliance of Sec 21 of Contract Labour (R&A) Act 1970 regarding responsibility for payment of Wages. In case of "Non-compliance of Sec 21 or non-payment of wages" to the workmen before the expiry of wage period by the contactor, BHEL will reserve its right to pay the workmen under the orders of Appropriate authority at the risk and cost of the Contractor.

1.10.6.4 The Contractor shall submit copies of Final Settlement statement of disbursal of retrenchment benefits on retrenchment of each workman under I D Act 1948, copies of Form 6-A (Annual Return of PF Contribution) along with Copies of PF Contribution Card of each member under PF Act and copies of monthly return on ESI Contribution – Form 6 under ESI Act1948 (If applicable) to BHEL along with the Final Bill.

1.10.6.5 In case of any dispute pending before the appropriate authority under I D act 1948, WC Act 1923 or ESI Act 1948 and PF Act 1952, BHEL reserve the right to hold such amounts from the final bills of the Contractor which will be released on submission of proof of settlement of issues from the appropriate authority under the act.

1.10.6.6 In case of any dispute prolonged/pending before the authority for the reasons not attributable to the contractor, BHEL reserves the right to release the final bill of the contractor on submission of Indemnity bond by the contractor indemnifying BHEL against any claims that may arise at a later date without prejudice to the rights of BHEL.

1.10.7 DEPLOYMENT OF SKILLED / SEMI-SKILLED TRADESMEN

The following clause is applicable in case the contract value / contract price is Rs. Five crores and above.

The contractor shall, at all stages of work deploy skilled / semi-skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute / Industrial Training. Institute / National Institute of Construction Management and Research (NICMAR), National Academy of Construction, CIDC or any similar reputed and recognized Institute managed / certified by State / Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled / semi-skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified

tradesmen along with requisite certificate from recognized Institute to Engineer-in-Charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer-in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman per day. Decision of Engineer-in-Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

1.10.8 RECOVERY OF COMPENSATION PAID TO VICTIM(S) BY BHEL IN CASES OF DEATH/ PERMANENT INCAPACITATION OF PERSON DUE TO AN ACCIDENT DURING THE WORKS

BHEL shall recover the amount of compensation paid to victim(s) by BHEL towards loss of life / permanent disability due to an accident which is attributable to the negligence of contractor, agency or firm or any of its employees as detailed below.

1.10.8.1 Victim: Any person who suffers permanent disablement or dies in an accident as defined below.

1.10.8.2 Accident: Any death or permanent disability resulting solely and directly from any unintended and unforeseen injurious occurrence caused during the manufacturing / operation and works incidental thereto at BHEL factories/ offices and precincts thereof, project execution, erection and commissioning, services, repairs and maintenance, trouble shooting, serving, overhaul, renovation and retrofitting, trial operation, performance guarantee testing undertaken by the company or during any works /during working at BHEL Units/ Offices/ townships and premises/ Project Sites.

1.10.8.3 Compensation in respect of each of the victims:

(i) In the event of death or permanent disability resulting from Loss of both limbs: Rs. 10,00,000/- (Rs. Ten Lakh)

(ii) In the event of other permanent disability: Rs. 7,00,000/- (Rs. Seven Lakh)

1.10.8.4 Permanent Disablement: A disablement that is classified as a permanent total disablement under the proviso to Section 2 (I) of the Employee's Compensation Act, 1923.

1.10.9 GENERAL

1.10.9.1 Site Visit by the Bidder

Prior to submitting his tender for the work, the bidder shall visit, examine and acquire full knowledge & information of necessary conditions prevailing at the site and its surroundings of the plant premises together with all statutory, obligatory, mandatory

requirements of various authorities about the site of works at his own expense, and obtain and ascertain for himself on his own responsibility that may be for preparing his tender and entering into a contract, and take the same into account in the quoted contract price for the work.

1.10.9.2 The bidder shall satisfy themselves about the following factors:

i) Site conditions including access to the site, existing and required roads and other means of transport/communication for use by him in connection with the work including diverting and re-routing of services.

ii) Requirement and availability of land and other facilities of his enabling works, establishment of his nursery, office, stores etc.

iii) Ground conditions including those bearing upon transportation, disposal, handling and storage of materials required for the work or obtained there-from.

iv) Source and extent of availability of suitable materials, including water etc., and labour (skilled and unskilled) required for work, and laws and regulations governing their use and employment.

v) Geological, meteorological, topographical and other general features of the site and its surroundings as are pertaining to and needed for the performance of the work.

vi) The limit and extent of surface and subsurface water to be encountered during the performance of the work, and the requirement of drainage and pumping.

vii) The type of equipment and facilities needed, for and in the performance of the work;

viii) The extent of lead and lift required for the work in complete form over the entire duration of the contract, and

ix) All other information pertaining to and needed for the work including information as to the risks, contingencies and other circumstances which may influence or affect the work or the cost thereof under this contract.

1.10.9.3 The bidder should note that information, if any, in regard to the local conditions, as contained in these tender documents, has been given to tenderer merely for guidance and is not warranted to be complete.

1.10.9.4 A bidder shall be deemed to have full knowledge of the site, whether he inspects it or not, and no extra charges consequent on any misunderstanding or otherwise shall be allowed.

1.10.9.5 The bidder and any of his personnel or agents will be granted permission by the Site-In-Charge or his authorized nominee, on receipt of formal application in respect thereof

a week in advance of the proposed date of inspection of site, to enter upon his premises and lands for purpose of such inspection, but only on the express condition that the tenderer (and his personnel and agents) will relieve and indemnify the Employer (and his personnel and agents) from and against all liability in respect thereof and will be responsible for personal injury (whether fatal or otherwise), loss of or damage to property and any other loss, damage, costs and expenses however caused which, but for the exercise of such permission, would not have arisen.

1.10.9.6 Scope of work covered under this specification requires quality workmanship, engineering and green belt management along with the supply of all consumables, tools and tackles and testing instruments. The contractor shall ensure timely completion of work. The contractor shall have adequate tools, measuring instruments etc. in his possession. He shall also have adequate trained, qualified and experienced engineers, supervisory staff and skilled personnel. The manpower deployment identified by contractor shall match with above scope of works.

1.10.9.7 It is not the intent to specify herein all details of all material. Any item related this work not covered by this but necessary to complete the system will be deemed to have been included in the scope of the work.

1.10.9.8 All the necessary certificates and licenses required to carry out this scope of work are to be arranged by the contractor then and there at no extra cost.

1.10.9.9 Site testing wherever required shall be carried out for all items / materials installed by the contractor to ensure proper installation and functioning in accordance with drawings, specifications and manufacturer's recommendations.

1.10.9.10 The contractor shall carryout additional tests, if any, which the Engineer feels necessary because of site conditions and also to meet system specification.

1.10.9.11 The work shall be executed under the usual conditions without affecting power plant construction / operation and in conjunction with other operations and contracting agencies at site. The contractor and his personnel shall co-operate with the personnel of other agencies, co-ordinate his work with others and proceed in a manner that shall not delay or hinder the progress of work as a whole.

1.10.9.12 All the work shall be carried out as per instructions of BHEL engineer. BHEL engineer's decision regarding the correctness of the work and method of working shall be final and binding on the contractor.

1.10.9.13 Wherever Construction sequences are furnished by BHEL, the contractor shall follow the same sequence.

1.10.9.14 Contractor shall execute the supply and works as per sequence prescribed by BHEL at site engineer. No claims for extra payment from the contractor will be entertained on the grounds of deviation from the methods of execution of similar job in any other site or for

any reasons whatsoever.

1.10.9.15 If required by BHEL, the contractor shall change the sequence of his operation so that work on priority sectors can be completed within the projects schedule. The contractor shall afford maximum assistance to BHEL in this connection without causing delay to agreed completion date.

1.10.9.16 Contractor shall, transport all materials to site and unload at site / working area for inspection and checking. All material handling equipment required shall be arranged by the contractor.

1.10.9.17 Contractor shall retain all T&P / Testing instrument / Material handling equipment's etc. at site as per advice of BHEL engineer and same shall be taken out from site only after getting the clearances from engineer in charge.

1.10.9.18 The contractor at his cost shall arrange necessary security measures for adequate protection of his machinery, equipment, tools, materials etc. BHEL shall not be responsible for any loss or damage to the contractor's construction equipment and materials. The contractor may consult the Engineer-in-Charge on the arrangements made for general site security for protection of his machinery equipment tools etc.

1.10.9.19 The Contractor may have to execute work in such a place and condition where other agencies also will be under such circumstances. However, completion time for construction, agreed will be subject to the condition that contractor's work is not hampered by the agencies.

1.10.9.20 Contractor has to work in close co-ordination with other agency at site. BHEL engineer will co-ordinate area clearance. In a project of such magnitude, it is possible that the area clearance may be less / more at a particular given time. Activities and Construction program have to be planned in such a way that the milestones are achieved as per schedule/ plans. Contractor shall arrange & augment the resources accordingly.

1.10.9.21 The contractor must obtain the signature and permission of the security personnel of the customer / BHEL for bringing any of their materials inside the site premises. Without the Entry Gate Pass these materials will not be allowed to be taken outside.

1.10.9.22 Contractor shall remove all scrap materials periodically generated from his working area and collect the same at one place earmarked for the same. Load of scraps is to be shifted to a place earmarked by BHEL. Failure to collect the scrap is likely to lead to accidents and as such BHEL reserves the right to collect and remove the scrap at contractor's risk and cost if there is any failure on the part of contractor in this respect.

1.10.9.23 The contractor shall ensure that his premises are always kept clean and tidy to the extent possible. Any untidiness noted on the part of the contractor shall be brought to the attention of the contractor's site representative who shall take immediate action to clean the surroundings to the satisfaction of the Engineer-in-Charge.

1.10.9.24 The contractor is strictly prohibited from using BHEL's regular components like angles, channels, beams, plates, pipe / tubes, and handrails etc. for any temporary supporting or scaffolding works. Contractor shall arrange himself all such materials. In case of such misuse of BHEL materials, a sum as determined by BHEL engineer will be recovered from the contractor's bill. The decision of BHEL engineer is final and binding on the contractor.

1.10.9.25 No member of the already erected structure / buildings, other component and auxiliaries should be removed / modified without specific approval of BHEL engineer.

1.10.9.26 Contractors shall ensure that all their Staff / Employees are exposed to periodical training programme conducted by qualified agencies/ personnel on latest ISO 9001 Standards.

1.10.9.27 Some time it may be required to re-schedule the activities to enable other agencies to commence / continue the work so as to keep the overall project schedule.

1.10.9.28 The terminal points decided by BHEL are final and binding on the contractor for deciding the scope of work and effecting the payment for the work done up to the terminals.

1.10.9.29 Crane operators deployed by the contractor shall be tested by BHEL before he is allowed to operate the cranes.

1.10.9.30 On Completion of work, all the temporary buildings, structures, pipe lines, cable etc. shall be dismantled and leveled and debris shall be removed as per instruction of BHEL by the contractor at his cost. In the event of his failure to do so, the expenditure towards clearance of the same will be recovered from the contractor. The decision of BHEL Engineer in this regard is final.

1.10.9.31 It is the responsibility of the contractor to do the checking, testing etc. if necessary, repeatedly to satisfy BHEL Engineer with all the necessary tools and tackles, manpower etc. without any extra cost. The testing will be completed only when jointly certified so, by the BHEL Engineer.

1.10.9.32 If any item not covered but requires being executed, same shall be carried out by the contractor. Equivalent or proportional unit rate shall be considered wherever possible from the BOQ. The rates quoted by the contractor shall be uniform as far as possible for similar items appearing in rate schedule.

1.10.9.33 The contractor's work shall not hinder other work, either underground or over ground, such as electrical, phone lines, water or sewage lines, etc. In areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities will be penalized and contractor shall be responsible for cost for such damages.

1.10.9.34 SITE INSPECTION

1.10.9.34.1 BHEL or his authorized agents may inspect various stages of work during the currency of the contract awarded to him. The contractor shall make necessary arrangements for such inspection and carry out the rectification pointed out by the owner / employer without any extra cost to the owner / employer. No cost whatsoever such duplication of inspection of work be entertained.

1.10.9.34.2 BHEL / Customer will have full power and authority to inspect the works at any time, either on the site or at the contractor's premises. The contractor shall arrange every facility and assistance to carry out such inspection. On no account will the contractor be allowed to proceed with work of any type unless such work has been inspected and entries are made in the site inspection register by customer / BHEL.

1.10.9.34.3 Wherever the performance of work by the contractor is not satisfactory in respect of workmanship, deployment of sufficient labour or equipment, delay in execution of work or any other matter, BHEL shall have the right to engage labour at normal ruling rates and get the work executed through other agency and debit the cost to the contractor and the contractor shall have no right to claim compensation thereof. In such a case, BHEL shall have the right to utilize the materials and tools brought by the contractors for the same work.

1.10.9.35 DOCUMENTATION

1.10.9.35.1 Record of Quantity of FREE / Chargeable items issued by BHEL must be maintained during contract execution. Also reconciliation statement to be prepared at regular intervals.

1.10.9.35.2 The under mentioned Records/ Log-books/ Registers applicable to be maintained.

a) Hindrance Register.

b) Site Order Book.

c) Test Check of measurements.

d) Steel & Cement Supply and Consumption Daily Register

e) Records of Test reports of Field tests.

f) Records of manufacture's test certificates.

g) Records of disposal of scraps generated during and after the work completion.

h) List of T&Ps and MMEs

1.10.9.35.3 Other documents / records as specified in chapter -Progress of work in PART- I of Technical conditions of Contract Volume IA (Volume I Book I).

1.10.9.35.4 Schedule as specified in chapters of Technical conditions of Contract Volume IA (Volume I Book I).

VOLUME-IA PART – I CHAPTER - XI

1.11.0 PROGRESS OF WORK

The scope of the work will comprise of following but not limited to the following:

1.11.1 **PROGRESS AND MONITORING OF WORK**

1.11.2 Refer forms F -14 to F-18 of volume I D of volume -I book-II. Plan and review will be done as per the formats.

1.11.3 Contractor is required to draw mutually agreed monthly construction programs in consultation with BHEL well in advance monthly as per the Form-14. Contractor shall ensure achievement of agreed program and shall also timely arrange additional resources considered necessary at no extra cost to BHEL. Progress review meetings will be held at site during which actual progress during the week vis-a-vis scheduled program shall be discussed for actions to be taken for achieving targets. Contractor shall also present the program for subsequent week. The contractor shall constantly update / revise his work program to meet the overall requirement. All quality problems shall also be discussed during above review meetings. Necessary preventive and corrective action shall be discussed and decided upon in such review meetings and shall be implemented by the contractor in time bound manner so as to eliminate the cause of nonconformities.

1.11.4 The contractor shall submit daily, weekly and monthly progress reports, manpower reports, materials reports, consumables (gases / electrodes / ferules / lugs) report, T&Ps availability report and other reports as per Performa considered necessary by the Site Engineer as per the BHEL formats.

1.11.5 The contractor shall submit weekly / fortnightly / monthly statement report regarding consumption of all consumables for cost analysis purposes.

1.11.6 The monthly report ending on 24th of every month shall be submitted as a booklet and shall contain the following details:-

a) Colour Progress photographs to accompany the report should be submitted.

b) Construction progress in terms of quantity, CUM, etc., completed as relevant to the respective work areas against planned.

c) Site Organization chart of engineers & supervisors as on 24th of the month with further mobilization plan

d) Category- wise man hours engaged during the previous month under the categories like fitters, electricians, welders, riggers, khalasis, grinder-men, gas-cutters, crane

operators, store keepers, lab technicians, helpers, security etc. Data will be spilt up under the work area.

e) Consumables report giving consumption of all types of gases and electrodes during the previous month (as applicable).

f) Availability report of cranes/T&Ps

g) Safety implementation report in the format

h) Pending material and any other inputs required from BHEL for activities planned during the subsequent month.

1.11.7 The manpower reports shall clearly indicate the manpower deployed, category wise specifying also the activities in which they are engaged.

1.11.8 During the course of construction, if the progress is found unsatisfactory, or if the target dates fixed from time to time for every milestone are to be advanced, or in the opinion of BHEL, if it is found that the skilled workmen like fitters, operators, technicians etc employed are not sufficient BHEL will induct required additional workmen to improve the progress and recover all charges incurred on this account including all expenses together with BHEL overheads from contractor's bills.

1.11.9 It is the responsibility of the contractor to provide all relevant information on a regular basis regarding construction progress, laborer availability, equipment deployment, testing, etc.

1.11.10 The progress reports shall indicate the progress achieved against plan, indicating reasons for delays, if any. The report shall also give remedial actions which the contractor intends to make good the slippage or lost time so that further works can proceed as per the original plan the slippages do not accumulate and affect the overall programme.

1.11.11 The contractor to reflect actual progress achieved during the month and will be submitted to BHEL, so that slippages can be observed and necessary action taken in order to ensure that the situation does not get out of control will update the construction schedule forming part of this contract each month.

VOLUME-IA PART- I CHAPTER-XII

1.12.0 MATERIAL HANDLING

1.12.1 Open land as available shall be provided by BHEL on free of cost basis as provided by NTPL. Contractor shall maintain one centralized fenced store cum bar bending yard at his own cost. Hard surfacing of this yard and all round drain shall be carried out by the contractor at his own cost within the quoted rate. Batching plant area, shall be provided nearer plant premises and contractor shall make use of the area for installation and operation of the Batching Plant at his own cost. The bidder shall make complete arrangement of necessary security personnel, to safeguard all such materials in his custody at his own cost. Materials issued will be used only for construction of permanent work. The contractor shall take care of material issued by BHEL and shall protect the same from theft, damage and weathering at his own cost.

1.12.2 The system for receipt, storage & issue of materials shall be available with vendors for easy traceability.

1.12.3 Periodic audit of system of purchasing, storing and issue, etc. will have to be carried out by the vendors. BHEL will also audit the same.

1.12.4 The contractor shall construct waterproof cement store (capacity 400MT or as directed by engineer in-charge based on requirement at site) for initial period for storing and stacking of cement at his own cost, CGI/ asbestos roofing (slope) with brick masonry wall, PCC flooring. Materials required for the same shall be provided by contractor at his own cost. Cement has to be kept over wooden raised platform. Stacking of cement is to be done as per IS codes with proper illumination and locking arrangements.

1.12.5 The contractor shall in no case be entitled for any compensation or damages on account of any delay in supply or non-supply thereof for all or any such material.

1.12.6 Clotting of cement and excessive rusting of steel must be avoided. In case, due to any cause attributable to the contractor, rusting of steel for BHEL issued steel occur rendering the same unusable, then such quantity of cement steel shall be recovered from the interim payment at the penal rate specified in the tender.

1.12.7 The contractor shall maintain proper store account for all the BHEL issued materials and shall give three copies of computerized reconciliation statement of such account to the BHEL with each running bill.

1.12.8 All TMT shall be stacked over sleeper's diameter wise.

1.12.9 Materials shall not under any circumstances taken out of the project site unless otherwise permitted by BHEL.

1.13ACCOUNTING OF MATERIAL ISSUE

The material issued to the contractor by BHEL will be accounted as follows:

1.13.1 ISSUE OF CEMENT

1.13.1.1 Cement as received from the manufacturer/ stockiest will be issued **free of cost** to the contractor. The cement shall be provided normally in bulkers and shall be unloaded in the silos (2 Nos cement silo of 100MT per 30CUM batching plant) to be installed by the bidder nearer to their batching plants. This is only minimum requirement and the No of cement silos shall be increased based on the site requirement. Unloading arrangements shall be provided by the bidder at his own cost including provision of necessary manpower support.

1.13.1.2 On advance request of the bidder, the cement shall be supplied in 50kg tamper proof sealed Bags for other than RCC works like masonry, flooring works etc. The theoretical weight of each bag of cement for issued purposes will be considered as 50 kg, the contractor shall be accountable for the cement issued to him on this notional weight only. No claim whatsoever will be entertained because of difference between theoretical and actual weight of the bags of cement. The empty cement bags duly accounted for against issue shall be in the custody of the contractor and the same shall be disposed by the contractor as per statutory regulation prevailing in the project. Proper storage area/ shed shall be constructed by successful bidder at his own cost.

1.13.1.3 The contractor shall submit to the engineer, a statement indicating estimated quantity of cement required during a quarter, at least two months in advance of the quarter. In addition, the contractor shall also furnish the estimated requirement of cement during a month by the third week of the previous month indicating his requirement.

1.13.1.4 Bidder is responsible for unloading the cement as soon as the arrival of cement, either in silo, if received in bulker or in the weather proof cement storage sheds, if received bags. Bagged cement shall be stored in a weatherproof shed having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements (to be made by the contractor at his own cost) shall be fully completed and approved by the owner (BHEL/NTPL) before any cement is delivered to site. The construction of cement storage sheds as per the requirement of BHEL, unloading of cement bags, stacking properly in the storage sheds, removal of the sheds after the completion of the work is in the scope of bidder within the quoted price.

1.13.1.5 Bidder is responsible for sampling and testing of cement as per Indian Standard/Specification/approved quality plan in the testing laboratory established by the bidder.

1.13.1.6 Bidder is responsible for carrying out design mix as per IS 456/10262 Latest revision and specification, using the cement provided by BHEL and submit the design mix proportions for the approval of BHEL/NTPL. The design/trial mix shall be carried out time to time on change of brand/type of cement supplied by BHEL and suitable adjustments on the quantity of ingredients (fine aggregates, coarse aggregates, admixture) of the concrete to get the required workability and durability, shall be the responsibility of the bidder without any extra cost to BHEL.

1.13.1.7 Following shall be limit for the maximum quantity of BHEL issue materials that would be with the contractor at any point of time when work is in progress (excluding what has already been incorporated in the works).

SLNO	ISSUE OF MATERIALS	MAX. QTY IN CONTRACTOR'S STORE
1.	Cement	Requirement of one month

1.13.2 RETURN OF CEMENT

Sealed cement bags remaining unused and in perfectly good condition at the time of completion or termination of the contract shall be returned promptly, (within 15 days from assessment) if BHEL/ Engineer is satisfied of the physical condition of the cement. Return of such cement to the project stores/ place as identified within the project area by Engineer/ BHEL will not be entitled to handling and incidental charges. Surplus sealed and good conditioned cement bags will be taken back on weighment basis.

1.13.3 CEMENT CONSUMPTION AND WASTAGE

The theoretical consumption of cement shall be based on the following.

i. For design mix concrete as per approved design mix.

ii. For nominal mix concrete work, as per minimum cement as specified or as approved by Engineer-in-charge.

For item of works, where volume mix is permitted in writing by the BHEL, for masonry works, plaster other miscellaneous items, the cement consumption shall be governed by the "Statement of Cement Consumption" attached to the Delhi schedule of Rates of CPWD-DSR- LATEST REVISION unless otherwise specified in the specifications or the drawing of contract or mutually agreed by Engineer-in-charge and contractor.

Actual consumption = Issue – Surplus/ unused quantity of cement returned in good condition by contractor to store. (No sweep cement will be taken back by BHEL).

1.13.4 CEMENT WASTAGE

Allowable wastage: One and half percent (+1.5%) of theoretical consumption of cement unless specified otherwise in the technical specification.

For any material issued by BHEL to the contractor free of cost, and which is not accounted by the contractor to BHEL, then recovery for such material shall be effected at penal rates.

Sl No	Cement consumption	Basis of issue & penal recovery
C-1	Theoretical consumption (without considering any wastage or loss).	Free
C-2	Actual consumption being Limited to one and half percent (+1.5%) of aforesaid theoretical consumption towards allowable wastage.	Free
C-3	Actual consumption beyond one and half percent (+1.5%) of above (C-1).	Penal rate

1.13.5 ISSUE OF STEEL

1.13.5.1 The steel shall be issued to the contractor on the following basis:

(a) Structural Steel : Weighment basis (Unit – MT)

(b) Reinforcement Steel : Weighment basis (Unit – MT)

and Earthing rod (MS round).

1.13.5.2 All the steel (structural, reinforcement, earthing MS rod,) issued by the BHEL shall be properly accounted for. The total quantity of steel required for the work will be calculated from the approved Bar Bending schedule, fabrication drawings, approved laps, chairs and lugs. The measurement for payment as well as for accounting shall be based on the sectional weights as indicated in the following IS specifications. No rolling tolerances shall be accepted in any case for issue, return of materials, reconciliation and payment purposes.

IS: 808 (Latest revision) Beams, Channels and Angles

IS: 1730 (Latest revision) Plates, Sheets and Strips/Flats

IS: 1732 (Latest revision) Rounds including deformed high yield strength bars.

IS:1786 (Latest revision) Reinforcement steel

1.13.5.3 In case any such sectional weights are not available in the above documents, the manufacturer recommendation shall be binding.

1.13.5.4 The steel issued to the contractor shall be mainly in standard length and sections as received from the supplier. However, the contractor shall be bound to accept the steel in length as available in the project stores no claims for extra payment because of issue of non-standard length will be entertained.

1.13.5.5 The contractor shall satisfy himself of the quality and quantity of the materials at the time of taking delivery from BHEL stores. No claims whatsoever will be entertained by BHEL because of quality or quantity after the materials are taken by the contractor from BHEL stores.

1.13.5.6 The contractor shall submit to the engineer, a statement indicating estimated quantity of steel required during a quarter, at least two months in advance of the quarter. In addition, the contractor shall also furnish the estimated requirement of steel during a month by the third week of the previous month indicating his requirement.

1.13.5.7 Following shall be limit for the maximum quantity of BHEL issue materials that would be with the contractor at any point of time when work is in progress (excluding what has already been incorporated in the works).

Sl.No	Issue of materials	Max Qty in contractor's store
1.	Reinforcement steel & earthing rod MS round.	Requirement of one month.

1.13.5.8 Bidder to note that steel materials required for foundation bolts, embedded items, etc. other than those supplied by BHEL, etc shall be supplied by the bidder. However, Bidder shall use the scrap materials (if issued by BHEL) for their use in the permanent works as embedment/inserts etc. after necessary store issue formalities and shall be accounted for monthly reconciliation.

1.13.6 RETURN OF MATERIALS

1.13.6.1 All surplus steel and all wastage materials will be taken back on weighment basis.

1.13.6.2 Surplus, unused and untampered steel shall be sorted section-wise and returned separately for a place directed by BHEL/Engineer within the project area. Return of such materials will not be entitled to any handling and incidental charges.

1.13.6.3 All wastage / scrap (including melting scrap, wastage, un usable scrap) shall be promptly returned to the stores and a receipt obtained for material accounting purposes. Return of such material will not be entitled to any transportation and incidental charge.

1.13.7 **SCRAP & SERVICEABLE MATERAILS:**

1.13.7.1 All pipes measuring 2 M and above in length shall be treated as serviceable materials provided, they are in good and acceptable condition. Pipe in less than 2 M length shall be treated as scrap.

1.13.7.2 All TMT measuring 3 M and above in length shall be treated as serviceable materials provided, they are in good and acceptable condition. TMT in less than 3 M length shall be treated as scrap.

1.13.7.3 All structural steel of length above 2m except MS plate shall be considered as serviceable materials provided the material is in good and acceptable condition. Structural steel in length less than 2m shall be treated as scrap.

1.13.7.4 MS plates having both sides greater than 1 meter or if any side is less than 1m but greater than 0.5m and the total area is equal or greater than 2 sq. m. shall be considered as serviceable.

1.13.8 **STEEL CONSUMPTION AND WASTAGE**

1.13.8.1 **REINFORCEMENT AND EARTHING ROD MS ROUND STEEL CONSUMPTION AND WASTAGE.**

a) CONSUMPTION.

The theoretical consumption of various sections and/or diameter of reinforcement and earthing rod steel shall be based on approved construction drawing and bar bending schedule. Weight shall be calculated considering the sectional weights as per Indian standards. No extra cost shall be payable to the contractor for any deviation in weights for the different procedures adopted for issue and calculation of the theoretical consumption including rolling tolerances.

i) Actual consumption = Issue – Surplus.

Surplus = Un-tampered & unused quantity of steel and

Serviceable materials as stipulated under clause “Scrap and Serviceable Materials (Refer Clause 1.8.2.2 above)” returned by the contractor to BHEL store along with relevant documents.

ii) Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

ALLOWABLE WASTAGE: - (+3%) of the theoretical consumption shall be considered as allowable wastage. Invisible wastage (max limit to 0.5%), if any, shall be considered to be included in the specified 3 % allowable wastage.

S.No	CONSUMPTION OF REINFORCEMENT STEEL & EARTHING ROD, MS ROUND	BASIS OF ISSUE
R-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
R-2	Wastage limited to plus three percent (+3%) of the aforesaid theoretical consumption (R-1) towards allowable wastage including invisible wastages (invisible wastages limited to 0.5% of theoretical consumptions)	Free
R-3	Wastage beyond three Percent (3%) of the aforesaid theoretical consumption (R-1)	Penal Rate

1.13.8.2 **STRUCTURAL STEEL, (ROLLED SECTION, PLATES ETC.) CONSUMPTION & WASTAGE.**

A) CONSUMPTION: -

The theoretical consumption of various sections shall be based on approved drawings. Weights shall be calculated considering the sectional weights as per Indian standard. No extra shall payable to the contractor for any deviation in weights for the two different procedures adopted for issue and calculation of the theoretical consumption including rolling tolerances.

i) Wastage = Actual consumption – Theoretical consumption.

b) WASTAGE

Allowable wastage: - 4% (FOUR percent) of the theoretical consumption shall be considered. Wastage shall be considered as cut pieces and scrap material, measured as per actual weighment basis. Invisible wastage (max limit to 0.5%), if any, shall be considered to be included in the specified 4 % allowable wastage.

S.No	CONSUMPTION OF STRUCTURAL STEEL (ROLLED SECTION, PLATES)	BASIS OF ISSUE
S-1	Theoretical consumption (without considering any wastage, scrap or loss) as per spec. & drg.	Free
S-2	Wastage limited to plus Four percent (+4%) of the aforesaid theoretical consumption (S-1) towards allowable wastage including invisible wastages (invisible wastages limited to 0.5% of theoretical consumptions)	Free
S-3	Wastage beyond four Percent (4%) of the aforesaid theoretical consumption (S-1)	Penal Rate

1.13.9 RECONCILIATION OF MATERIALS

The contractor shall submit a reconciliation statement of steel issued to him along with each RA Bill.

At the time of submission of bills, the contractor shall properly account for the material issued to him as specified herein to the satisfaction of BHEL certifying that the balance material are available in contractor's custody at site.

At the time of submission of bills by the contractor, if it is noticed by BHEL that the wastage is high and calls recovery at the penal rate, then, BHEL will proceed for recovery for the excess wastage as per penal recovery rates as specified.

The reference drawings for actual material consumption to be used for the purpose of reconciliation shall be drawings prepared by the BHEL and drawings approved by BHEL for fabrication works and such other drawings approved by BHEL. This shall also include the bar bending schedule prepared by the contractor and approve by BHEL.

1.13.10 RECOVERY OF MATERIAL

If wastage exceeds the specified limit, the recovery of excess wastage shall be made from monthly R/A Bill at the Penal Rate.

1.13.11 PENAL RATE OF MATERIALS

A	**REINFORCEMENT STEEL** Cold rolled steel, high strength, deformed bar or mild steel round bars including earthing rod MS round	**Rs. 43,050/- per MT** + GST and/or other taxes & duties
B	**STRUCTURAL STEEL** MS plates, MS flats, rolled steel joists, channels, and angles, MS pipes, Chequered Plates, etc in sizes and lengths as available	**Rs. 47,395/- per MT** + GST and/or other taxes & duties
C	**CEMENT (OPC/ PPC/PSC)**	**Rs. 4,127/- per MT** + GST and/or other taxes & duties

1.14 MODALITY FOR RISK & COST WORK

1.14.1 If contractor fails to comply with the project requirement at site, then at discretion of BHEL Engineer In-Charge BHEL reserves the right to get the work carried out at risk & cost of contractor. Before taking up such work, contractor will be served due notice of intimation.

1.14.2 For general modality of risk & cost process & rights of BHEL, amendment to GCC (Sl. No. 6, attached with TCC) shall be referred.

1.14.3 Risk and cost work can be taken up in following manner:

a. To terminate the contract or withdraw one portion of work and get it done through other agency

b. To provide

i. construction material viz. coarse aggregate, fine aggregate, admixture, corrosion inhibitor, binding wire, nails, shuttering ply wood & wooden battens, gunny bags, water proofing admixtures, bricks, grouting mixes, soling materials, grits for short blasting, cutting gases, welding electrodes, diesel, lubricants, etc.

ii. Bought out materials: doors & windows, ventilators, partitions, sanitary wares, rain water down comers, plumbing items, sheeting & cladding items, false ceiling & false flooring, under deck insulation, paints, foundation bolts, insert plates, flooring items, fencing & gate items, erection bolts, handrail pipes, gratings, etc.

iii. Tools & plants: Excavator (all capacities upto 0.9 cum bucket), pick & carry cranes, crawler cranes upto 150 tonne SWL, tyre mounted crane, compressor for short blasting, dewatering pumps, well point dewatering system, welding machine, welding rectifiers, gas cutting machine, bar bending machine, bar cutting machine, shuttering plate cutting tool, dumper, loader, trailer, transit mixer, cube testing machine, soil testing apparatus, aggregate testing apparatus, ultra- sonography machine with printing facility, drilling machine, concrete cutting tools, bolt tightening machine, etc.

iv. Manpower: Bar bender, carpenter, gas cutter, rigger, khalasi, foreman, mason, welder, helper, unskilled labour, supervisors, HR service providers (or HR facilitation agencies), painter, semi- skilled labour, skilled labour, highly skilled labour, batching plant operator, crane operator, operator for other machineries, engineers and other supervisory & administrative staff, etc.

1.14.4 For modality of 1.12.3 (a), notice of risk & cost will be served from BHEL-PSSR Sub-contracting department prior to commencement of such risk & cost work. For remaining all cases, notice will be served by BHEL Site In- Charge (or BHEL Engineer In- Charge, as applicable).

1.14.5 Detailed mode of operation for 1.12.3 (b):

i. Construction materials:

a. After commencement of work at site, contractor shall submit details of all the suppliers to BHEL along with their valid account number, detail of contact person, copy of agreement made between contractor & supplier and terms of payment & mode of measurement for supply. The details of suppliers shall be updated to BHEL office as and when changes (i.e. addition or deletion) occur.

b. Contractor shall submit details of material supplied by each supplier along with RA bill. Copy of invoice submitted by supplier shall be submitted to BHEL office along with each RA bill corresponding to the quantum of work claimed in RA bill.

c. Contractor shall make payment to his supplier within 30 days of receipt of invoice from supplier. In case, contractor fails, supplier may approach BHEL site office. After taking cognizance of the matter & scrutiny of quantity supplied, BHEL site shall serve letter to contractor for making payment with a time line of 7 days. If contractor fails, BHEL site will make direct payment due to supplier and the same along with BHEL overhead (i.e. @5%) shall be deducted/ recovered from payment due to contractor (or shall be adjusted in RA bill in currency). For making direct payment, quantity scrutinized by BHEL shall be given to contractor for their acceptance. Contractor shall submit their acceptance / comments (if any) within 3 days of such notice. After that, BHEL site will initiate direct payment to supplier in context.

d. In the event of contractor's failure in supply of construction material, BHEL site will supply such construction material at risk & cost of contractor. For such supply, requirement of material as per monthly planning shall be considered. Contractor shall depute his representative for measurement of receipt of such materials, which will be jointly signed by BHEL representative & contractor's representatives. If contractor fails to depute such representative, then measurement finalized by BHEL representative shall be final and binding on contractor. Arrangement of all gate passes required for entry of material inside plant shall be made by contractor. If contractor fails, then the same shall be arranged by BHEL site (i.e. either by means of engaging required personnel through a separate agency or through direct engagement of such personnel on contract basis) at risk & cost of contractor. Material received shall be unloaded in contractor's yard and its watch & ward will be in the scope of contractor.

ii. Bought out materials:

a. After commencement of work at site, contractor shall submit details of all the approved suppliers to BHEL along with their valid account number, detail of contact person, copy of agreement made between contractor & supplier and terms of payment & mode of measurement for supply. The details of suppliers shall be updated to BHEL office as and when changes (i.e. addition or deletion) occur.

b. Contractor shall submit details of material supplied by each supplier along with RA bill. Copy of invoice submitted by supplier shall be submitted to BHEL office along with each RA bill corresponding to the quantum of work claimed in RA bill.

c. Contractor shall make payment to his supplier within 60 days of receipt of invoice from supplier. In case, contractor fails, supplier may approach BHEL site office. After taking cognizance of the matter & scrutiny of quantity supplied, BHEL site shall serve letter to contractor for making payment with a time line of 14 days. If contractor fails, BHEL site will make direct payment due to supplier and the same along with BHEL overhead (i.e. @5%) shall be deducted/ recovered from payment due to contractor (or shall be adjusted in RA bill in currency). For making direct payment, quantity scrutinized by BHEL shall be given to contractor for their acceptance. Contractor shall submit their acceptance / comments (if any) within 3 days of such notice. After that, BHEL site will initiate direct payment to supplier in context.

d. In the event of contractor's failure in supply of bought out material, BHEL site will supply such bought out material at risk & cost of contractor. For such supply, requirement of material as per drawing at site shall be considered. Contractor shall depute his representative for measurement of receipt of such materials, which will be jointly signed by BHEL representative & contractor's representatives. If contractor fails to depute such representative, then measurement finalized by BHEL representative shall be final and binding on contractor. Arrangement of all gate passes required for entry of material inside plant shall be made by contractor. If contractor fails, then the same shall be arranged by BHEL site (i.e. either by means of engaging required personnel through a separate agency or through direct engagement of such personnel on contract basis) at risk & cost of contractor. Material received shall be unloaded in contractor's store and its watch & ward will be in the scope of contractor.

iii. Tools & plants: A. Hired T & Ps:

a. After commencement of work at site, contractor shall submit details of all the T & Ps service provider to BHEL along with their valid account number, detail of contact person, copy of agreement made between contractor and T&Ps owner and terms of payment & mode of measurement for service. The details of service provider shall be updated to BHEL office as and when changes (i.e. addition or deletion) occur.

b. Contractor shall submit details of hired T&Ps by each service provider along with RA bill. Copy of invoice submitted by service provider shall be submitted to BHEL office along with each RA bill corresponding to the quantum of work claimed in RA bill.

c. Contractor shall make payment to his service provider within 60 days of receipt of invoice from service provider. In case, contractor fails, service provider may approach BHEL site office. After taking cognizance of the matter & scrutiny of service provided, BHEL site shall serve letter to contractor for making payment with a time line of 7 days. If contractor fails, BHEL site will make direct payment due to service provider and the same along with BHEL overhead (i.e. @5%) shall be deducted/ recovered from payment due to contractor (or shall be adjusted in RA bill in currency). For making direct payment, quantity scrutinized by BHEL shall be given to contractor for their acceptance. Contractor shall submit their acceptance / comments (if any) within 3 days of such notice. After that, BHEL site will initiate direct payment to supplier in context.

d. In the event of contractor's failure in mobilization/ providing service of required T&Ps, BHEL site will arrange at risk & cost of contractor. Contractor shall depute his representative for measurement of receipt of such service, which will be jointly signed by BHEL representative & contractor's representatives. If contractor fails to depute such representative, then measurement finalized by BHEL representative shall be final and binding on contractor. Arrangement of all gate passes required for entry of T&Ps inside plant shall be made by contractor. If contractor fails, then the same shall be arranged by BHEL site (i.e. either by means of engaging required personnel through a separate agency or through direct engagement of such personnel on contract basis) at risk & cost of contractor.

iv. Manpower:

a. After commencement of work at site, contractor shall submit details of all the manpower service provider (and/ or direct labour being engaged and/ or own engineer & supervisory staff) to BHEL along with their valid account number, detail of contact person, copy of agreement made between contractor and manpower service provider and terms of payment & mode of measurement for service. The details of service provider shall be updated to BHEL office as and when changes (i.e. addition or deletion) occur.

b. Contractor shall submit details of each service provided along with RA bill. Copy of invoice submitted by service provider shall be submitted to BHEL office along with each RA bill corresponding to the quantum of work claimed in RA bill.

c. Contractor shall make payment to his service provider within 15 days of receipt of invoice from service provider. In case, contractor fails, service provider may approach BHEL site office. After taking cognizance of the matter & scrutiny of service provided, BHEL site shall serve letter to contractor for making payment with a time line of 7 days. If contractor fails, BHEL site will make direct payment due to service provider and the same along with BHEL overhead (i.e. @5%) shall be deducted/ recovered from payment due to contractor (or shall be adjusted in RA bill in currency). For making direct payment, quantity scrutinized by BHEL shall be given to contractor for their acceptance. Contractor shall submit their acceptance / comments (if any) within 3 days of such notice. After that, BHEL site will initiate direct payment to supplier in context.

d. In case of direct labour engaged by contractor, wages shall be paid on the due date as finalized among customer, BHEL & contractor in line with provisions of various labor acts. Failing to which, BHEL site shall serve letter to contractor for making payment with a time line of 7 days. If contractor fails, BHEL site will make direct payment due to labourer and the same along with BHEL overhead (i.e. @5%) shall be deducted/ recovered from payment due to contractor (or shall be adjusted in RA bill in currency). For making direct payment, quantity scrutinized by BHEL shall be given to contractor for their acceptance. Contractor shall submit their acceptance / comments (if any) within 3 days of such notice. After that, BHEL site will initiate direct payment to labourer. This category of labourer also includes operators of various T & Ps mobilised by contractor.

e. In case of engineering/ supervisory staff of contractor, salary shall be paid on the due date as finalized contractor in line with provisions of various labor acts and intimated to BHEL site office at the time of commencement of work. Failing to which, BHEL site shall serve letter to contractor for making payment with a time

line of 14 days. If contractor fails, BHEL site will make direct payment due to engineering/ supervisory staff and the same along with BHEL overhead (i.e. @5%) shall be deducted/ recovered from payment due to contractor (or shall be adjusted in RA bill in currency). For making direct payment, quantity scrutinized by BHEL shall be given to contractor for their acceptance. Contractor shall submit their acceptance / comments (if any) within 3 days of such notice. After that, BHEL site will initiate direct payment to engineering/ supervisory staff.

f. In the event of contractor's failure in deploying required manpower, BHEL site will arrange at risk & cost of contractor. Contractor shall depute his representative for measurement of receipt of such service, which will be jointly signed by BHEL representative & contractor's representatives. If contractor fails to depute such representative, then measurement finalized by BHEL representative shall be final and binding on contractor. Arrangement of all gate passes, including labour license, insurance, PF, etc. required for entry of manpower inside plant (or compliance of various labour laws in vogue) shall be made by contractor. If contractor fails, then the same shall be arranged by BHEL site (i.e. either by means of engaging required personnel through a separate agency or through direct engagement of such personnel on contract basis) at risk & cost of contractor. If direct labour engaged on daily basis, then manday will be the mode of measurement. If labour/ supervisory staff engaged through another agency, then the mode of measurement finalized between BHEL & the agency shall prevail.

g. In case, BHEL provides operator of various T&Ps mobilized by contractor (upon failure of contractor), then BHEL reserves all the rights to use such mobilized T&Ps for the package/ project through thus provided operators. Contractor shall be responsible for providing all necessary support to BHEL and thus provided operators to operate the T&Ps successfully and ensure the continuous progress in site. If required, contractor shall train such operator regarding their mobilized T&Ps. For all sort of risk or damage, if any, takes place to the T&Ps mobilized by contractor in the course of operation by such operators, contractor shall be fully responsible and will not be entitled to raise any claim against those to BHEL.

VOLUME - IA PART – I CHAPTER – XV

1.15 TEST PILE INSTALLATION AND LOAD TESTING

1.15.1 Commencement of test pile installation work and completion of all initial pile load test is very critical for this package. Hence, contractor has to mobilize minimum necessary T & Ps required for completion of test pile work, within 15 days of placement of LOI or 7 days of handing over of drawings for test pile work, whichever is later.

1.15.2 Approximate number of tests piles are 30. Diameter of pile will 450mm, 600mm and 760mm. Depth of pile will vary tentatively from 6m to 20m. For exact length of pile, drawings for test pile shall be referred, which will be issued after award of contract.

1.15.3 Arrangement of cement and reinforcement steel required for test pile work is in the scope of contractor. Generally, cement shall be of 43 grade ordinary Portland cement conforming to IS:269-2015. Reinforcement steel shall be of Fe 500 grade corrosion resistant steel and as per relevant IS specification as mentioned in the contract/ drawings/ instructions. All bars shall be of tested quality. Reinforcement steel brought to site shall be of prime steel manufacturer viz. SAIL, JSPL, RINL, TATA STEEL. Reinforcement steel shall be procured either from the manufacturer as mentioned above or from authorized dealer of those mentioned manufacturer. Prior to procurement of cement, approval shall be sought from BHEL/ Owner. For RMC, approval shall be taken for cement to be used by RMC supplier.

1.15.4 For casting of test piles, effort shall be made for making tie up with available RMC supplier in and around Thoothukudi for supply of ready-mix concrete for faster execution of test piles. Prior approval of RMC supplier shall be sought from BHEL/ Customer/ Owner. In connection to approval of RMC, all the relevant document of RMC supplier viz. source of aggregate, petrographic examination report of aggregates, initial tests and routine tests of aggregates (as per technical specification or IS:383), calibration certificate of batching plant, License for RMC production, water test report, etc. shall be submitted for BHEL/ Owner review.

1.15.5 Following concrete mix shall be used for reference, only for test piling works:

Cement: 425 kg, Water: 183 kg, Fine aggregate: 748 kg, Coarse aggregate (20mm – 562kg, 12.5mm downsize – 562 kg), Admixture – 2.975 kg (SIKAMENT 3007NS)

1.15.6 Prior to use, trial mix at site shall be taken and to be tested by ACT (Accelerated curing tank) method for establishment of concrete strength. Minimum number of cubes to taken are as follows:

a) For ACT – 6 nos

b) For 3 days testing – 6 nos

c) For 7 days testing – 6 nos

d) For 28 days testing – 6 nos

After establishment of concrete strength by ACT method, supply of RMC for test pile casting can be commenced.

1.15.7 Minimum one hydraulic rotary rig (or DMC rig as approved by BHEL/ Owner for installation of test pile or as mentioned in drawing) for test pile works shall be arranged within 15 days of placement of LOI or 7 days of handing over of drawing for test pile, whichever is later. The same can be demobilized after installation of all test piles or as per direction of engineer in-charge.

1.15.8 Tie up with technically capable pile load testing agency shall be made within 20 days of placement of LOI and all relevant document shall be submitted to BHEL/ Owner for approval. Subsequently methodology for initial pile load testing shall be submitted to BHEL/ Owner for approval prior to commencement of initial load testing work.

1.16 Amendment to Technical speciation for earth work in excavation and backfilling (Specification no. PE-TS-483-600-C001, Volume IIB, Section-D, Sub-section – D1, Clause no. 5.2.0)

1.16.1 Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

1.16.2 The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

1.16.3 For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

1.16.4 Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

1.16.5 Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

VOLUME-IA PART – II CHAPTER 1

CORRECTIONS / REVISIONS IN SPECIAL CONDITIONS OF CONTRACT, GENERAL CONDITIONS OF CONTRACT AND FORMS & PROCEDURES

Sl No: 1

Clause 4.1.11 of SCC is deleted.

Sl No: 2:

OCCUPATIONAL HEALTH, SAFETY & ENVIRONMENT MANAGEMENT/ QUALITY ASSURANCE PROGRAMME

The following clauses in Occupational Health, Safety & Environment Management / Quality Assurance Programme published in Chapter-IX of Special Conditions of Contract (Volume I Book-II) is revised as under.

Chapter IX Clause 9.1 is modified as below:

Contractor will comply with HSE (Health, Safety & Environment) requirements of BHEL as per the "HSE Plan for Site Operations by Subcontractor" (Document No. HSEP: 14 Rev01) enclosed.

Chapter IX Clause 9.1.1 to 9.1.25 stands deleted.

Chapter IX Clause 9.2 to 9.62 stands deleted.

Sl No: 3:

Clause No. 10.5 on RA Bill Payments, in Special Conditions of Contract (SCC), Volume-IB, Book-II, is revised as under:

The payment for running bills will normally be released within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc., and other dues in the meanwhile.

Sl No: 4

The EARNEST MONEY DEPOSIT (EMD) clause 1.9 published in General Conditions of Contract (Volume I Book-II) is revised as under.

1.9 EARNEST MONEY DEPOSIT

1.9.1 Every tenderer must furnish the prescribed amount of Earnest Money Deposit (EMD) to BHEL PSSR, only in the following forms: -

i. Electronic Fund Transfer credited in BHEL account (before tender opening).

ii. Through Online EMD payment portal, before tender opening, by following these steps.
    1. Visit www.onlinesbi.com -> Go to State Bank Collect (In the tab section)
    2. Click Check box to proceed for payment -> Click on Proceed
    3. Under State of Corporate/Institution ->Select Tamilnadu
    4. Under Type of Corporate/Institution -> Select PSU – Public Sector Undertaking ->Go
    5. Under PSU – Public Sector Undertaking Name -> Select BHEL PSSR CHENNAI and Submit
    6. Under Select Payment Category ->-> SCT Tender EMD & Tender Fees
iii. Banker's cheque or Pay order or Demand Draft in favour of 'Bharat Heavy Electricals Limited' (along with offer) and payable at Chennai.
iv. Fixed Deposit Receipt (FDR) issued by Scheduled Banks/ Public Financial Institutions as defined in the Companies Act (FDR should be in the name of the Contractor, a/c BHEL) along with the offer.
v. In case EMD amount is more than Rs. Two Lakhs, Tenderer has the option to submit Rs. Two lakhs in the forms described above in clause no. 1.9.1. (i) to (iv) and the remaining amount over and above Rs. Two Lakhs in the form of Bank Guarantee from Scheduled Bank (along with the Offer).

Note:

a) Proforma for Bank Guarantee for EMD- Form WAM 23 is enclosed with this Tender in Volume-1A Part II Chapter 9.
b) The Bank Guarantee shall be valid for at least six months from the due date of tender submission mentioned in the Notice Inviting Tender.
c) Date of Expiry of Claim shall be as given in Proforma of Bank Guarantee (in lieu of Earnest Money)-Form WAM 23.

Bank Details for the purpose of Taking EMD BG

Name and Address of Beneficiary:	Bharat Heavy Electricals Ltd. Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097.
Name of Bank of Client :	State Bank Of India
Bank Branch Address:	SBI Saidapet Branch, EVR Periyar Building, Nandanam, Anna Salai, Chennai - 600035
IFSC Code :	SBIN0000912
Account No. :	10610819499

Details for SFMS (Structured Financial Messaging System) transmission of BG

Bank and Branch	SBI TFCPC Branch
Branch Code	5056
IFSC Code	SBIN0005056

1.9.2 EMD shall not carry any interest.

1.9.3 EMD by the Tenderer will be forfeited as per NIT Conditions, if:

i. After opening the tender and within the offer validity period, the Tenderer revokes his tender or makes any modification in his tender which is not acceptable to BHEL.

ii. The Contractor fails to deposit the required Security deposit or commence the work within the period as per LOI/Contract

1.9.4 EMD given by all unsuccessful tenderers will be refunded normally within 15 days of award of work.

1.9.5 EMD of successful tenderer will be retained as part of Security Deposit.

1.9.6 EMD by the tenderer shall be withheld in case any action on the tenderer is envisaged under the provisions of extant" Guidelines on Suspension of Business dealings with suppliers/contactors" and forfeited / released based on the action determined under these guidelines.

Sl No: 5

SECURITY DEPOSIT: The SECURITY DEPOSIT (SD) clause 1.10 published in General Conditions of Contract (Volume I Book-II) is revised as under.

1.10 Security Deposit:

1.10.1 Upon acceptance of Tender, the successful Tenderer should deposit the required amount of Security Deposit for satisfactory completion of work, as given below:

1.10.2 The total amount of Security Deposit will be 5% of the contract value. EMD of the successful tenderer shall be converted and adjusted towards the required amount of Security Deposit.

1.10.3 The security Deposit should be furnished before start of the work by the contractor.

1.10.4 Modes of deposit:

1.10.4.1 The balance amount to make up the required Security Deposit of 5% of the contract value may be furnished in any one of the following forms

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

ii. Local cheques of Scheduled Banks (subject to realization)/ Pay Order/ Demand Draft/ Electronic Fund Transfer in favour of BHEL

iii. Bank Guarantee from Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The Bank Guarantee format for Security Deposit shall be in the prescribed formats.

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

v. Securities available from Indian Post offices such as National Savings Certificates, Kisan Vikas Patras etc. (Certificates should be held in the name of Contractor furnishing the security and duly endorsed/ hypothecated/ pledged, as applicable, in favour of BHEL and discharged on the back)

(Note: BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith)

1.10.5 At least 50% of the Security Deposit including the EMD should be deposited in any form as prescribed before start of the work and the balance 50% of the Security Deposit will be recovered by deducting 10% of the gross amount progressively from each running bills of the contractor till the total amount of the required Security Deposit is collected.

1.10.6 The recoveries made from running bills (cash deduction towards balance SD amount) will be released against submission of equivalent Bank Guarantee in the prescribed formats, but only once, before completion of work.

1.10.7 The Security Deposit shall not carry any interest.

1.10.8 If the value of work done at any time exceeds the contract value, the amount of Security Deposit shall be correspondingly enhanced and the excess Security Deposit due the enhancement shall be immediately deposited by the Contractor or recovered from payment/s due to the Contractor.

1.10.9 The validity of Bank Guarantees towards Security Deposit shall be initially upto the completion period as stipulated in the Letter of Intent/Award + 3 months, and the same shall be kept valid by proper renewal till the acceptance of Final Bills of the Contractor, by BHEL Date of Expiry of Claim shall be as given in the prescribed formats for Bank Guarantee towards Security Deposit.

1.10.10 BHEL reserves the right of forfeiture of Security Deposit in addition to other claims and penalties in the event of the Contractor's failure to fulfill any of the contractual obligations or in the event of termination of contract as per terms and conditions of

contract. BHEL reserves the right to set off the Security Deposit against any claims of other contracts with BHEL.

1.10.11 Penalty for Delayed Remittance of Security Deposit

If the contractor fails to furnish SD before start of work, in line with 1.10.3 above, Simple Interest against delayed remittance of the Security Deposit shall be deducted from the sub-contractor at the rate of SBI PLR + 2% on the value of 50% SD of the contract, for the delayed period (i.e., period between start of work and date of remittance of Initial SD, i.e., atleast 50% of SD). In case, the delayed period has different SBI PLR rates, Simple Interest shall be calculated based on different rates by considering the corresponding time period. On similar lines Penalty shall be levied for delayed remittance of Additional Security Deposit (if applicable).

Note: - Bank details & SFMS details provided above in Sl. No. 04 Earnest Money Deposit) may be used for the purpose of arranging Bank Guarantees towards Security Deposit / Additional Security Deposit also.

Sl No: 6

Clause 2.7.2 and 2.7.3 in GCC regarding Rights of BHEL is revised as under:

2.7.2.

2.7.2.1 To terminate the contract or withdraw portion of work and get it done through other agency, at the risk and cost of the contractor after due notice of a period of 14 days' by BHEL in any of the following cases:

i. Contractor's poor progress of the work vis-à-vis execution timeline as stipulated in the Contract, backlog attributable to contractor including unexecuted portion of work does not appear to be executable within balance available period considering its performance of execution.
ii. Withdrawal from or abandonment of the work by contractor before completion of the work as per contract.
iii. Non-completion of work by the Contractor within scheduled completion period as per Contract or as extended from time to time, for the reasons attributable to the contractor.
iv. Termination of Contract on account of any other reason (s) attributable to Contractor.
v. Assignment, transfer, subletting of Contract without BHEL's written permission.

vi. Non-compliance to any contractual condition or any other default attributable to Contractor.

Risk & Cost Amount against Balance Work:

Risk & Cost amount against balance work shall be calculated as follows:

Risk & Cost Amount= [(A-B) + (A x H/100)]

Where,

A= Value of Balance scope of Work (*) as per rates of new contract

B= Value of Balance scope of Work (*) as per rates of old contract being paid to the contractor at the time of termination of contract i.e. inclusive of PVC & ORC, if any.

H = Overhead Factor to be taken as 5

In case (A-B) is less than 0 (zero), value of (A-B) shall be taken as 0 (zero).

* Balance scope of work (in case of termination of contract):

Difference of Contract Quantities and Executed Quantities as on the date of issue of Letter for

'Termination of Contract', shall be taken as balance scope of Work for calculating risk & cost amount. Contract quantities are the quantities as per original contract. If, Contract has been amended,

quantities as per amended Contract shall be considered as Contract Quantities.

Items for which total quantities to be executed have exceeded the Contract Quantities based on drawings issued to contractor from time to time till issue of Termination letter, then for these items

total Quantities as per issued drawings would be deemed to be contract quantities.

Substitute/ extra items whose rates have already been approved would form part of contract quantities for this purpose. Substitute/ extra items which have been executed but rates have not been approved, would also form part of contract quantities for this purpose and rates of such items shall be determined in line with contractual provisions.

However, increase in quantities on account of additional scope in new tender shall not be considered for this purpose.

NOTE: Incase portion of work is being withdrawn at risk & cost of contractor instead of termination of contract, contract quantities pertaining to portion of work withdrawn shall be considered as 'Balance scope of work' for calculating Risk & Cost amount.

LD against delay in executed work in case of Termination of Contract:

LD against delay in executed work shall be calculated in line with LD clause no. 2.7.9 of GCC, for the delay attributable to contractor. For limiting the maximum value of LD, contract value shall be taken as Executed Value of work till termination of contract.

Method for calculation of "LD against delay in executed work in case of termination of contract" is given below.

i). Let the time period from scheduled date of start of work till termination of contract excluding the period of Hold (if any) not attributable to contractor = T1

ii). Let the value of executed work till the time of termination of contract= X

iii). Let the Total Executable Value of work for which inputs/fronts were made available to contractor and were planned for execution till termination of contract = Y

iv). Delay in executed work attributable to contractor i.e. T2=[1-(X/Y)] x T1

v). LD shall be calculated in line with LD clause (clause 2.7.9) of the Contract for the delay attributable to contractor taking "X" as Contract Value and "T2" as period of delay attributable to contractor.

2.7.2.2 In case Contractor fails to deploy the resources as per requirement, BHEL can deploy own/hired/otherwise arranged resources at the risk and cost of the contractor and recover the expenses incurred from the dues payable to contractor. Recoveries shall be actual expenses incurred plus 5% overheads or as defined in TCC.

2.7.3 **Recoveries arising out of Risk & Cost and LD or any other recoveries due from Contractor**

Following sequence shall be applicable for recoveries from contractor:

a) Dues available in the form of Bills payable to contractor, SD, BGs against the same contract.

b) Demand notice for deposit of balance recovery amount shall be sent to contractor, if funds are insufficient to effect complete recovery against dues indicated in (a) above.

c) If contractor fails to deposit the balance amount to be recovered within the period as prescribed in demand notice, following action shall be taken for balance recovery:

i) Dues payable to contractor against other contracts in the same Region shall be considered for recovery.

ii) If recovery cannot be made out of dues payable to the contractor as above, balance amount to be recovered, shall be informed to other Regions/Units for making recovery from the Unpaid Bills/Running Bills/SD/BGs/Final Bills of contractor.

iii) In-case recoveries are not possible with any of the above available options, Legal action shall be initiated for recovery against contractor.

SL No: 7

In addition to clause 2.7.9 of General Conditions of Contract (GCC), a New clause 2.7.9.1 is added as below.

2.7.9.1 Penalty for Intermediate Milestones

2.7.9.1.1 M1 and M2 shall be intermediate Milestones for this work.

2.7.9.1.2 In case of slippage of these identified Intermediate Milestones, Delay Analysis shall be carried out on achievement of each of these two Intermediate Milestones in reference to Form 14.

2.7.9.1.3 Incase delay in achieving M1 milestone is solely attributable to the contractor,0.5% per week of executable contract value* limited to Maximum 2% of executable contract value will be withheld.

2.7.9.1.4 Incase delay in achieving M2 milestone is solely attributable to the contractor,0.5% per week of executable contract value* limited to maximum 3% of executable contract value will be withheld.

2.7.9.1.5 Amount already withheld, if any, against slippage of M1 milestone, shall be released only if there is no delay attributable to contractor in achievement of M2 milestone.

2.7.9.1.6 Amount required to be withheld on account of slippage of identified intermediate milestone(s) shall be withheld out of respective milestone payment and balance amount (if any) shall be withheld @10% of RA Bill amount from subsequent RA bills.

2.7.9.1.7 Final deduction towards LD (if applicable), on account of delay attributable to contractor shall be based on final delay analysis on completion / closure of contract. Withheld amount, if any due to slippage of intermediate milestones shall be adjusted against LD or released as the case may be.

2.7.9.1.8 In case of termination of contract due to any reason attributable to contractor before completion of work, the amount already withheld against slippage of intermediate milestones shall not be released and be converted in to recovery.

Note: *Executable contract value-value of work for which inputs/fronts were made available to contractor and were scheduled for execution till the date of achievement of that milestone.

SL No: 8

OVERRUN COMPENSATION (ORC)

The **OVERRUN COMPENSATION (ORC)** clause 2.12 published in General Conditions of Contract (Volume I Book-II) is revised as under.

2.12 OVERRUN COMPENSATION (ORC)

2.12.1 **ORC during original contract period:** No ORC shall be applicable during the original contract period.

2.12.2 **ORC during extended period for the reasons solely attributable to contractor:** No ORC shall be applicable during the extended period granted for the reasons solely attributable to contractor and work executed during this period shall be paid as per original contract rates.

2.12.3 **ORC during extended period for the reasons not attributable to contractor:** ORC shall be payable as per following procedure:

2.12.3.1 For initial period of twelve months of extended period, ORC rate applicable over executed value shall be 5%. For every subsequent period of twelve months, ORC rate shall be further increased by 5% over the previous rate. For example, ORC rates applicable for initial period of 12 months and subsequent period of 12 months are given below.

Sl. No.	Extended Period for the reasons attributable to BHEL	ORC rate applicable over executed value
1	First 12 months	5%
2	13^{th}-24^{th} month and so on	10.25% {[(1.05 x 1.05)-1] x 100}

This process of increasing ORC rate for each subsequent period of 12 months shall continue till applicability of ORC.

2.12.3.2 On completion of original contract period as well as on completion of each subsequent period of twelve months i.e. at the time of change in applicable ORC rate, Delay Analysis

shall be carried out and percentage shortfall attributable to both BHEL & Contractor shall be calculated.

2.12.3.3 For the purpose of calculation of ORC, executed value of work in the month shall be divided in Part-1 and Part-2 in proportion of percentage shortfall attributable to BHEL and contractor respectively, based on the last delay analysis as worked out in 2.12.3.2.
ORC shall be payable only on Part-1 and no ORC shall be payable on Part-2.
Value of Part-1 shall be further limited to the value of actual inputs provided by BHEL i.e. "Plan - Shortfall attributable to BHEL" for the month, as per Form-14 for calculation of ORC.

2.12.3.4 Payment of ORC amount shall be further regulated as follows:

(i) 50% of the ORC is allocated for deployment of matching resources (with weightages) agreed as per the joint programme drawn vide 2.11.4. ORC Payment against resources shall be calculated in proportion to percentage of resources actually deployed w.r.t. planned resources, as per Form-14.

(ii) 50% of ORC is allocated for achieving of planned progress agreed as per the joint programme drawn vide 2.11.4. ORC Payment shall be reduced in proportion to percentage shortfall attributable to contractor w.r.t.–"Plan - Shortfall attributable to BHEL" for the month, as per Form-14.

2.12.3.5 The maximum amount of ORC payable for the month shall be limited to Rs. 5,00,000/- .

2.12.3.6 In case, there is no shortfall attributable to contractor for the month and also contractor has deployed the resources as agreed in Form-14 but ORC amount payable for the month worked out as per procedure mentioned in clause 2.12.3.3, 2.12.3.4 and 2.12.3.5, is less than Rs.1,00,000/-, then ORC amount payable for the month shall be Rs.1,00,000/- otherwise ORC amount payable for the month shall remain same.

2.12.3.7 In case execution is on **HOLD** (Other than Force Majeure), ORC shall be payable as per following:

i). Contractor has not been permitted by BHEL to de-mobilize

a) ORC amount of Rs. 1,00,000/- per month shall be applicable during the period of HOLD provided resources as planned are deployed (not demobilized) during the period of hold.

b) Subsequent to lifting of HOLD, Period of HOLD shall not be excluded in calculation of period for deciding applicable ORC rate as per clause 2.12.3.1.

ii). Contractor has been permitted to demobilize and to remobilize after lifting of HOLD

a) No ORC shall be payable to contractor for the period of HOLD.

b) Subsequent to lifting of HOLD, Period of HOLD shall not be excluded in calculation of period for deciding applicable ORC rate as per clause 2.12.3.1.

2.12.3.8 In case **Force Majeure** is invoked:

i). No ORC shall be applicable during the period of Force Majeure.

ii). Subsequent to revocation of Force Majeure, period of Force Majeure shall be excluded in calculation of period for deciding applicable ORC rate as per clause 2.12.3.1.

2.12.4 Applicability of ORC: ORC shall not be applicable for following activities.

(i) Area cleaning, removal of temporary structures and return of scrap.

(ii) Punch list points / pending points liquidation pending due to reasons attributable to contractor

(iii) Submission of "As built Drawing"

(iv) Material Reconciliation

(v) Completion of Contract Closure formalities like HR Clearance/ No dues from various dept./ Statutory Authorities etc.

2.12.5 Total Over Run Compensation shall be limited to 10% of the cumulatively executed contract value till the month (excluding Taxes and Duties if payable extra). For this purpose, executed contract value excludes PVC, ORC and Extra/Supplementary Works.

Sl No: 9

Clauses 2.13.1, 2.13.6 & 2.13.7 in GCC on Interest Bearing Recoverable Advances,

9.1 Clauses 2.13.1,2.13.6 & 2.13.7 in GCC is revised as under:

9.1.1 Clause 2.13.1 in GCC is revised as "Normally no advance payment shall be payable to the contractor. Mobilization advance payment in exceptional circumstances shall be interest bearing and secured through a Bank Guarantee and shall be limited to a maximum of 5% of contract value. This 'Interest Bearing Recoverable Advance' shall be payable in not less than two installments with any of the installment not exceeding 60% of the total eligible advance".

9.1.2 Clause 2.13.6 in GCC is revised as "The rate of interest applicable for the above advances shall be the Base rate of State Bank of India prevailing at the time of

disbursement of the advance + 6%, and such rate will remain fixed till the total advance amount is recovered".

9.1.3 Clause 2.13.7 in GCC is revised as "Unadjusted amount of advances paid shall not exceed 5% of the total contract value at any point of time. Recovery of advances shall be made progressively from each Running Bill such that the advance amounts paid along with the interest is fully recovered by the time the contractor's billing reaches 90% of contract value."

Sl. No: 10:

Clause 2.14.1 on Quantity Variation in General Conditions of Contract (GCC), Volume-IC, Book-II, is revised as under:

2.14.1 The quantities given in the contract are tentative and may change to any extent (both in plus side and minus side). The quoted rates for individual items shall remain firm irrespective of any variations in the individual quantities. No compensation becomes payable in case the variation of the final executed contract value is within the limit of Minus (-) 30% of awarded contract value."

Sl No: 11

PRICE VARIATION COMPENSATION (PVC)

The PRICE VARIATION COMPENSATION (PVC) clause 2.17 published in General Conditions of Contract (Volume I Book-II) is revised as under.

2.17 PRICE VARIATION COMPENSATION

2.17.1 In order to take care of variation in cost of execution of work on either side, due to variation in the index of LABOUR, HIGH SPEED DIESEL OIL, WELDING ROD, CEMENT, STEEL, MATERIALS, Price Variation Formula as described herein shall be applicable (only for works executed during extended period, if any, subject to other conditions as described in this section).

2.17.2 **85%** component of executed Contract Value shall be considered for PVC calculations and remaining 15% shall be treated as fixed component. The basis for calculation of price variation in each category, their component, Base Index, shall be as under:

Sl. No.	CATEGORY	BASE INDEX	PERCENTAGE COMPONENT ('K')		
			CIVIL PACKAGES	MECHANICAL	Electrical, C&I, Material

			(See Note A/B/C)			PACKAGES	Management / Handling and other labour oriented packages
			A	**B****	**C**		
i)	LABOUR (ALL CATEGORIES)	'MONTHLY ALL-INDIA AVERAGE CONSUMER PRICE INDEX NUMBERS FOR INDUSTRIAL WORKERS' published by Labour Bureau, Ministry of Labour and Employment, Government of India. (Website: labourbureau.nic.in)	**40**	**25**	**30**	**65**	**80**
ii)	HIGH SPEED DIESEL OIL	Name of Commodity: HSD Commodity code: 1202000005 (**See Note E**)	**5**	**3**	**5**	**5**	**5**
iii)	WELDING ROD	Name of Commodity: MANUFACTURE OF BASIC METALS Commodity code:1314000000 (**See Note E**)				**15**	
iv)	CEMENT	Name of Commodity: ORDINARY PORTLAND CEMENT Commodity code: 1313050003 (**See Note E**)		**20**	**30**		
v)	STEEL (Structural and Reinforcement Steel)	Name of Commodity: MILD STEEL: LONG PRODUCTS Commodity code: 1314040000 (**See Note E**)		**25**			
vi)	ALL OTHER MATERIALS (Other than Cement & Steel)	Name of Commodity: ALL COMMODITIES Commodity code: 1000000000 (**See Note E**)	**40**	**12**	**20**		

Note: A) Cement & Steel: Free Issue (BHEL Scope)

B) Cement & Steel: In Contractor Scope

C) Cement in Contractor Scope, and Steel is Free Issue (BHEL Scope)

D) For Composite packages (i.e. Civil + Mechanical + Electrical and / or CI or Civil + Mechanical or Mechanical + Electrical and / or CI), the Component ('K') for various categories shall be as per respective packages as above

E) As per the 'MONTHLY WHOLE SALE PRICE INDEX' for the respective Commodity and Type, published by Office of Economic Adviser, Ministry of Commerce and Industry, Government of India. (Website: http://www.eaindustry.nic.in/download

data 0405.asp). Revisions in the index or commodity will be re adjusted accordingly.

2.17.3 **Void**

2.17.4 Payment / recovery due to variation in index shall be determined on the basis of the following notional formula in respect of the identified component ('K') viz LABOUR, HIGH SPEED DIESEL OIL, WELDING ROD, CEMENT, STEEL, MATERIALS.

$$P = K \times R \times \frac{(X_N - Xo)}{Xo}$$

Where

P = Amount to be paid/recovered due to variation in the Index for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials

K = Percentage component ('K') applicable for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials

R = Value of work done for the billing month (Excluding Taxes and Duties if payable extra)

XN = Revised Index for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials for the billing month under consideration

Xo = Index for Labour, High Speed Diesel Oil, Welding Rod, Cement, Steel and Materials as on the Base date.

2.17.5 **Base date shall be the calendar month of the schedule completion date (i.e. Actual Start date + Scheduled Contractual Completion period as per Letter of Intent / award and / or work order).**

2.17.6 PVC shall not be payable for the ORC amount, Supplementary / Additional Items, Extra works. However, PVC will be payable for items executed under quantity variation of BOQ items under originally awarded contract.

2.17.7 The contractor shall furnish necessary monthly bulletins in support of the requisite indices from the relevant websites along with his Bills.

2.17.8 The contractor will be required to raise the bills for price variation payments on a monthly basis along with the running bills irrespective of the fact whether any increase/decrease in the index for relevant categories has taken place or not. In case there is delay in publication of bulletins (final figure), the provisional values as published can be considered for payments and arrears shall be paid/recovered on getting the final values.

2.17.9 PVC shall be applicable only, during extended period of contract (if any) after the scheduled completion period and for the portion of work delayed/backlog for the reasons not attributable to the contractor.

However, the total Quantum of Price Variation Amount payable/recoverable shall be regulated as follows:

i) For the portion of shortfall/backlog not attributable to contractor, PVC shall be worked out on the basis of indices applicable for the respective month in which work is done. Base index shall be applicable as defined in clause 2.17.5

ii) In case of Force Majeure, the PVC shall be regulated as per (a) or (b) below.

a) Force Majeure is invoked before "Base Date" / "revised base date" (as explained below) OR immediately after "base date" / "revised base date" in continuation (i.e. during the period when PVC is not applicable):

vii. Base date shall be revised: Revised Base date = Previous base date + duration of Force Majeure.

No PVC will be applicable for the work done till revised base date.

viii. PVC will be applicable for the work done after "base date"/" revised date" as the case may be (during extended period when delay is not attributable to contractor). PVC shall be worked out on the basis of indices applicable for the respective month in which work is done with base index as on "base date"/ "revised base date" as the case may be.

b) Force Majeure is invoked after "base date"/ "revised base date" as the case may be (during extended period when delay is not attributable to contractor).

2. PVC shall be applicable for the work done after revocation of Force Majeure.

3. PVC for the work done after revocation of Force Majeure shall be worked out on the basis of indices applicable for the respective month on which work is done excluding the effect of change in indices during total period of Force Majeure(s) invoked after "base date" / "revised base date" as the case may be. Base index shall be taken as on "base date" / "revised base date" as the case may be.

The total amount of PVC shall not exceed 15% of the cumulatively executed contract value. Executed Contract value for this purpose is exclusive of PVC, ORC, Supplementary / Additional items and Extra works except items due to quantity variation

Sl No: 12

Clauses 2.21 in GCC regarding Arbitration is amended as below

2.21 ARBITRATION & CONCILIATION

2.21.1 ARBITRATION:

2.21.1.1 Except as provided elsewhere in this Contract, in case Parties are unable to reach amicable settlement (whether by Conciliation to be conducted as provided in Clause 2.21.2 herein below or otherwise) in respect of any dispute or difference; arising out of the formation, breach, termination, validity or execution of the Contract; or, the respective rights and liabilities of the Parties; or, in relation to interpretation of any provision of the Contract; or. in any manner touching upon the Contract (hereinafter referred to as the 'Dispute'), then, either Party may, commence arbitration in respect of such Dispute by issuance of a notice in terms of section 21 of the Arbitration & Conciliation Act, 1996 (hereinafter referred to as the 'Notice'). The Notice shall contain the particulars of all claims to be referred to arbitration in sufficient detail and shall also indicate the monetary amount of such claim. The arbitration shall be conducted by a sole arbitrator to be appointed by the Head of the BHEL Power Sector Region issuing the Contract within 60 days of receipt of the complete Notice. The language of arbitration shall be English.

The Arbitrator shall pass a reasoned award.

Subject as aforesaid, the provisions of Arbitration and Conciliation Act 1996 (India) or statutory modifications or re-enactments thereof and the rules made thereunder as in force from time to time shall apply to the arbitration proceedings under this clause. The seat of arbitration shall be **Chennai** (the place from where the contract is Issued). The Contract shall be governed by and be construed as per provisions of the laws of India. Subject to this provision 2.21.1.1 regarding ARBITRATION, the principal civil court exercising ordinary civil jurisdiction over the area where the seat of arbitration is located shall have exclusive jurisdiction over any DISPUTE to the exclusion of any other court.

2.21.1.2 In case of Contract with Public Sector Enterprise (PSE) or a Government Department, the following shall be applicable:

In the event of any dispute or difference relating to the interpretation and application of the provisions of commercial contract(s) between Central Public Sector Enterprises (CPSEs)/ Port Trusts inter se and also between CPSEs and Government Departments/Organizations (excluding disputes concerning Railways, Income Tax, Customs & Excise Departments), such dispute or difference shall be taken up by either party for resolution through AMRCD (Administrative Mechanism for Resolution of CPSEs Disputes) as mentioned in DPE OM No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22-05-2018 as amended from time to time.

2.21.1.3 The cost of arbitration shall initially be borne equally by the Parties subject to the final allocation thereof as per the award/order passed by the Arbitrator.

2.21.1.4 Notwithstanding the existence of any dispute or differences and/or reference for the arbitration, the Contractor shall proceed with and continue without hindrance the performance of its obligations under this Contract with due diligence and expedition in a professional manner unless the dispute inter-alia relates to cancellation, termination or short-closure of the Contract by BHEL.

2.21.2 CONCILIATION:

If at any time (whether before, during or after the arbitral or judicial proceedings), any Disputes (which term shall mean and include any dispute, difference, question or disagreement arising in connection with construction, meaning, operation, effect, interpretation or breach of the agreement, contract), which the Parties are unable to settle mutually, arise inter-se the Parties, the same may, be referred by either party to Conciliation to be conducted through Independent Experts Committee (IEC) to be appointed by competent authority of BHEL from the BHEL Panel of Conciliators.

Notes:

1. No serving or a retired employee of BHEL/Administrative Ministry of BHEL shall be included in the BHEL Panel of Conciliators.
2. Any other person(s) can be appointed as Conciliator(s) who is/are mutually agreeable to both the parties from outside the BHEL Panel of Conciliators.

The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided in Procedure 2.3 enclosed in Vol 1A Part II. The Procedure 2.3 together with its Formats

will be treated as if the same is part and parcel hereof and shall be as effectual as if set out herein in this GCC.

The Contractor hereby agrees that BHEL may make any amendments or modifications to the provisions stipulated in the Procedure 2.3 enclosed in Vol 1A Part II from time to time and confirms that it shall be bound by such amended or modified provisions of the Procedure 2.3 with effect from the date as intimated by BHEL to it.

2.21.3 No Interest payable to Contractor

Notwithstanding anything to the contrary contained in any other document comprising in the Contract, no interest shall be payable by BHEL to Contractor on any moneys or balances including but not limited to the Security Deposit, EMD, Retention Money, RA Bills or the Final Bill, or any amount withheld and/or appropriated by BHEL etc., which becomes or as the case may be, is adjudged to be due from BHEL to Contractor whether under the Contract or otherwise.

Sl No: 13: Reverse Auction

The chapter Reverse auction procedure published in _Forms and Procedures' of Volume I Book-II stands deleted. Revised Reverse Auction Guidelines 2020 available in the website http://www.bhel.com shall be applicable.

Sl No: 14

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-14 of Volume ID Forms and procedure stands Deleted. Form No.- F-14 (Rev 01) is enclosed.

Sl No: 15

Existing format on Monthly Performance Evaluation of Contractor, as available in Form No F-15 of Volume ID Forms and procedure stands Deleted. Form No.- F-15 (Rev 02) is enclosed.

Sl No:16

Clause 2.22 in GCC regarding Retention Amount is revised as under:

2.22 Performance Security Deposit

2.22.1 After award of work, Vendor shall submit 5% of the contract value towards Performance Security Deposit, in the form of (a) or (b) below.

(a) CASH (DD/ Online payment), 5% of the contract Value towards Performance Security Deposit, before commencing the contract

(or)

(b) Recovery 5% from Each Running Bill towards Performance security deposit.

(Note: Subcontractor has to choose either Option (a) or (b) before issue of Detailed LOI).

(c) However, Performance Security Deposit on part of PVC will be recovered at the rate of 5% from every running bill towards performance security deposit.

2.22.2 Refund of Performance Security Deposit:

a) 50% of Performance Security Deposit shall be released along with the final bill.

b) Balance 50% will be released after completion of Performance Guarantee Period (i.e., after expiry of Guarantee period), provided all the defects noticed during the guarantee period have been rectified to the satisfaction of BHEL Site Engineer/ BHEL Construction Manager, and after deducting all expenses/ other amounts due to BHEL under the contract/ other contracts entered into by BHEL with them. This portion of Performance Security Deposit, amount can be released on commencement of the Guarantee Period, on submission of equivalent Bank Guarantee.

The performance security deposit mentioned herein above, is in addition to Security Deposit as per Sl No. 5 above.

Sl No: 17

Existing format for Integrity Pact, as available in Volume ID Forms and procedure stands Deleted. Revised Format is enclosed.

Sl No: 18

Existing format for BANK GUARANTEE FOR SECURITY DEPOSIT, as available in Form No. F-11 (Rev 00) of Volume ID Forms and procedures stands deleted. Refer Proforma of Bank Guarantee (in lieu of Security Deposit)-Form WAM 22 provided in Chapter-10, Part-II of Volume-IA Technical Conditions of Contract.

Sl No: 19

Clause 2.15.5 of GCC in Extra Works is revised as under:

2.15.5: After eligibility of extra works is established and finally accepted by BHEL engineer / designer, payment will be released on competent authority's approval at the following rate.

MAN-HOUR RATE FOR ELIGIBLE EXTRA WORKS:

Single composite average labour man-hour rate, including overtime if any, supervision, use of tools and tackles and other site expenses and incidentals, consumables for carrying out

any major rework / repairs / rectification / modification / fabrication as certified by site as may arise during the course of erection, testing, commissioning or extra works arising out of transit, storage and erection damages, payment, if found due will be at Rs 108/- per man hour.

VOLUME-IA PART – II

CHAPTER 2-10

In the next 1439 pages as below:

CHAPTER	Details	No. of sheets
CHAPTER 2	Technical Specifications and Plot Plan	1321
CHAPTER 3	HSE Plan For Site Operations By Subcontractor	82
CHAPTER 4	Form 15 Rev 02	06
CHAPTER 5	Form 14 Rev 01	06
CHAPTER 6	Proforma Of Bank Guarantee (In Lieu Of Earnest Money)-Form WAM 23	03
CHAPTER 7	Proforma Of Bank Guarantee (In Lieu Of Security Deposit)-Form WAM 22	03
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FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE FOR NTPL TUTICORIN (2x500 MW)

VOLUME: IIB

SECTION - C

SPECIFIC TECHNICAL REQUIREMNTS FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

Bharat Heavy Electricals Limited

Project Engineering Management
Power Sector, BHEL

	SPECFIC TECHNICAL REQUIREMENT FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS FOR FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE FOR 2x500 MW NTPL TUTICORIN.	SPECIFICATION NO. PE-TS-483-600-001 VOLUME - IIB SECTION - C REV.NO. 0 DATE 12/05/2020 SHEET 2 OF 17

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PART-II : SPECIFIC DESIGN REQUIREMENTS - CIVIL

	SPECFIC TECHNICAL REQUIREMENT FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS FOR FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE FOR 2x500 MW NTPL TUTICORIN.	SPECIFICATION NO. PE-TS-483-600-001 VOLUME - IIB SECTION - C REV.NO. 0 DATE 12/05/2020 SHEET 3 OF 17

PART-I

GENERAL CIVIL REQUIREMENT

1. GENERAL

Two Volumes-Section C & Section D of this specification cover site survey, soil investigation, site development works, design and construction of Civil, Structural and Architectural works. The scope of works covers complete Civil, Structural and Architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the packages. This Part-I of Section-C Lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. **If there is any ambiguity and/or contradiction between Section C and Section D, the provisions / requirements laid in Section C shall prevail. In case of ambiguity between BOQ and Part C former shall prevail**.

(Contractor shall read the parts of the specification relevant to the contract and shall ignore the other parts of the specification. Relevant clauses of this section as applicable for respective package to be followed.)

2. CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/ Technical Specifications as appropriate. The latest editions/ revision of following codes and standards along with addendums/ amendments, if any, shall be followed:

2.1. Earthwork

a) IS-1498: Classification and identification of soils for General Engineering purposes.
b) IS-3764: Safety Code for excavation work.
c) IS-7293: Safety Code for working with construction machinery.
d) IS-4701: Code of practice for earth work on canals.
e) IS-9759: Guide lines for dewatering during construction.
f) IS-10379: Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

2.2. Concrete

a) IS-269: Ordinary and low heat Portland cement.
b) IS-383: Coarse and fine aggregate from natural sources for concrete.
c) IS-432: (Part I & II) Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
d) IS-455: Portland Slag Cement.
e) IS-456: Code of Practice for Plain and reinforced concrete.
f) IS-457: Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
g) IS-460: Test Sieves (all parts).
h) IS-516: Methods of test for strength of concrete.
i) IS-1199: Methods of sampling and analysis of concrete.
j) IS-1566: Hard drawn steel wire fabric for concrete Reinforcement.
k) IS-1786: High strength deformed steel bars and wires for concrete Reinforcement.
l) IS-1791: General requirement for batch type concrete mixers.
m) IS-1834: Hot applied sealing compounds for joints in concrete.
n) IS-1838: Preformed fillers for expansion joints in concrete pavement and structures.

o) IS-2386: (Part I-VIII) Methods of test for aggregates for concrete (all parts).
p) IS-2438: Specification for roller pan mixers.
q) IS-2502: Code of practice for bending and fixing of bars for concrete Reinforcement.
r) IS-2505: Concrete vibrators - immersion type.
s) IS-2506: General requirements for screed board concrete vibrators.
t) IS-2722: Specification for Portable Swing weigh batchers for concrete (single and double bucket type).
u) IS-2750: Steel scaffoldings.
v) IS-2751: Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
w) IS-3150: Hexagonal wire netting for general purposes.
x) IS-3366: Specification for pan vibrators.
y) IS-3370: (Part I-IV) Code of practice for concrete structures for storage of liquids (all parts).
z) IS-3414: Code of practice for design and installation of joints in buildings.
aa) IS-3558: Code of practice for use of immersion vibrators for consolidating concrete.
bb) IS-4014: (Part I & II) Code of practice for steel tubular scaffolding.
cc) IS-4656: Form vibrators for concrete.
dd) IS-4925: Concrete batching and mixing plant.
ee) IS-4948: Welded steel wire fabrics for general use.
ff) IS-4990: Plywood for concrete shuttering work.
gg) IS-5256: Code of practice for sealing expansion joints in concrete lining on canals.
hh) IS-6452: High Alumina Cement for Structural use.
ii) IS-6461: Glossary of terms relating to cement concrete.
jj) IS-6494: Code of practice for water proofing of underground reservoir and swimming pools.
kk) IS-6509: Code of practice for installation of joints in concrete pavements.
ll) IS-7320: Concrete slump test apparatus.
mm) IS-7861: (Part I & II) Code of practice for extreme weather concreting.
nn) IS-8041: Rapid Hardening Portland Cement.
oo) IS-8112: High strength ordinary Portland Cement.
pp) IS-9012: Recommended practice for shotcreting.
qq) IS-9103: Admixtures for concrete.
rr) IS-9417: Recommendations for welding cold worked bars for reinforced concrete construction.
ss) IS-10262: Recommended guidelines for concrete mix design.
tt) IS-458: Specification for precast concrete pipes.
uu) IS-3935: Code of practice for composite construction.
vv) IS-4995: Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials.
ww) IS-5525: Recommendation for detailing of reinforced concrete works.
xx) IS-11384: Code of practice for composite construction in structural steel and concrete.
yy) IS-11682: Criteria for design of RCC staging for overhead water tanks.
zz) IS:12118: Two parts polysulphide based sealants.
aaa) IS:12200: Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams.
bbb) IS:13311: Non-destructive testing of concrete - methods of test.
Part I - Ultrasonic pulse velocity.
Part II - Rebound hammer.
ccc) IS-13920: Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

ddd) SP-16: Design codes for reinforced concrete to IS:456-1978.
eee) SP-23: Hand book of concrete mixes.
fff) SP-24: Explanatory handbook on Indian standards code for plain and reinforced concrete. (IS: 456)
ggg) SP-34: Hand book on concrete reinforcement and detailing.
hhh) ACI-318: American Concrete Institute code for structural concrete.
iii) IS-280: Mild steel wire for general engineering purpose.
jjj) IS-10297: Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.
kkk) IS-10505: Code of practice for construction of floors and roofs using pre-cast reinforced concrete waffle units.
lll) IS-15658: Pre-cast concrete block for paving.

2.3. Foundations

a) IS-1080: Code of practice for Design and Construction of shallow foundations on soils (other than raft, ring and shell)
b) IS-1904: Code of practice for Design and Construction of foundations in soils: General Requirements
c) IS-2314: Steel sheet piling sections.
d) IS-2911: Code of practice for Design and Construction of Pile foundations (all parts).
e) IS-2950: Code of practice for design and construction of raft foundations.
f) IS-2974: Code of practice for design and construction of machine foundations.
g) IS-4091: Code of practice for Design and Construction of foundations for transmission line towers and poles
h) IS-6403: Code of practice for determination of Bearing capacity of Shallow foundations.
i) IS-8009: Code of practice for calculation of settlement of foundations: (all parts)
j) IS-9556: Code of practice for Design and Construction of diaphragm walls.
k) IS-11089: Code of practice for Design and Construction of ring foundation.
l) IS-12070: Code of practice for design and construction of shallow foundations on rocks.
m) IS-13301: Guidelines for vibration isolation for machine foundation.
n) ISO 10816: Criteria for assessing mechanical vibrations of machines.
o) ISO 1940: Criteria for assessing the st of balance of rotating rigid bodies.
p) DIN: EN13906-1: Helical compression spring made of round wire and rod: calculation and design of compression.
q) DIN: 2096 Helical compression spring out of round wire and rod: Quality requirements for hot formed compression spring.
r) DIN: 4024 Flexible supporting structures for machine with rotating machines.

2.4. Loading

a) IS-875: Code of practice for Structural safety of buildings - loading standards.
b) IS-1911: Schedule of unit weights of building materials.
c) IRC-6: Standard specifications & Code of practice for road bridges.

2.5.Masonry

a) IS-712: Building limes.
b) IS-1077: Common Burnt Clay Building Bricks.
c) IS-1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.
d) IS-1528: Methods of sampling and physical tests for refractory materials.

e) IS-1597: Code of practice for construction of stone masonry (all parts).
f) IS-2212: Code of practice for brickwork.
g) IS-2116: Sand for masonry mortars
h) IS-2185: Concrete masonry units. (all parts - Hollow and Solid concrete blocks).
i) IS-2250: Code of practice for preparation and use of masonry mortars.
j) IS-2572: Code of practice for construction of hollow concrete block masonry.
k) IS-2691: Burnt clay facing bricks.
l) IS-3414: Code of practice for design and installation of joints in buildings.
m) IS-3495: Methods of tests of burnt clay building bricks.
n) IS-4441: Code of practice for use of Silicate type chemical resistant mortars.
o) IS-4860: Acid Resistant Bricks.
p) IS-1905: Code of practice for structural use of unreinforced masonry.
q) IS-10440: Code of practice for construction of reinforced brick and reinforced brick concrete floors and roofs.
r) SP-20: Hand book on masonry design and construction.
s) IS-1489: Portland-pozzolana cement.
t) IS-1542: Sand for Plaster.
u) IS-12269: 53 grade ordinary Portland cement.
v) IS-12894: Specification for fly ash lime bricks.
w) IS-13757: Burnt clay fly ash building bricks.

2.6.Doors, Windows and Ventilators

a) IS-399: Classification of commercial timbers and their zonal distribution.
b) IS-883: Code of practice for design of structural timber in building.
c) IS-1003: Timber panelled and glazed shutters (all parts).
d) IS-1038: Steel doors, windows and ventilators.
e) IS-1081: Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
f) IS-1361: Steel windows for industrial buildings.
g) IS-2835: Transparent sheet glass for glazing and framing purposes.
h) IS-1948: Aluminium doors windows and ventilators.
i) IS-1949: Aluminium windows for industrial building.
j) IS-2191: Wooden flush door shutters (Cellular and hollow core type).
k) IS-2202: Wooden flush door shutters (solid core type).
l) IS-3103: Code of practice for Industrial ventilation.
m) IS-3548: Code of practice for glazing in buildings.
n) IS-3614: Fire check doors.
o) IS-4021: Timber door, windows and ventilator frames.
p) IS-4351: Steel door frames.
q) IS-6248: Metal rolling shutters and rolling grills.
r) IS-208: Door Handles.
s) IS:281: Mild steel sliding door bolts for use with padlocks.
t) IS-362: Parliament Hinges.
u) IS-419: Putty, for use on window frames.
v) IS-451: Technical supply conditions for wood screws.
w) IS-733: Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
x) IS-1285: Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes).
y) IS-1341: Steel butt hinges.
z) IS-1823: Floor door stoppers.
aa) IS-1868: Anodic coatings on Aluminium and its alloys.

bb) IS-2209: Mortice locks (vertical type)
cc) IS-2553: Safety glass.
dd) IS-3564: Door closers (Hydraulically regulated).
ee) IS-5187: Flush bolts.
ff) IS-5437: Figured, rolled and wired glass.
gg) IS-6315: Specification for floor springs (Hydraulically regulated) for heavy doors.
hh) IS-7196: Hold fast.
ii) IS-7452: Hot rolled steel sections for doors, windows and ventilators.
jj) IS-10019: Mild steel stays and fasteners.
kk) IS-10451: Steel sliding shutters (top hung type)
ll) IS-12823: Prelaminated particle boards.

2.7.Roof and Flooring

a) IS-2204: Code of practice for construction of reinforced concrete shell roof.
b) IS-3201: Criteria for the design and construction of precast concrete trusses.
c) IS-2210: Criteria for Design of R.C. shell structures and folded plates.
d) IS-809: Rubber flooring materials for general purposes.
e) IS-1195: Bitumen mastic for flooring.
f) IS-1196: Code of practice for laying bitumen mastic flooring.
g) IS-1198: Code of practice for laying, fixing and maintenance of linoleum floors.
h) IS-1237: Cement concrete flooring tiles.
i) IS-1443: Code of practice for laying and finishing of cement concrete flooring tiles.
j) IS-2114: Code of practice for laying in situ terrazzo floor finish.
k) IS-2571: Code of practice for laying in situ cement concrete flooring.
l) IS-5491: Code of practice for laying in situ granolithic concrete floor topping.
m) IS-5766: Code of practice for laying burnt clay brick flooring.
n) IS-1197: Code of practice for laying of rubber floors.
o) IS-2441: Code of practice for fixing ceiling coverings.

2.8.Waterproofing

a) IS-1322: Bitumen felts for waterproofing and damp proofing.
b) IS-1346: Code of practice for waterproofing of roofs with bitumen felts.
c) IS-1609: Code of practice for laying damp proof treatment using bituminous felts.
d) IS-3036: Code of practice for laying lime concrete for a waterproofed roof finish.
e) IS-3037: Bitumen mastic for use in waterproofing of roofs.
f) IS-3067: Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
g) IS-3384: Bitumen primer for use in water proofing and damp proofing.
h) IS-4365: Code of practice for application of bitumen mastic for waterproofing of roofs.
i) IS-5318: Code of practice for laying of flexible PVC sheet and tile flooring.
j) IS-8042: White Portland cement.
k) IS-13755: Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).
l) IS-13801: Chequered cement concrete tiles.

2.9.Soil Engineering

a) IS-1498: Classification and identification of soils for general engineering purposes.
b) IS-1892: Code of practice for sub-surface investigation for foundations.
c) IS-2131: Method for standard penetration test for soils.
d) IS-2720: Methods of test for soils (all parts).

2.10. Water Supply, Drainage and Sewerage

a) IS-404: Lead pipes
b) IS-458: Concrete pipes
c) IS-651: Salt glazed stoneware pipes and fittings.
d) IS-771: Glazed fire-clay sanitary appliances (all parts).
e) IS-774: Flushing cisterns for water closets and urinals other than plastic cisterns.
f) IS-783: Code of practice for laying of concrete pipes.
g) IS-1172: Code of basic requirements for water supply, drainage and sanitation.
h) IS-1626: Asbestos cement building pipes, gutters and fittings (all parts).
i) IS-1742: Code of practice for building drainage.
j) IS-2064: Code of practice for selection, installation and maintenance of sanitary appliances.
k) IS-2065: Code of practice for water supply in buildings.
l) IS-2470: Code of practice for installation of septic tanks (all parts).
m) IS-3114: Code of practice for laying of Cast Iron pipes.
n) IS-4127: Code of practice for laying of glazed stoneware pipes.
o) IS-12251: Code of practice for Drainage of Building Basement.
p) IS-1200: Method of measurement: Laying of water and [Part- XVI] sewer lines including appurtenant items.
q) IS-1536: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
r) IS-1537: Vertically cast iron pressure pipe for water, gas and sewage.
s) IS-3486: Cast iron spigot and socket drain pipes.
t) IS-5329: Code of practice for sanitary pipe work above ground for buildings.
u) IS-3076: Low density polyethylene pipes for potable water supplies.
v) IS-1538: Cast iron fittings for pressure pipes for water, gas and sewage.
w) IS-1230: Cast iron rainwater pipes and fittings.
x) IS-1729: Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
y) IS-784: Prestressed concrete pipes.
z) IS-1726: Cast iron manhole covers and frames.
aa) IS-5961: Cast iron grating for drainage purposes.
bb) IS-5219: (Part-I) "P" and "S" traps.
cc) IS-772: General requirements for enamelled cast iron sanitary appliances.
dd) IS-775: Cast iron brackets and supports for wash basins and sinks.
ee) IS-777: Glazed earthenware wall tiles.
ff) IS-2548: Plastic water closet seats and covers (all parts).
gg) IS-2527: Code of practice for fixing rainwater gutters and downpipes for roof drainage.
hh) IS-554: Pipe threads where pressure tight joints are made on the threads – dimensions, tolerances and designation.
ii) IS-778: Copper alloy gate, globe and check valves for water works purposes.
jj) IS-781: Cast copper alloy screw down bib taps & stop valves for water services.
kk) IS-782: Caulking lead.
ll) IS-1703: Copper alloy float valve for water supply fitting.
mm) IS-2326: Automatic flushing cisterns for urinals.
nn) IS-2556: Vitreous sanitary appliances (vitreous china).
oo) IS-3311: Waste plug and its accessories for sinks and wash basins.
pp) IS-3438: Silvered glass mirrors for general purposes.
qq) IS-3589: Steel pipe for water and sewage (168.3 to 2540mm outside diameter)
rr) IS-3989: Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
ss) IS-4111: (Part I to V) Code of practice for ancillary structure in sewerage system.

tt) IS-4733: Methods of sampling and testing sewage effluents.
uu) IS-4764: Tolerance limits for sewage effluents discharged into inland surface waters.
vv) IS-1068: Electroplated coating of nickel plus chromium and copper plus nickel plus chromium.
ww) IS-5382: Rubber sealing rings for gas mains, water mains and sewer
xx) IS-5822: Code of practice for laying of electrically welded steel pipes for water supply.
yy) IS-7740: Code of practice for construction and maintenance of road gullies.
zz) IS-8931: Copper alloy fancy single taps combination tap assembly and stop valves for water services.
aaa) IS-9762: Polyethylene floats for float valves.
bbb) IS-10592: Industrial emergency showers, eye and face fountains and combination units.
ccc) IS-12592: Specification for precast concrete manhole covers and frames.
ddd) IS-12701: Rotational moulded polyethylene water storage tanks.
eee) IS-13983: Stainless steel sinks for domestic purposes.
fff) SP-35: Hand book on water supply and drainage with special emphasis on plumbing.

2.11. Paving and Road works

a) IS-73: Paving bitumen
b) IS-702: Industrial Bitumen
c) IS-1201: Method of testing tar and bituminous materials. thru' 1220
d) : Practice followed by Indian Road Congress (all parts).

2.12. Earthquake Resistant Design

a) IS-1893: Criteria for earthquake resistant design of structures.
b) IS-4326: Code of practice for earthquake resistant design and construction of buildings.

2.13. Chimney

a) IS-4998: Criteria for Design of R.C. Chimneys (all parts).
b) IS-6533: Code of practice for design and construction of steel chimneys
c) ACI-307: Specification for the design and construction of reinforced concrete chimneys
d) BS-4076: Specification for steel chimneys
e) CICIND: Model Code for concrete chimneys / Model code for steel chimneys

2.14. Cooling Tower

a) BS-4485: (Part 4) Structural design of cooling towers.

2.15. Structural Steelwork

a) IS-800: Code of practice for general construction in steel.
b) IS-802: Code of practice for use of structural steel in Overhead Transmission Line (All Parts).
c) IS-806: Code of practice for use of steel tubes in general building construction.
d) IS-808: Rolled steel beams, channels and angle sections.
e) IS-813: Scheme of symbols for welding.
f) IS-814: Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.
g) IS-816: Code of practice for use of metal arc welding for general construction in mild steel.

h) IS-817: Code of practice for training and testing of metal arc welders.
i) IS-818: Code of practice for safety and health requirements in electric and gas welding and cutting operation.
j) IS-819: Code of practice for Resistance spot welding for light assemblies in Mild Steel.
k) IS-919: Recommendations for limits and fits for engineering.
l) IS-1024: Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m) IS-1161: Steel tubes for structural purposes.
n) IS-1182: Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o) IS-1200: (Part-VIII) Method of measurement of steelwork and ironwork.
p) IS-1239: Mild steel tubes, tubulars and other wrought steel fittings (all parts).
q) IS-1363: Black hexagonal bolts, nuts and locknuts (Dia. 6 to 39 mm) and black hexagon screws (Dia.6 to 24 mm). [all parts]
r) IS-1364: Precision and semi-precision hexagon bolts, screws, nuts and locknuts (Dia. range 6 to 39 mm). [all parts]
s) IS-1365: Slotted counter sunk head screws (Dia. range 1.6 to 20 mm).
t) IS-1367: Technical supply conditions for threaded steel fasteners. (Part 1 to 18)
u) IS-1443: Code of practice for laying and finishing of cement concrete flooring tiles.
v) IS-1608: Method for tensile testing of steel products.
w) IS-1730: Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
x) IS-1731: Dimensions for steel flats for structural and general engineering purposes.
y) IS-1852: Rolling and cutting tolerances for hot rolled steel products.
z) IS-1977: Structural steel (Ordinary quality)
aa) IS-2016: Plain Washers
bb) IS-2062: Steel for General structural purposes.
cc) IS-2074: Ready mixed paint, air drying, red oxide zinc-chrome, priming.
dd) IS-2633: Methods of testing uniformity of coating of zinc coated articles.
ee) IS-3613: Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
ff) IS-3664: Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
gg) IS-3757: High strength structural bolts.
hh) IS-4000: High strength bolts in steel structures.
ii) IS-4759: Hot dip zinc coatings on structural steel and other allied products.
jj) IS-5334: Code of practice for Magnetic Particle Flaw detection of welds.
kk) IS-7215: Tolerances for fabrication of steel structures.
ll) IS-7280: Base-wire electrodes for sub-merged arc welding of structural steels.
mm) IS-7318: (Part-I) Approval test for welders when welding procedure approval is not required.
nn) IS-8500: Structural steel - micro alloyed (medium and high strength qualities).
oo) IS-9595: Recommendation for metal arc welding of carbon and carbon manganese steels.
pp) AWS D.1.1 Structural Welding Code.
qq) IS-8640: Recommendations for dimensional parameters for industrial building.
rr) IS-9178: Criteria for design of steel bins for storage of bulk material (all parts).
ss) IS-12843: Tolerances for erection of steel structures.
tt) IS-1181: Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).
uu) IS-2595: Code of practice for Radiographic testing
vv) IS-2629: Hot dip galvanising of iron and steel
ww) IS-3502: Steel chequered plate.

xx) IS-3658: Code of practice for liquid penetrant flaw detection.
yy) IS-4353: Sub merged arc welding of mild steel and low alloy steel Recommendation.
zz) IS-5369: General requirements for plain washers and lock washer.
aaa) IS-6623: High strength structural nuts.
bbb) IS-6649: Hardened and tampered washers for high strength structural bolts & nuts.
ccc) IS-6911: Stainless steel plate, sheet and strip.
ddd) IS-7205: Safety code for erection of structural steel.
eee) IS-7307: Approved test for welding procedures
(Part I) Fusion welding of Steel
fff) IS-7310: Approval test for welders working to approval welding procedure.
(Part I) Fusion welding of Steel
ggg) SP-6: IS Handbook for structural engineers.

2.16. Painting

a) IS-348: Specification for French Polish.
b) IS-427: Specification for Distemper, dry colour as required.
c) IS-428: Specification for Distemper, oil emulsion, colour as required.
d) IS-1477: Code of practice for painting of ferrous metal in buildings.
(Part I & II)
e) IS-2338: Code of practice for finishing of wood and wood based materials.
(Part I & II)
f) IS-2339: Specification for Aluminium Paints for general purposes in dual containers.
g) IS-2395: Code of practice for painting concrete, masonry and plaster surface.
h) IS-2932: Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.
i) IS-2933: Specification for enamel, exterior - a) undercoating, b) finishing.
j) IS-5410: Specification for cement paint.
k) IS-162: Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
l) IS-1650: Specification for colours for building and decorative materials.
m) IS-2395: Code of practice for painting concrete, masonry and plaster surfaces.
(Part I) Operations and Workmanship.
(Part II) Schedule.
n) IS-2524: Code of practice for painting of nonferrous metals in buildings.
(Part I) Pre-treatment.
(Part II) Painting.
o) IS-15489: Plastic emulsion paint.
p) IS-6278: Code of practice for white washing and Colour washing.
q) IS-10403: Glossary of term related to building finish.
r) IS-12027: Silicone based water repellent.
s) IS-13238: Epoxy based zinc phosphate primer (2 pack).
t) IS-13239: Epoxy surface (2 pack).
u) IS-13467: Chlorinated rubber for paints
v) IS-14209: Epoxy enamel, two component glossy.
w) BS-5493: Code of practice for protective coating of iron and steel structures against corrosion.

2.17. Sheeting

a) IS-277: Galvanised steel sheets (Plan & corrugated).
b) IS-513: Cold-rolled low carbon steel sheets & strips.
c) IS-730: Hook bolts for corrugated sheet roofing.
d) IS-801: Code of practice for use of cold formed light gauge steel structural members in general building construction.

e) IS-7178: Technical supply condition for tapping screw.
f) IS-8183: Bonded mineral wool.
g) IS-8869: Washers for corrugated sheet roofing.
h) IS-12093: Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanized steel sheets.
i) IS-12436: Preformed rigid Polyurethane (PUR) and Polyisocyanurate (PIR) foams for thermal insulation.
j) IS-12866: Plastic translucent sheets made from thermosetting polyester resin (glass fiber reinforced).
k) IS-14246: Continuously pre-painted galvanized steel sheets and coils.
l) BS-5950: (Part VI) Code of practice for design of light gauge profiled steel sheeting

2.18. Plastering

a) IS-1661: Code of practice for application of cement and cement lime plaster finishes.
b) IS-2402: Code of practice for external rendered finishes.
c) IS-2547: Gypsum building plaster.

2.19. Acid / Alkali Resistant Tiling

a) IS-158: Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
b) IS-412: Expanded metal steel sheets for general purpose.
c) IS-4443: Code of practice for use of resin type chemical resistant mortars.
d) IS-4456: (Part I & II) Method of Test for chemical resistant tiles.
e) IS-4457: Ceramic unglazed vitreous acid resisting tiles.
f) IS-4832: Specification for chemical resistant mortars.
(Part I) Silicon Type
(Part II) Resin Type
(Part III) Sulphur Type
g) IS-9510: Bitumastic acid resisting grade.

2.20. Safety

a) IS-1641: Code of practice for fire safety of buildings - General principles of fire grading and classification.
b) IS-1642: Code of practice for fire safety of buildings - Details of construction.
c) IS-3696: (Part I & II) Safety code for scaffolds and ladders.
d) IS-4081: Safety code for blasting and related drilling operations.
e) IS-4130: Demolition of buildings - code of safety.
f) IS-5121: Safety code for piling and other deep foundations.
g) IS-5916: Safety code for construction involving use of hot bituminous materials.
h) IS-7205: Safety code for erection of structural steel work.
i) IS-7969: Safety code for handling and storage of building materials.

2.21. Architectural Design of Buildings

a) SP-7: National Building Code of India.
b) SP-41: Hand book on functional requirements of buildings (other than industrial buildings).
c) ECBC: Energy Conservation Building Code
d) GRIHA: Green Rating for Integrated Habitat Assessment.

2.22. Other

a) Indian Road Congress (IRC) Bridge Codes
b) Indian Railway Standard Bridge Rules

3. GENERAL

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The Bidder shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

4. LAYOUT

Before starting the work, the Contractor shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and bench mark. **If the Contractor uses the grid, bench mark and reference pillar made by other Contractors, he shall coordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks.** If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and bench
mark which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification/modification necessary. No complaint shall be entertained at a later stage. The Contractor shall accurately set out the position for holding down bolts and inserts.

If required, in the opinion of the Engineer, he shall construct and maintain pillars for grid, references and bench marks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The Contractor shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderer’s shall take into account the cost of these in quoting their price.

5. WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or

licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

6. TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the Contractor at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the Contractor shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re erection, if required, shall be carried out by the Contractor at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

7. INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

8. SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the Contractor. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The Contractor shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all important items of work.

9. CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanized from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, porcelains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All handling of materials shall be with cranes.

Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydraulically controlled grouting equipment.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed.

Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

	SPECFIC TECHNICAL REQUIREMENT FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS FOR FLUE GAS DESULPHURISATION (FGD) SYSTEM PACKAGE FOR 2x500 MW NTPL TUTICORIN.	SPECIFICATION NO. PE-TS-483-600-001 VOLUME - IIB SECTION - C REV.NO. 0 DATE 12/05/2020 SHEET 17 OF 17

PART-II

SPECFIC TECHNICAL REQUIREMNT

35720/2020/PS-SR-PM

NTPL

NLC TAMIL NADU POWER LTD.
2 X 500 MW PROJECT
TUTICORIN, TAMIL NADU

TENDER SPECIFICATION
FOR
FLUE GAS DESULPHURISATION PLANT
PACKAGE

VOLUME: II

TECHNICAL SPECIFICATION

DEVELOPMENT CONSULTANTS PRIVATE LIMITED
CONSULTING ENGINEERS
BLOCK DG-4, SECTOR-II, SALT LAKE CITY
KOLKATA- 700 091, INDIA

April, 2019

NLC TAMIL NADU POWER LTD.
2 X 500 MW PROJECT

TENDER SPECIFICATION

PACKAGE NAME : FGD PACKAGE

SPECIFICATION NUMBER : 17A14-SPC-G-001

JOB NUMBER : DCPL-17A14

CLIENT : NLC TAMIL NADU POWER LTD.

VOLUME : II

TECHNICAL SPECIFICATION

ISSUE	DATE	PREPARED	REVIEWED	APPROVED
FINAL	08.04.19	M. ROY	A. SEN	B. LAHIRI
FINAL DRAFT	01.02.19	M. ROY	A. SEN	B. LAHIRI
FINAL DRAFT	11.10.18	M. ROY	A. SEN	B. LAHIRI
DRAFT	30.05.18	M. ROY	A. SEN	B. LAHIRI

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NLC TAMIL NADU POWER LTD.
2 X 500 MW PROJECT
TUTICORIN, TAMIL NADU

FLUE GAS DESULPHURISATION PLANT PACKAGE

OVERALL CONTENTS

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VOLUME-II : Technical Specification

VOLUME-III : Bid Proposal Sheets [Technical Part]

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VOLUME II-C	:	Limestone and Gypsum Handling System
VOLUME II-D	:	Piping, Valves & Specialties, Thermal Insulation, etc.
VOLUME II-E	:	Instrumentation & Control
VOLUME II-F	:	Electrical Equipment & Accessories
VOLUME II-G/1 & VOLUME-II-G/2	:	Civil, Structural and Architectural Works [In Two Volumes]
VOLUME II-H	:	Miscellaneous Cranes, Hoists, Elevators, Sump Pump, Diesel Generator Sets, Fire Detection and Protection System etc.
VOLUME II-I	:	Ventilation and Air-Conditioning
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SECTION-IV	:	General Technical Requirements
SECTION-V	:	Painting
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SECTION - I

INTENT OF SPECIFICATION

VOLUME : II-A

SECTION-I

INTENT OF SPECIFICATION

1.00.00 This specification is intended to cover engineering, supply, erection, installation, testing, pre-commissioning, commissioning and performance testing of Flue Gas desulphurization Plant as detailed hereinafter for existing 2 x 500 MW Tuticorin Thermal Power Station at Tuticorin, Tamil Nadu of NLC Tamil Nadu Power Limited (NTPL).

The scope shall include design, engineering, manufacture, procurement, inspection and testing at manufacturer's works, packing and shipment and delivery at site for this retrofitting project. In addition, the Bidder's scope shall also include all necessary supervision of civil/structural/ architectural works, erection/installation including unloading storage and handling at site, connecting with existing equipment/ systems without any damage of the same, site testing, commissioning, trial run, performance and guarantee tests and other services including supply co-ordination, engineering, project management related to the equipment/systems comprising this Package for Flue Gas desulphurization Plant of existing 2 x 500 MW Units as specified hereinafter and in accordance with the requirements, conditions, appendices, drawings etc. stated in Volume-I and Volumes II-B to II-J which shall be considered as a part of this volume as completely as if bound herewith.

This specification consists of Volumes-I, II, III & IV detailed index of which has been furnished elsewhere. This specification shall be read and construed in conjunction with the drawings and annexures to determine the scope of work and terminal points.

The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to meet the intent of this specification, ensuring high degree of reliability and ease of operation and maintenance. The equipment and system/sub-systems shall conform to all aspects of high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the Owner and shall also be in line with the current practice for reliable and efficient functioning of the plant.

Owner shall interpret the meaning of the specification, drawings, requirement of operation, maintenance, redundancy etc., and shall have a right to reject or accept any work or material which in his assessment is not technically complete to meet the requirements of this specification and/or applicable National and International standards mentioned elsewhere in this specification.

Bidder is required to carefully examine and understand the specifications and seek clarifications, if required, to ensure that he has understood the specifications as intended by the Owner. In the absence of any specific clarifications made by the Owner during bidding stage, the interpretation of Owner shall be final. The Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. All such points are required to be clarified during bidding stage.

In the event of conflict between requirements of any two clauses of this specification/documents or requirements of different codes/standards specified, the more stringent requirement as per the interpretation of the Owner shall apply.

2.00.00 Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific items mentioned shall be understood as establishing type, function and quality desired. Equivalence needs to be established if the vendor offers a product that is equivalent during actual execution. The Contractor shall pass on the commercial benefit, if any, to the Owner. The Contractor shall bear the price difference if on the higher side. Owner reserves the right to accept/reject the equivalence.

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SECTION - II

PROJECT SYNOPSIS AND GENERAL INFORMATION

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VOLUME : II-A

SECTION-II

PROJECT SYNOPSIS AND GENERAL INFORMATION

1.00.00 INTRODUCTION

NLC Tamil Nadu Power Limited (NTPL) is presently operating a thermal power plant having two units of 500 MW capacity each, in Tuticorin, Tamil Nadu.

The Bidder shall acquaint himself with the conditions prevailing at site by a visit to the site, before submission of the bid. The information given here in under is for general guidance and shall not be contractually binding on the Owner. All relevant site data /information as may be necessary shall have to be obtained/ collected by the Bidder.

2.00.00 APPROACH TO SITE

The site is accessed by National Highway No. 7A adjacent to plant. Due South connecting Madurai. The nearest railway station is Port Trust Railway Yard at a distance of 1.0 km. Tuticorin sea port is located adjacent to the plant. Nearest airstrip is located at Pudukottai at a distance of 16.5 km. Nearest town is Tuticorin, which is located 5.5 km away from the plant and nearest city is Pallayamkottai, away from 60 km from the plant.

3.00.00 LAND

The site encompasses about 108 Ha, which is located at Tuticorin Taluk in Tuticorin district in the Southern Part of Tamil Nadu along the Bay of Munnar.
Latitude : $8^0$45’38.09”N
Longitude : $78^0$10’15.85”E

The natural land profile of the site 1.46 m above mean sea level.

4.00.0 SOURCE OF FUEL

The primary fuel for this plant is Coal. The Power plant will use coal from Talabira Mines and imported coal.

The daily coal requirement for 2x500 MW units is about 15360 tonnes (at TMCR). Annual coal requirement for the plant is around 4.48 MTPA.

5.00.00 SOURCE OF WATER

Main source of water of the plant is sea water, which shall be taken from the Bay of Munnar. The existing 2x 500 MW NTPL Tuticorin plant uses sea water based closed cooling system with Natural Draft Cooling Towers (NDCT). The sea water intake system comprises of gravity intake channels of a capacity 15000 m^3/hr. Out of this, around 9000 m^3/hr is fed as cooling tower makeup water through CT makeup pumps (2W+1S). Around 3000 m^3/hr sea water is utilized in the RO plant for utilization as service water, potable water, power cycle makeup and miscellaneous uses. The blow down from the Cooling tower back to sea is around 7000 m3/hr.

6.00.00 ASH DISPOSAL AREA

Fly ash is taken by consumer for further utilization. Balance ash is disposed off by HCSD method to the ash dumping area.

7.00.00 METEOROLOGICAL DATA

7.01.00 For the purpose of equipment design, the following Meteorological data of site (as per IMD Tuticorin) shall be taken into consideration

a)	Ambient temperature	:	36.5 ºC maximum 20.8 ºC minimum
b)	Extreme Ambient temperature	:	36.4 ºC maximum (Annual) 24.1 ºC minimum (Annual)
d)	Relative humidity (i) Maximum (ii) Minimum (iii) Average	:	 82% 35% 57 to 68%
e)	Annual Rainfall	:	437 mm
f)	Wind load	:	In accordance with IS-875, Part-3
g)	Seismic Zone	:	Zone II as per IS: 1893 latest edition.
h)	Altitude	:	1.46 M above MSL

VOLUME : II-A

SECTION - III

SCOPE OF SUPPLY AND SERVICES, TERMINAL POINTS AND EXCLUSIONS

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VOLUME : II-A

SECTION - III

SCOPE OF SUPPLY AND SERVICES, TERMINAL POINTS AND EXCLUSIONS

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1.00.00 **SUPPLY OF EQUIPMENT AND SYSTEMS**

The Works, as detailed hereinafter, for the Flue Gas Desulphurisation Plant (FGD) Package of existing 2 x 500 MW Units of NTPL Tuticorin Plant, shall be contracted on complete Engineering, Procurement, Erection/installation of various equipment under this Package with complete civil/structural/ architectural works including unloading storage and handling at site, connecting with existing equipment/ systems without any damage of the same, site testing, commissioning, trial run, performance and guarantee tests and other services including supply co-ordination, engineering and project management. The contractor's scope shall include supply of first fill and further topping up of lubricants / consumables / chemicals, upto successful completion of trial operation, supply of mandatory spares, special tools and tackles, etc. Contractor shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilized during the first year of operation. This additional quantity shall be supplied in separate Containers.

The maintenance scope of the contractor covers all maintenance works, up to completion of trial operation or COD whichever is earlier. In case of any delay or dispute by the contractor, the purchaser may carry out the maintenance work on necessity and back charge the contractor during the period prior to the completion of trial operation or COD whichever is earlier. The contractor shall also carry out major repairs and replacement under warranty obligations until the completion of warranty period, including spares if any. In case the contractor fails to carry out any repair or replacement during the warranty period, the purchaser shall carry out such repair/replacement at his discretion at the risk and cost of the contractor. The spares required for such repair /replacement may be spared to the contractor, if available with the purchaser.

1.01.00 For each 500 MW unit, two (2) nos. axial booster fans each of capacity identical to existing ID fan with constant speed motor drive and blade pitch control for each FGD plant along with oil cooling system comprising of lube oil tank, 2 x100% lube oil pumps, coolers, duplex oil filters etc. and other accessories as required.

1.02.00 Two (2) nos. Limestone based Flue Gas Desulphurisation system each complete with all related auxiliaries and consisting of, but not limited to, the following sub-systems:

1.02.01 Limestone, Unloading, Grinding and Slurry makeup system to absorber

1.02.02 Absorber System

1.02.03 Gypsum Dewatering System

1.02.04 Process Water Storage & Pumping System

1.02.05 Waste Water collection and Treatment Effluent Reuse System.

1.02.06 Limestone Handling System

1.02.07 Gypsum Handling System

1.02.08 Auxiliary equipment like Suspended Magnets, Belt Scales, Dust Suppression and Dust Extraction System, etc.

For detailed specification of Limestone based Flue Gas Desulphurisation, Limestone Handling and Gypsum Handling Systems refer to Volumes: II-B and II-C of this specification.

1.03.00 Common Equipment and Systems, as applicable, for the complete Flue Gas Desulphurisation Plant (Limestone based system)

1.03.01 Piping, valves and specialties for each of the units and common systems [within this Package for FGD Plant area and as per the terminal points defined in Annexure I] as specified in Volume: IID of this specification.

1.03.02 All Ducting, including lining requirement complete with supports, structures, trestles as required and as specified in Volume: IIB of this specification.

1.03.03 All Pipe racks for routing of piping required for the complete process operations and utilities [within this Package for FGD Plant area].

1.03.04 Steel storage tanks / vessels such as Process Water tank, waste drain and other tanks not specifically mentioned but required for completion of various systems supplied under this specification, as specified in Volume: IIB of this specification.

1.03.05 Thermal insulation including cladding material as required for conservation of heat and for personnel protection for both the units, as specified in Volume: IID of this specification.

1.03.06 Miscellaneous Cranes complete with drives, electrical and all other accessories for the following buildings in this Package for FGD Plant as a minimum and as specified in Volume: IIH of this specification.

a) Limestone storage shed
b) Limestone slurry preparation area
c) Absorber Recirculation Pump Building
d) Oxidation Compressor house
e) Any other area if necessary from operation and maintenance requirements.

1.03.07 Miscellaneous hoists & Lifting devices complete with drives and accessories in all buildings within this Package for FGD Plant area, not covered by cranes above and required for handling during operation & maintenance of any equipment weighing above 250 Kg supplied under the package. For detailed scope refer Volume: IIH of this specification.

1.03.08 Elevators complete with drives, electricals, control and instrumentation and all other accessories, inclusive of, but not limited to the following facilities in this Package for FGD Plant area.

a) Absorber
b) Silo and Limestone preparation building
c) Limestone Crusher House

For detailed scope refer Volume: IIH of this specification.

1.03.09 Sump Pumps complete with drives and accessories for drainage of pits for the following areas in this Package for FGD Plant as a minimum and as specified in Volume: IIH of this specification.

a) Limestone slurry preparation area

b) Absorber area

c) Gypsum Dewatering area

d) Limestone unloading area

1.03.10 Two (2) nos. of skid mounted Diesel Generator Sets complete with all accessories for supplying emergency power to FGD plant equipment in case of power failure as required and as specified in Volume: IIH of this specification.

1.03.11 Complete fire detection and protection system for the FGD package, compressed air system as specified in Volume: II-H of this specification.

1.03.12 Ventilation and Air-conditioning system including all equipment, piping, false ceiling, insulation, ducting etc. as required for this Package for Flue Gas Desulphurisation Plant area as specified in Volume: II-I of this specification.

i) The Ventilation system shall cover the following areas as a minimum:
a) Electrical and Control Building
b) Absorber Pump House
c) Oxygen Blower House

d) Limestone Storage Building (only applicable for Limestone based FGD)
e) Limestone Crusher House (only applicable for Limestone based FGD)
f) Limestone Grinding Building (only applicable for Limestone based FGD)
g) Gypsum Dewatering Building (only applicable for Limestone based FGD)
h) Gypsum Storage Building (only applicable for Limestone based FGD)
i) Any other area if necessary from process requirements

ii) The air-conditioning system shall cover the following areas as a minimum:

a) Electrical and Control Building
b) Any other area if necessary from process requirements

1.03.13 Platforms, walkways, staircase, safety rails, etc. as required for operation and maintenance.

1.04.00 Control & instrumentation (C&I) systems required for each unit and common system of this Package for Flue Gas Desulphurisation Plant shall include but not be limited to the following. Any item not specifically mentioned herein but required for completion of the total C&I system shall be included. Refer Vol. IIE of the specification for further detail.

a) Programmable Logic Controller for control, monitoring, data acquisition, alarm and sequence of events recording for Flue Gas Desulphurisation Plant auxiliaries.
b) Human-Machine-Interfaces including servers/ work stations. etc.
c) Vibration Monitoring System
d) Control Panel, Desks, Racks & Enclosures
e) Communication cable including suitable hardware/ software between station DCS and FGD PLC based systems.
f) Power supply and distribution system including FGD Plant UPS and DC power supply.
g) System cabinets unit control panel, control Desks & control room furniture, Junction boxes and local control panels etc.
h) All Measuring instruments and analyzers like transmitters, switches, temperature elements , gauges, SO2 analysers, O2 analysers etc.
i) Flow elements with root valves and accessories.
j) Control valves with actuators and accessories.
k) Erection hardware for instrument process hook up viz. impulse pipes, isolation valve, instrument blow down valves, fittings, tubes etc.
l) Erection hardware for the pneumatic hook up viz. tubes, fittings, valves etc.
m) Local instrument racks and enclosures.
n) All instrumentation signal & control cable, extension & compensating cable, special cable and optical fiber cables etc as required.
o) Cable erection hardware including cable tray, conduits, supports, glands, ferrules and others.
p) C&I earthing (above ground) for Bidder's supplied equipment/ items.

q) Interface With third party systems as applicable.

1.05.00 Complete electrical equipment and accessories for this Package for the Flue Gas Desulphurisation Plant which shall include but not be limited to the following. Any item not specifically mentioned herein but required for completion of the package Electrical system shall be included. Refer Vol. IIF of the specification for further detail.

a) 11/3.3 kV Auxiliary Power transformers and 11/ 0.433 kV Service transformers.

b) 220 / 11.5 / 11.5/ 11KV, 63 / 31.5 / 31.5 MVA FGD Station Transformer

c) 11 & 3.3 kV Switchgears

d) 415V PCC/ PMCC/MCC, 415V AC & 220V DCDB, 220V DC Starter.

e) Local Control Boards/ Panels, Local Isolating Switch Units and Local Push Button Stations.

f) 3.3 kV phase segregated bus ducts.

g) 415V non- segregated phase bus ducts

h) AC & DC motors, Electric motor actuators

i) Variable frequency drives as applicable.

j) Batteries and battery chargers uninterrupted power supply (UPS) system and DC distribution system.

k) Illumination system.

l) All cables, cable trays/racks interconnecting various equipment supplied under the package and interfacing with other plant facilities as specified.

m) Complete grounding and lightning protection system

n) Neutral grounding resistors.

o) Electrical Relay, protection and metering system.

1.06.00 Design and supply of complete civil, structural, architectural & building service works for miscellaneous plant buildings & other indoor/outdoor facilities as included in this Package for the Flue Gas Desulphurisation Plant including supply of materials as required. The services shall include but not be limited to the following:

a) Supply of all foundation plans and footprints, anchor bolts, sleeves

and other embedded fixtures.

b) Fabrication & supply of all types of steel work as required for buildings, platforms, stairs, ladders, hangers & supports etc.
c) Supply of grounding & lightning protection mat for all equipment & building including risers, sub-grids, down conductors, shielding masts etc. as necessary.
d) Engineering, Procurement and supply of doors, rolling/ sliding shutters, windows/louvers, internal partitions, glazing, false ceiling, false flooring, external cladding, roof protection, painting, sanitary & plumbing works etc. as specified and necessary for all the buildings constructed under this package.
e) Layout / plans of Permanent & construction roads around power house and other buildings, as well as arterial roads, culverts and area drainage as specified elsewhere in this specification.

The following plant buildings/structures will be required to be designed and materials supplied under this specification package:

A. Limestone Based FGD System

- Limestone Storage Building
- Limestone Crusher House
- Limestone Grinding Building
- Oxygen Blower House
- Absorber Pump House
- Electrical & Control Building
- Gypsum De-watering House
- Gypsum Storage Building

B. All Civil & Structural works for the followings are also to be provided:

- Flue gas booster fans and ducting arrangements
- FGD Absorber System
- Limestone Handling System and Gypsum Handling System as applicable
- Buildings, silos, equipment foundations, sumps, tanks etc.
- Conveyor gallery, trestle as necessary to provide to meet the functional requirements
- Foundations of all technological structures and equipment
- Pipe racks, Cable racks and related supporting structures (as applicable)
- Provision for Rainwater harvesting pertaining to FGD area to be considered.
- All RCC road works with RCC storm water drains and provision of RCC box culvert at interconnecting locations of other plant roads, RCC pavement within the battery limit & construction of manholes & sewer lines including RCC manholes within the battery limit and connecting the same to the nearest plant main sewerage system.

The above list is not exhaustive and any building/ facilities required to be

designed and materials supplied, as incidental to this contract shall be deemed to be included under the scope of the present specification.

For further details refer Volume: IIG of this specification.

1.07.00 **Equipment shop painting**

Corrosion protection painting for equipment, structures and piping. For details please refer section-V of volume-IIA.

1.08.00 Supply of all consumables required for the works as per provision of respective clauses specified in contract.

1.09.00 Supply of one set of mandatory and erection/commissioning spares. Bidder shall recommended spares required for after-sales services during and after the warranty period.

1.10.00 One set of tools and tackle, fixtures etc. in new condition, as required for regular operation and maintenance of the plant and equipment offered. Price for such tools & tackle, fixtures etc. shall be furnished separately in the prescribed format.

2.00.00 **SERVICES TO BE RENDERED BY THE BIDDER**

The services to be rendered by the Bidder shall include but not be limited to the following:

2.01.00 Deleted

2.01.00 Services for complete engineering, co-ordination and project management as detailed in Section-VI of this specification volume.

2.02.00 Services for shop tests and quality assurance, etc. as detailed elsewhere in this specification.

2.03.00 Computational Fluid Dynamics (CFD) Modelling

2.04.00 Services for construction, fabrication, equipment erection, testing as well as trial run & commissioning of various equipment and accessories under the contract. The details of such services are indicated in Volume IB of this specification. Bidder shall arrange tower crane for erection and construction work, wherever necessary.

2.05.00 Furnishing of all documents, drawings, design basis reports, optimization, study reports, instruction manuals, etc. including "As built" drawings, as called for in the specification both in requisite no. of hard copies and in soft form (CD).

2.06.00 Operation and Maintenance training.

2.07.00 Obtaining approval from statutory bodies in India. However, Purchaser shall provide necessary signatory assistance.

2.08.00 Equipment shop painting. For details of painting, please refer section-V of volume-IIA.

2.09.00 Any other service, although not specifically called for but required for a turn-key contract of the size and nature indicated in this specification for the Flue Gas Desulphurisation Plant

3.00.00 **EXCLUSIONS**

The following items are excluded from this contract:

3.01.00 Communication System for the entire plant.

3.02.00 Internal roads and surface drains outside of the FGD package area.

3.03.00 Illumination outside of the FGD package area.

3.04.00 Additional Wet Chimney

3.05.00 Necessary coordination with Owner/ Consultant for interface engineering and construction shall be the responsibility of the Bidder.

3.06.00 GPS Master Clock System

3.07.00 Station DCS

4.00.00 **TERMINAL POINTS**

The terminal points shall be as specified in Annexure-I of this section.

ANNEXURE-I

TERMINAL POINTS

A) Mechanical:

Sl. No.	Items/ Description	Terminal Point	Scope of FGD Bidder	Remarks
1.	**Flue Gas System**			
i.	Raw Flue Gas (FGD inlet)	At existing common discharge duct of ID Fans.	Flue Gas ducting from the existing common discharge duct of ID Fans to Flue gas booster fans inlet including isolating inlet damper. Isolation damper in the common raw flue gas duct to existing chimney	Raw flue gas dampers are in the bidder's scope. Welding of duct is also under the bidder's scope.
ii.	Clean Flue Gas (FGD outlet)	At the inlet to the new Chimney.	Flue Gas ducting from absorber outlet to the new chimney including necessary isolating damper.	Clean flue gas damper is under the bidder's scope. Necessary Welding of duct is also under the bidder's scope.
2.	**Fire water, DMCC water & other Auxiliary water systems**			
i.	Process Water	New Desalination plant storage area	From the terminal point to the Process water tank for further distribution within FGD plant.	Isolation valve and counter flange is in bidder's scope. Necessary Welding is also under the bidder's scope. Upstream system of the terminal point shall be in Desalination Package Vendor scope.
ii.	Initial filling of DMCW System for FGD Plant Equipment Cooling	From existing DMCW system near ID Fan for each Unit.	From the terminal point entire DMCW system distribution network & equipment shall be within FGD Plant package vendor scope.	Isolation valve and counter flange shall be within bidder's scope. Necessary Welding is also under the bidder's scope.
iii.	Service Water	At a nearby location from existing service water distribution header	From the terminal point further distribution within FGD plant	Isolation valve and counter flange is in bidder's scope. Necessary

ANNEXURE-I

Sl. No.	Items/ Description	Terminal Point	Scope of FGD Bidder	Remarks
				Welding is also under the bidder's scope.
iv.	Drinking Water	At a nearby location from existing drinking water distribution header	From the terminal point further distribution within FGD plant	Isolation valve with screwed counter flange is in bidder's scope. Necessary Welding is also under the bidder's scope.
v.	Treated Waste Water.	At the Outfall Pipe	System with Piping upto the outfall pipe is in bidder's scope.	Connection and necessary Welding is under the bidder's scope.
vi.	Fire Detection and Protection System.	Entire fire detection and protection system including Emergency cooling water system of FGD plant are in FGD package vendor scope. However, water for firefighting system of the FGD plant system shall be tapped-off from the nearby existing Fire Water distribution header, for different systems. Spray water lines for the Station Transformers shall be tapped-off from the existing fire water spray Header. Drain/ Pipe Trenches shall also be connected with the existing drain/ trenches in the transformer area.	From the terminal points onward piping and isolating valve will be done by the Bidder.	Existing Fire water header shall be provided by Owner. However, connection & welding details shall be done by the Bidder.
3.	**Compressed Air System**			
i.	Instrument air	Complete Instrument air system is in FGD Plant package vendor's scope.	Complete Instrument air system shall be provided by FGD Plant package vendor.	-

ANNEXURE-I

Sl. No.	Items/ Description	Terminal Point	Scope of FGD Bidder	Remarks
ii.	Service air	Complete Service air system is in FGD Plant package vendor's scope.	Complete Service air system shall be provided by FGD Plant package vendor.	-
4.	**Miscellaneous**			
i.	Limestone supply	At inlet of unloading hopper grating	From the unloading hopper further conveying and conditioning for use in FGD system	Supply of Limestone in (-) 250 mm size by Owner
ii.	Gypsum disposal	Storage building in FGD plant area	Conditioning and storage of gypsum	Sale/ disposal of conditioned Gypsum by Owner
iii.	Pipe and Cable Racks	All pipe and cable racks required for the FGD Package is in Bidder's scope.	All pipe and cable racks required for the FGD Package is in Bidder's scope.	

ANNEXURE-I

TERMINAL POINTS

B) Electrical:

Sl. No.	Items/ Description	Terminal Point	Scope of - FGD Bidder	Remarks
1.	11 KV Power and control supply	Arrangement of power supply to Switchgears in FGD area is under the scope of the bidder.	Incoming power supply to 11 kV FGD Switchgear shall be arranged by the Bidder as under- **i. <u>Incomer-1</u>:** (From owner's existing Unit Switchboard -1BA & 2BB). Power supply arrangement from the Circuit Breaker terminal of Owner's existing Unit Switchboards to 11kV FGD Switchgear is under bidder's scope. Modifications required (retrofitting) in existing Switchgear (1BA, 2BB, 0BA, 0BB, 0BC), is also under the scope of the bidder. **ii. <u>Incomer-2</u>:** (From 220 / 11.5 / 11.5/ 11KV, 63 / 31.5 / 31.5 MVA FGD Station Transformer). Installation of 220 / 11.5/ 11.5/ 11KV Power supply transformer and connection to Owner's SF6 to Air bushing of 220KV Switchyard along with all necessary inter connecting hardwares, such as intermediate gantries, connecting tube conductors, clamps etc., necessary Relay Panels in Switchyard to suite the new Station Transformer for FGD shall be covered in the scope of bidder. Arrangement of necessary control supply is	**Owner** i. The source of power supply for Incomer-1 (existing Unit Switchgear panels 1BA & 2BB) shall be provided by the Owner. ii. Existing 220kV spare line bay (Bay no. 207) fully equipped up to SF6 to Air Bushing shall be provided by the Owner for installation of FGD Station transformer (Bidder's scope).

ANNEXURE-I

Sl. No.	Items/ Description	Terminal Point	Scope of - FGD Bidder	Remarks
			under the scope of the bidder.	
2.	**Cables: Supply & Routing**	Supply and routing of all cables required for power supply arrangement to FGD plant is in bidder's scope.	**Supply & cabling:** Supply and routing of all cables from Owner's terminal point (from Unit Switchboard circuit breaker terminal) and Station Transformer up to 11 kV FGD Switchgear & all downstream in the FGD area shall be under the scope of the bidder.	
3.	Earthing in FGD area	Complete earthing of the FGD area is under the Bidder's scope.	**Underground earthing:** Laying of underground earth mat in FGD area and connection of the same with the existing Main Plant earth mat at minimum four (4) points.is under the scope of the bidder. **Above ground earthing:** All metallic parts of equipment, Buildings, structures, towers, plant rail, road tracks, the perimeter fencing. etc shall also be connected to the grounding mat, by the bidder.	

TERMINAL POINTS

Sl. No.	Items/ Description	Terminal Point	Scope of FGD Bidder	Remarks
C	**INSTRUMENTATION / CONTROL CABLES**			
1	Interface with station DCS	Marshalling rack of station DCS	Entire cabling from FGD PLC to station DCS marshalling rack and termination.	

ANNEXURE-I

Sl. No.	Items/ Description	Terminal Point	Scope of FGD Bidder	Remarks
2	GPS Master Clock System	Terminal block of existing Master Clock System.	Cabling from FGD PLC to Terminal block of existing Mater Clock System	

D) CIVIL:

Sl. No.	Items/ Description	Terminal Point	Scope of FGD Bidder	Remarks
1.	Plant Roads	Roads within and upto the Battery limits are under the contractors scope.	Roads within and upto the Battery limits are under the contractors scope.	
2.	Storm water Drains	Storm water drains within and upto the Battery limits are under contractors scope.	Storm water drains within and upto the Battery limits are under contractors scope.	
3.	Pipe and cable rack	Portions of Pipe and Cable rack under the package limits are under the scope of contractor.	Portions of Pipe and Cable rack under the package limits are under the scope of contractor.	
4.	Sewage discharge from various buildings	The sewage discharge from various buildings within the battery limits of package and upto 1st available manhole of Sewage conveying system.	The sewage discharge from various buildings within the battery limits of package and upto 1st available manhole of Sewage conveying system.	

NOTE:

Utilities required from the Existing Plat for the FGD plant, Bidder shall provide the quantities clearly. Any boosting stations are required that shall be provided by the Bidder.

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SECTION - IV

GENERAL TECHNICAL REQUIREMENTS

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SECTION - IV

GENERAL TECHNICAL REQUIREMENTS

1.00.00 CODES AND STANDARDS

1.01.00 Except where otherwise specified, the design of FGD Plant package shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the Annexure-I to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the FGD Plant package in the same detail as would be possible had there been a Standard Specification.

1.02.00 The Bidder shall submit along with his bid the list of main codes and standards proposed to be used for the design, construction and testing of the plant. Where the Bidder proposes alternative codes or standards in place of those mentioned in this technical specification, he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 Wherever specified or required to the FGD Plant package shall conform to all applicable statutory regulations such as Indian Boiler Regulations, Indian Electricity Rules, Indian Explosives Act, Factories Act etc. Wherever required, approval for the FGD Plant package supplied under the specification from statutory authorities shall be the responsibility of the Bidder.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern. And if they are equally stringent, the Bidder shall follow the hierarchy as follows:

i) Local regulations
ii) Local codes and standards
iii) This Technical Specifications
iv) Industry codes and standards

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Bidder proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Bidder to bring such changes to the notice of the Owner and advise Owner of the resulting effect.

1.06.00 Combining or mixing of codes and standards of different institutions with respect to individual engineered components/equipments shall not be permitted without the written approval of the Owner.

2.00.00 DESIGN CRITERIA

2.01.00 Capability

The Flue Gas Desulphurisation (FGD) System shall be designed to comply with the design and guarantee point conditions mentioned below and should achieve Sulphur Dioxide (SO_2) level of not exceeding 150 mg/Nm^3 and 150 mg/Nm^3 respectively at 6% excess oxygen level at the stack outlet under all plant operating conditions. The SO_2 removal efficiency shall not be less than 95 % under all operating condition. These shall be modified to more conservative values if Contractor experience warrants the same. However, no credit shall be given to the Contractor for this during evaluation of the bids. Utilization of these values in no way relieves the Contractor of his responsibility to meet all the guarantee requirements.

a) Design Point : BMCR load with worst Coal, 45 deg.C and 60% RH ambient condition

b) Guarantee Point : TMCR load with worst Coal, 27deg.C and 60% RH ambient condition

2.02.00 Equipment Sizing Margins

The following equipment sizing design margins shall be used, as a minimum, based on normal operation of the plant (2x500MW at TMCR) with Coal having highest Sulphur content unless other margins are specified in this Design Specifications.

Equipment/ System	Mass Flow Margin	Pressure Margin
Absorber (gas and slurry)	10%	NA
Limestone Grinding system	10%	NA
Gypsum Dewatering System	10%	NA
Hydro-cyclone	10%	NA
Pumps	10% min.	15% (friction losses)
Blowers/Compressors/ Vacuum pumps	10% min.	10%
Conveyors	10% min.	NA
Crushers	20% min.	NA
Flue Gas Booster Fans	20%	44%

2.03.00 Off-normal operation

2.03.01 The FGD system shall also be capable of operating with partial bypass of flue gas.

2.03.02 The flue gas temperature at inlet to FGD shall be about 175^0C. However, in case of APH failure the flue gas temperature may rise to about 375^0Cfor a short duration and the FGD system shall be designed to suitably withstand such operation without any damage to the system.

2.03.03 The FGD plant shall be capable of following the load imposed by the boiler, including rate of load changes, minimum load and the anticipated daily and annual load schedules. Furthermore, the FGD plant shall be capable to be put in operation, while the boiler is in operation at any load, without any disturbance in the operation of the Units.

3.00.00 REDUNDANCY

3.01.00 Redundancy of design shall be such that the performance of primary and auxiliary equipment shall be sufficient to meet the availability requirements of the plant.

3.02.00 Each equipment whose failure could result in damages to another equipment, or reduce the availability of the plant shall be backed up by a stand-by equipment.

3.03.00 Each equipment whose unavailability due to a failure could result in damages to another equipment or create a health & safety risk for the personnel shall be backed up by a stand-by equipment, one of them being fed by an emergency source in case of external black out.

3.04.00 Design of availability of the FGD Plant equipment & auxiliaries will be such that a failure with consequential shutdown of one Absorber & auxiliaries will in no circumstances be at the origin of a shutdown of the other Absorber & auxiliaries.

3.05.00 Redundancy criteria applicable for specific systems have been addressed in respective sections of the specification (Volume IIB to II-I) and tender drawings (Volume IIJ).

4.00.00 NAME PLATES/ RATING PLATES/ LABELS

4.01.00 Instruction plates, nameplates (rating plates) or labels shall be permanently attached to each main and auxiliary item of FGD Plant equipment & auxiliaries, including instruments, in a conspicuous position. These plates shall be of stainless steel and shall be engraved with the identifying name, type, identification number and manufacturer's serial number, together with the loading conditions under which the item of plant has been designed to operate.

4.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Bidder shall pay specific attention to the nameplates/labels during painting, so that these are not painted over. Direction of flow is also to be engraved. All actuated valves shall be provided with labels, which shall include the valve and actuator reference number.

4.03.00 All nameplates and labels shall be in English language. All measurements shall be in S.I. units.

4.04.00 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.

4.05.00 Nameplates shall be 3 mm thick laminated white, black, white traffolyte for electrical and control panels and stamped stainless steel with lettering of a minimum height 5 mm for other equipment of FGD Plant Equipment & auxiliaries. Warning labels and emergency equipments shall have red lettering in place of black. Danger labels shall have red lettering on a white background. Labels shall be of sufficient size to carry a full description of the FGD Plant item and its complete KKS identifier. The size and location of nameplates shall be subject to Approval of the Owner. Lettering in all cases shall be machine-made and made to be legible after prolonged time in the range of ambient conditions prevailing at the Site.

4.06.00 Universal designation system utilizing six level breakdown KKS numbering system shall be followed for equipment identification. Each piece of equipment, motor, pump, valve, instrument, switchgear cabinet, junction box, control panel, panel board and associated apparatus shall be provided with tag plates indicating tag number and description. All major equipment (including the absorber, hydrocyclone, ball mills, belt filters, auxiliary transformers, booster fans, large pumps and blowers and motors) shall be provided with the data plates, indicating the name of the vendor, type, serial number, year of fabrication, main characteristics, and all further information necessary for a complete identification of the equipment.

4.07.00 All piping shall be painted and/or marked in accordance with the fluid contained according to a power plant color code to be proposed by Bidder and approved by Owner.

4.08.00 Tags shall be fitted by stainless steel self-tapping screws, stainless steel banding such that they are not readily lost or broken during routine operations and maintenance.

4.09.00 Surfaces of labels for cubicles and control equipment shall have a matte or satin finish to avoid dazzle. Colors shall be permanent and free from fading. Danger labels shall have red lettering on a white background. Labels shall be

provided on front and rear access doors of all cubicles. Labels shall also be provided inside cubicles to assist the identification of apparatus and terminals.

4.10.00 All lifting beams, cranes, rails, jibs, hoists, slings, straps and other lifting equipment shall be properly tested and permanently marked with their lifting capacity.

5.00.00 SAFETY AND SECURITY

5.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.

5.02.00 Ready and safe access with clear head room shall be provided to all parts of the FGD Plant Equipment & auxiliaries for operation, inspection, cleaning and maintenance. All platforms shall be fenced and all stairways shall be provided with handrails.

5.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the personals in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The FGD Plant Equipment & auxiliaries layout shall be designed to localise and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, etc. as necessary shall be followed in all respects.

5.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of prohibited materials in any form as mentioned elsewhere in this specification.

6.00.00 GUARDS

6.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.

6.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.

6.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.

6.04.00 Guards for couplings and rotating shafts shall be in accordance with latest revisions of BS PD 5304-2005/ BS EN 953-1998 or similar approved standard. All rotating shafts and parts of shafts must be covered.

6.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure hand hold must be provided on each side of the opening or doorway.

7.00.00 LOCATION AND LAYOUT REQUIREMENTS

The majority of FGD Plant Equipment & auxiliaries (excluding Absorber and DG sets) shall all be of indoor installation. A broad list of buildings housing such equipment is given elsewhere in this specification. Layout should facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the FGD Plant Equipment & auxiliaries. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout drawings show the location of major facilities. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the FGD area as shown in the tender drawings is indicative. The Bidder may, subject to Owner's approval alter the same to suit the space requirement of the equipment offered.

Bidder may give alternate layout of their own with different orientation and relocation but all the equipments and facilities as in tender drawing/specification should be covered and the overall BTG area layout as shown in tender drawing is to be maintained.

While preparing the detailed layout and deciding upon the transportation and construction/ erection strategy and functional requirements, the following aspects shall be ensured:

a) Face of the buildings and facilities shall be located in such a way so as to have an offset of minimum 20 m with respect to center line of double lane road and 15 meter with respect to center line of single lane road.

b) The spacing between various buildings and facilities shall be suitably decided so as to avoid interference between the foundations.

c) The area for construction/erection facilities like lay-down, pre-assembly, offices and stores will be accommodated within the areas available in General Layout Plan.

d) All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including local by-laws will be complied with.

e) Minimum clearances/ dimensions

i)	Around the equipment	:	1200mm
ii)	Width of all staircases	:	1200mm (Minimum)
iii)	Clear Head room within Plant Buildings for pipes, ducts, Structures & cable trays etc.	:	2.5m (Minimum)
iv)	Clear head room in outdoor Power Block area for cable trays & piping	:	8m (BOS)
v)	Clear head room in other outdoor Areas for cable trays & piping	:	3m (BOS)
vi)	Clear head room for conveyors	:	8m (BOS)

f) All piping shall be routed at a clear height of 2500mm (min.) from the nearest access level to clear man movement.

g) A walkway of 600mm (minimum width) with pipe hand rails & toe guards shall be provided all along length of the trestle for maintenance of cables & pipes. Ladders for approach to these platforms shall be provided near roads, passage ways and turning points.

h) Head room for man movement shall be minimum 2.5m at ground floor in boiler area and 2.1m over all platforms.

i) Height of trestles at approach roads to various buildings/facilities shall be 8M. In case building are located in off-site area and are adjacent to each other, then as a good engineering practice, the height of trestle shall be maintained all over as 8.0M.

j) Each equipment room shall be provided with alternate exits in case of fire/accidents as per requirements of factory act and TAC.

k) All cranes shall be provided with approach rung ladders at least at two places. Where ever cranes can't be maintained in situ on the carriage, facility to draw them to maintenance platforms as well as provision of suitable platforms with access facility shall be provided.

l) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as

specified.

m) The plinth level with respect to the existing grade level shall be as indicated elsewhere in this specification.

n) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.

o) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.

p) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified elsewhere in this specification shall be complied with.

q) Top cover over underground pipes/cables shall be minimum one (1) meter.

r) Cubicle for operating personnel shall be located at safe place near the equipment.

s) Cable racks / pipe racks shall have hand railings in walkways on both sides at appropriate heights.

t) All the buildings and facilities will be approachable by the fire tenders.

u) Utility pipes except fire water pipes will be routed over ground on trestles. No trenches for pipes will be envisaged as far as possible. In the Power block area, Fire water pipes will be routed in RCC trenches.

v) Wherever steam pipes or pipes conveying hazardous fluids are running over the trestle, fire water pipes shall not be routed on the same trestle.

8.00.00 OPERATION & MAINTENANCE CONSIDERATIONS

8.01.00 Space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that

they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with hand railing and access ladders/structural steel staircase shall be provided as per layout availability to facilitate operation and maintenance.

8.02.00 Lifting devices i.e. hoists, chain pulleys, etc. shall be provided for handling of any equipment and/or part having weight in excess of 250 Kg during erection and maintenance activities**.** Suitable monorail beams, hooks etc. for this purpose shall be provided in the buildings. The monorail shall be extended to outside the buildings by minimum 2m. The monorail beam shall extend through suitable opening in the building fitted with an approved double flap steel door [with chain or better opening and closing mechanism], removable handrails, platforms etc to enable removal of equipment to ground level or vice-versa.

Lifting tackles, slings, etc. to be connected to hook of the hoist/crane shall also be provided by the Bidder for lifting the various equipment and accessories covered under this specification.

8.03.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Wherever feasible common components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.04.00 Suitable machinery-hatch, removable steel gratings / covers / hand-railing etc. shall be provided in Buildings, etc. as found necessary during detailed engineering.

9.00.00 MATERIALS

9.01.00 In selecting materials of construction of equipment, the Bidder shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. Wherever deviations are taken in respect of materials specified, the reasons shall be spelt out clearly in the proposal.

All materials shall be new and shall be of the quality most suited to the proposed application.

9.02.00 As far as possible, materials shall be in accordance with Indian or international standard specifications and shall be used in accordance with Indian or international codes of practice. Where such standards or codes of practice are not available sufficient information shall be provided to allow the Owner/ Consultant to assess the suitability of the material for the particular application.

Materials used for various components shall be those which have already proven operating experience in similar type of applications.

9.03.00 All parts which could deteriorate or corrode under the influence of the

atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

9.04.00 Prohibited Materials

The use of the following materials is prohibited:

a) High alumina cement in structural elements

b) Wood wool slabs in permanent framework to concrete

c) Calcium chloride in mixtures for use in concrete works

d) Naturally occurring aggregate for use in reinforced concrete that does not comply with the applicable codes and standards

e) Cast iron for any oil service

f) Carcinogenic material and suspected carcinogenic materials by World Health Organization.

g) Asbestos or any other fibrous form of hydrated magnesium silicate

h) Any other material generally known to be deleterious if used or incorporated in such project like the facility.

10.00.00 LUBRICATION

10.01.00 Suitable efficient lubrication system shall be provided where necessary to ensure smooth operation free from undue wear.

10.02.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

10.03.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant which may drop from operating parts.

10.04.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

10.05.00 The Bidder shall supply grease gun equipment suitable to service each type of nipple fitted

11.00.00 LUBRICANTS, SERVO FLUIDS AND CHEMICALS

11.01.00 The Bidder shall provide a detailed and comprehensive specification for all lubricating oils, greases, control fluids and essential chemicals required for the entire plant. A sufficient supply of these shall be provided by the Bidder for initial commissioning, first fill and one year's topping.

11.02.00 The Bidder shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants, control fluids and chemicals shall be provided. The Bidder shall endeavour to reduce the varities and grades of required lubricants and control fluids to a minimum, match them to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

11.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment. Safety data sheets for all lubricants, oils, chemicals etc .specifying composition, application, chemical properties and preventive or accidental care that must be taken before and after use shall be papered by the Bidder and submitted to Owner for approval

12.00.00 PLANT LIFE AND MODE OF OPERATION

The complete FGD Plant Equipment & auxiliaries including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of thirty (30) years under the prevailing site conditions and for the type of duty intended.

The critical components of the FGD Plant, the life of which is limited by time and temperature dependent mechanisms such as corrosion, thermal stress, creep and low cycle fatigue, etc. are to be designed considering expected duty conditions and cyclic load variations.

The allowable stresses shall be reduced so that life expectancy to minimum 2,00,000 hours of operation can be achieved.

The plant would be designed for base load operation as well as cyclic load variation. The load variation is expected to be as per schedule depending on power demand. The FGD Plant Equipment & auxiliaries shall be suitable for shutdown on every weekend, if required. Moreover, the FGD Plant Equipment & auxiliaries should be capable to operate frequently down to 40% load.

13.00.00 PACKAGING & MARKING

All the equipment 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 limitations

from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Bidder shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

As per the information available, the dimensions of over-dimensioned (OD) consignment for transportation of the equipment by rail (if any equipment to be handled through rail transportation) are as below:

a) Width of the Package (from centre-line of rails - 1.6 metres on both sides) : 3.2 Meters

b) Height of the package from rail top : 4.47 Metres

The above indicates the dimensions which can be normally transported on the wagons without infringement of the "moving gauge". However, Bidder shall conduct his own route survey and transportation logistics for transportation of the equipments to project site by road/rail/sea and indicate the same in his proposal. In case of sea transportation, Bidder to consider unloading of equipment at Tuticorin port. Transportation to project site from the nearest railway station or sea port shall be considered by road only.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Bidder shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Bidder, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

14.00.00 PROTECTION

Equipment having antifriction or sleeve bearings shall be protected by weather-tight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.

Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other suitable covering to ensure their full protection. All exposed threaded parts shall be greased and protected with metallic or other suitable protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs. Male threaded openings shall be closed with rough usage covers or plugs. Female threaded

openings shall be closed with forged steel plugs. The closures shall be taped to seal the interior of the equipment. Open ends of piping, tubing and conduit shall be sealed and taped.

Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Bidder's expense.

15.00.00 PAINTING

15.01.00 Please also refer to Section V of Volume-IIA, for details of painting.

15.02.00 For detail painting on building & structural steel elements refer Section-IIG/1 & IIG/2 of this specification.

16.00.00 COLOUR CO-ORDINATION & FINISH

16.01.00 Exterior surfaces throughout the FGD Plant area shall be finished in colours and textures which will blend harmoniously together and with the surrounding landscape.

16.02.00 Interior surfaces throughout the FGD area shall be finished in colours and textures which will blend harmoniously together and which will be conducive to; the comfort, well-being and high productivity of the operators. Operating equipment and services provided shall be colour coded for ease of identification.

16.03.00 All finishes shall be durable and as far as possible maintenance free. Finishes shall be easily cleaned.

16.04.00 Final colours and finishes shall be to the Approval of the Owner.

17.00.00 ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

17.01.00 Environment Protection

17.01.01 The FGD Plant Equipment & auxiliaries area shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to ensure zero discharge from liquid effluents and other effluents within the limits specified in Environment (Protection) Rules 1986 as amended till date.

In case 'The Ministry of Environment, Forest and Climate Change (MOEFCC)' stipulate any other conditions not specified hereunder while clearing the project, the same shall be complied by the Bidder.

17.01.02 Any specific requirement of State Pollution Authorities over and above the above stipulation shall also be complied with by the bidder.

17.02.00 Noise Level Requirement

The plant will be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

a) Maximum noise level shall not exceed 85 dB (A) when measured at 1 meter away from the noise emission source, at a height of 1.5 meters above finished floor level.

b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, `Ambient Air Quality Standards' in respect of noise.

c) Maximum noise level shall not exceed 105 dB(A) for safety valves and associated vent pipes and 90 dB(A) for regulating drain valves. For operating control valves, the noise level shall be within the limit of 85 dBA. For all valves & orifices, the measurement shall be made one (1) metre down stream of the devices and one (1) metre from the surface of the pipe for any combination of pressure drop and flow.

d) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or The Ministry of Environment, Forest and Climate Change regulation during tenure of the contract, the Bidder shall comply with the requirement.

17.03.00 Environmental design specifications

17.03.01 Construction materials and system contents prohibited

a) No equipment or construction materials brought onto or incorporated into the Facility shall contain asbestos at any content level. Only suitable substitutes for asbestos are permitted to be used.

b) Chemicals that are not accompanied by a material safety data sheet shall not be permitted to be used in any Work Area or incorporated into the Work.

c) No ozone depleting substances (as defined by the 1987 Montreal Protocol) at any level are allowed to be used in systems provided by Bidder. Only suitable substitutes are permitted.

17.03.02 Ambient noise mitigation

The Facility noise levels shall not exceed the more stringent of Applicable Law or the Noise Compliance Guarantee.

The Bidder shall abate ambient noise to public receptors in accordance with the more stringent of Applicable Law or the Noise Compliance Guarantee. Mitigation measures that shall be considered during project design include, but are not limited to, the following:

a) Selecting equipment with lower sound power levels;

b) Installing silencers for fans, blowers, compressors;

c) Installing suitable mufflers on engine exhausts and compressor components;

d) Installing acoustic enclosures for equipment causing radiating noise;

e) Applying sound insulation to improve the acoustic performance of buildings;

18.00.00 INSPECTION AND TESTING

18.01.00 Inspection and Tests during Manufacture

18.01.01 The method and techniques to be used by the Bidder for the control of quality during manufacture of all FGD Plant Equipment & auxiliaries shall be as stipulated elsewhere in the specification.

18.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

18.01.03 Before any item of FGD Plant Equipment & auxiliaries leaves its place of manufacture. the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

18.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

18.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Owner. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner.

18.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

18.01.07 All materials used for the manufacture of equipment covered under this

specification shall be of tested quality. Relevant test certificates shall be made available to the Owner. The certificates shall include tests for mechanical properties and chemical analysis of representative material.

18.01.08 All pressure parts shall be subjected to hydraulic testing as per the requirements of IBR. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than thirty (30) minutes.

18.01.09 All necessary non-destructive examinations shall be performed to meet the code requirements of ASME or IBR as applicable.

18.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by Bidder. Bidder's scope and responsibility shall also include preparation and submission of all necessary documents in the specific formats and manner stipulated by the statutory bodies, coordination and follow up for above approvals.

18.02.00 Inspection and Testing at Site

18.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested under the supervision of the Technical Advisor of the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

18.02.02 The Bidder shall provide complete details of his standard procedure for testing the quality of erection and the performance of erected FGD Plant Equipment & auxiliaries. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the pipe work and the adequacy of joints made at site.

18.03.00 For details of specific tests required on individual equipment refer to respective Technical volumes of this specification.

19.00.00 TRAINING OF OWNER'S PERSONNEL

The Bidder shall extend all possible assistance and co-operation to the Owner regarding the transfer of technology and developing expertise in the area of operation and maintenance of the FGD Plant Equipment & auxiliaries.

The details of the training programme will be discussed and finalised with the successful Bidder.

19.01.00 Training at Bidder's Premises

19.01.01 The Bidder shall conduct training of engineers and plant operators of the Owner on engineering, operation and maintenance of the Plant at the Bidder's or Associates or Sub-Bidder's premises where adequate training facilities are available during the design and manufacturing stage.

19.01.02 The training may also be arranged by the Bidder in any Plant where the equipment manufactured by the Bidder or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Bidder. All expenses inherently related to the training shall be borne by the Bidder and shall include but not be limited to travel expenses (international and inland fares), lodging and per diem charges as well as medical insurance, instructors fee, programme and miscellaneous cost to be incurred during the training.

19.01.03 The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the operation and maintenance of the FGD Plant Equipment & auxiliaries. The Bidder shall be responsible for the development of the Training Module and Programme Schedule which shall be submitted to the Owner for approval.

19.01.04 The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee. Three (3) sets of the materials included in the training modules shall be handed over to the Owner upon completion of the training. An evaluation shall be jointly undertaken by the Bidder and the Purchaser's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

19.01.05 The content of the training programme shall include but not be limited to:

1. Limestone based Flue Gas Desulphurisation Plant for Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.
2. Plant operation and systems training for operators including simulator training as applicable.
3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

19.01.06 The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the FGD Plant Equipment & auxiliaries. Said training programme shall be submitted to the Owner for approval.

The Bidder shall provide qualified English speaking instructors and training coordinator(s) during the tenure of the training programme.

19.02.00 Operation and Maintenance Training at Site

19.02.01 The Bidder shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Bidder's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final Acceptance of the first FGD Unit.

19.02.02 The following instructors shall be at the Site continuously during the training:

a) One (1) for Flue Gas Desulphurisation Plant
b) One (1) for Limestone Handling system (part time)
b) One (1) for Electrical Works
c) One (1) for Instrumentation and Control

19.03.00 The total man-months for training of engineers shall be maximum thirty (30), having following indicative break-up:

Discipline	**No. of Man-months**
Operation	12
Mechanical Maintenance	4
Electrical Maintenance	4
Control & Instrumentation	6
Maintenance Planning	4
	30

However, the details of the training programme will be discussed and finalised with the successful Bidder.

19.03.01 On-the-Job Training

19.03.02 During the period of pre-commissioning, commissioning and trial operation, the Owner shall provide operation and maintenance personnel to assist the Bidder in the operation and maintenance of his supply and work under the direction of the Bidder for the purpose of on-the-job training.

19.03.03 The Owner shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The Bidder shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

a) International Organisation for Standardisation (ISO).

b) International Electro-technical Commission (IEC).

c) American Society of Mechanical Engineers (ASME).

d) American National Standards Institute (ANSI).

e) American Society for Testing and Materials (ASTM).

f) American Institute of Steel Construction (AISC).

g) American Welding Society (AWS).

h) Architecture Institute of Japan (AIJ).

i) National Fire Protection Association (NFPA).

j) National Electrical Manufacturer's Association (NEMA).

k) Japanese Electro-technical Committee (JEC).

l) Institute of Electrical and Electronics Engineers (IEEE).

m) Federal Occupational Safety and Health Regulations (OSHA).

n) Instrument Society of America (ISA).

o) National Electric Code (NEC).

p) Heat Exchanger Institute (HEI).

q) Tubular Exchanger Manufacturer's Association (TEMA).

r) Hydraulic Institute (HIS).

s) International Electro-Technical Commission Publications.

t) Performance Test Codes (PTC).

u) Applicable German Standards (DIN).

v) Applicable British Standards (BS).

w) Applicable Japanese Standards (JIS).

ANNEXURE-I

x) Electric Power Research Institute (EPRI).

y) Standards of Manufacturer's Standardization Society (MSS).

z) Bureau of Indian Standards Institution (BIS).

aa) Indian Electricity Rules.

bb) Indian Boiler Regulations (IBR).

cc) Indian Explosives Act.

dd) Indian Factories Act.

ee) Tariff Advisory Committee (TAC) rules.

ff) Pollution Control regulations of Ministry of Environment, Forest and Climate Change, Govt. of India .

gg) Central Board of Irrigation and Power (CBIP) Publications.

hh) National Building Code (NBC).

ii) Indian Road Congress (IRC).

ANNEXURE-II

CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

The guidelines will be applied in general, unless otherwise stated in other technical Volumes. In addition to these guidelines, Bidder shall refer the attached Area Plans, drawing no. 17A14-DWG-M-0002A, 0002B and 0002C for tentative arrangement of the various facilities under this package.

	ITEM	SPECIFICATION REQUIREMENT
A.	Site conditions to be considered	
1.	Prevalent wind direction(s) during dry seasons (for deciding the location of limestone stock pile and unloading areas, minimising the pollution effect due to dust)	West to East. Also see wind-rose in plot plan.
2.	Location of:	
	a) Plant drainage outfall point(s).	Towards North East
	b) Railway entries & exits.	Not Applicable
B.	Layout Requirements	
1.	Maximum permissible slope in	
a)	Rail track	Not applicable
b)	Road	1 in 30
c)	Sides of unpaved embankment	1 in 2
2.	Required road width	
a)	Main Plant access road	10.0 Metres with 1.5 m wide shoulders on either side.
b)	Primary roads without access for 500 T crane	7.5 Metres with 1.5 m wide shoulders on either side
c)	Access ways	4.0 Metres with 1.2m shoulders on either side.

ANNEXURE-II

d)	Road to the absorber area :	Yes.
3.	Required minimum horizontal distance between the nearest points of	
a)	Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b)	Electrical transformer and any other	As per the Tariff Advisory building/facilityCommittee Rules.
c)	Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee Rules.
d)	Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Expolsives Act) and Indian Petroleum Code.
4.	Required minimum vertical clearance	
a)	Under pipes/cable racks at road crossings	8.0 Metres.
b)	Soil coverage over underground pipes for CW/ACW piping	1.0 Metre (minimum) 1.5M
c)	Outdoor Pipe/Cable trench (if required)	150 mm above FGL
d)	Minimum height of equipment (switchgear, cabinet etc.) above floor for HT cable entry	500 mm
e)	Minimum height of equipment (switchgear, cabinet etc.) above floor for LT cable entry	300 mm
5.	Railway Wagon clearance	Not applicable
6.	Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres.

ITEM **SPECIFICATION REQUIREMENT**

ANNEXURE-II

7.	Required level, above the local developed grade level, of	
a)	top of all roads	150 mm.
b)	all outdoor paved areas	150 mm.
c)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes.

ANNEXURE-II

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

1.0 BROAD GUIDELINES FOR LAYOUT PLAN

General layout plan indicating the available spaces for the exiting project is as shown in the tender drawing placed in Volume-J of the tender specification. It shall form the basis for further elaboration by the Bidder for the plant facilities, which are in his scope.

While preparing the detailed layout, planning the facilities in the Bidder's scope and deciding upon the transportation and construction/ erection strategy and functional requirements, the Bidder shall ensure the following aspects in addition to those mentioned earlier in this section:

i) The entire construction activity shall take into account the commissioning of the units.

ii) The finished floor level at ground level of the TG building shall be designated at EL. 0.0M and shall be 500mm above the finished ground level (FGL) of that area.

The finished floor level for various areas / facilities shall be as follows:-

FFL of Main Plant Building	-El.(±) 0.00M
Top of paving for Transformer Yard	El. (-) 0.10M
Top of paving for Boiler/ ESP/ FGD/ Chimney area	El. (-) 0.20M
FFL of buildings	500 mm above FGL of respective area

iii) Hazardous chemical storage complex shall be designed in accordance with statutory agencies guideline

iv) DG Set Exhaust Pipes (Height & Orientation) shall be designed as per Environmental Regulations.

1.1 Common Control Room

Common Control room shall be provided by the Bidder common for both units.

Common Control Rooms / Control Equipment Rooms for each unit/ RIO rooms for each unit shall be provided with air-conditioning by the Bidder.

ANNEXURE-II

2.0 PLANT LAYOUT REQUIREMENT

2.1 The location of main plant block is indicated in the Plot plan drawing enclosed in Volume-J of the tender specification, however Bidder has to develop layout keeping the location/orientation of the existing main power block same as indicated in bid document. Bidder shall develop his own layout for the equipment offered and the same to be clearly brought out in the bid under the scope of Bidder. However, while developing the layout the Bidder must give due considerations for the following requirements:

i. The FGD control, control equipment's room and the Electrical room shall be common for both units and be located near the Absorber tower.

ii. The Electrical and control room shall be single-level and shall essentially house but not be limited to the followings:

1. Electrical Panels
2. Control panels, operator's consoles etc. for all modules. The control room shall not have any internal column inside the room. Large span roof beams for control room to be adopted and designed.
3. Computer room with engineering work stations & associated workstations.
4. A small conference room.
5. FGD Plant In charge room.
6. UPS & batteries.
7. Cabling and all other facilities associated with the above system.

2.2 The Control Room and control equipment rooms, computer room with programmer station, UPS room, shall be provided with Air conditioning. Washroom/Toilet facilities for ladies & gents separately shall be provided. Further, no vertical bracings, pipes, cable shafts etc. shall be routed through control room or control equipment room area. Design of control room interior including lighting, roof, flooring and decoration will also be provided by the Bidder

2.3 The following clearances to be maintained for C&I DCS/ DDCMIS/ PLC cabinets:

i)	Clearance from back	1200mm
ii)	Clearance from front wall	1200mm
iii)	Clearance from side	1000mm

The above clearances are minimum requirement and may increase with increase in door swing of the cabinets.

2.4 Layout of facilities and equipment shall allow removal of transformers without disturbing equipment, piping, cabling, ducts routed in the area.

ANNEXURE-II

Adequate space and provision for handling/removal of booster fans, pumps, motors, heaters, heat-exchanger, compressors, Switchgear Panels, Transformers during maintenance shall be provided.

2.5 The Limestone slurry preparation building, Gypsum dewatering building, Gypsum storage building shall be of multi-storied type designed to utilize gravity flow wherever possible.

2.6 Equipment 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.

2.7 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.

2.8 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.

2.9 A 1500 mm space shall be provided around all pumps, except absorber recirculation pumps, where a 2000 mm space shall be provided.

2.10 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.

2.11 A 1000 mm wide platform with suitable approach shall be provided around each hydro-cyclone.

2.12 A 2000 mm wide floor/platform shall be provided all around each belt filter.

2.13 Independent floor drains with separate down comers shall be provided where fire protection system are provided.

2.14 All heavy equipment located in the buildings shall be accessible by the EOT cranes or hoists for their handling during erection and maintenance. Wherever special handling procedures are to be followed, the same shall be described in and attached with the bid.

ANNEXURE-II

2.15 Monorail for Magnetic Separators (ILMS & SEM) shall extend outside the building by minimum 2.0m. Tramp iron chute (up to ground level) shall be provided at floor on which above magnetic separators are installed.

2.16 The safety guard for the Take-up Carriage / Counterweight box of the Gravity Take-up unit shall be provided with a removable panel for entry of operating personnel for greasing / maintenance of pulleys etc.

2.17 Each Floor cleaning chute of Limestone Handling Plant buildings shall terminate at about 1.2 m above ground level. Floor cleaning chute (debris chute) shall be connected to tramp metal chute wherever feasible.

2.18 A suitable rail track and associated facilities like, mooring posts etc., shall be provided to facilitate the movement of transformers to the access road/ maintenance area.

2.19 Adequate distance shall be maintained between the transformers. As basic guidelines following norms will be adhered to:

i) Auxiliary transformers shall be separated from the adjacent building/structures and from each other by a minimum distance as defined below or by a fire wall of two hours of fire resisting of height at least 600 mm above bushing / pressure relief vent whichever is higher.

Oil capacity of individual transformer separating distance (in liters)	Clear (in Meters)
5,000 to 10,000	8.0
Above 10,000 to 20,000	10.0
Above 20,000 to 30,000	12.5
Over 30,000 or more	15.0

ii) In case of auxiliary transformers having an aggregate oil capacity in excess of 2300 liters or more but individual oil capacity of less than 5000 liters, the separating distance between transformers and surrounding building shall be at least 6M unless they are separated by fire separating walls or are protected by high velocity spray system.

iii) Waste water & oily waste from 220KV / 11 KV Transformer and auxiliary transformer yard areas shall be collected in common oil pits. These common oil pits shall be connected to ETP. Two nos. (1W+1S) vertical screw pumps shall be installed in each common oil pit. These pumps shall transfer oily waste to common oily pit located in ETP area for further treatment through suitable piping system.

iv) HVWS protection shall be provided as per CEA guidelines if the oil capacity more than 2000 liters or capacity of transformer 10MVA or more.

ANNEXURE-II

3.0 Layout requirements for Electrical MCC/switchgear rooms

For finalizing room size, following points shall be considered: -

i) Minimum clearance between HV/MV switchgear and LV switchgear shall be maintained as 2500mm.
ii) Minimum clearance between any obstruction like column, wall and vertical raceway, etc. and rear of LV switchboard shall be maintained as 1000mm respectively.
iii) Minimum clearance between two LV switchgear facing each other shall be maintained as 2000mm.
iv) Minimum rear to rear clearance of LV switchgear shall be maintained as 1000mm respectively.
v) Minimum rear to front clearance for PCC to PCC shall be maintained as 2000mm.
vi) Clearance between the bottom of ventilation duct and top of electrical panel shall be as per statutory requirement
vii) Minimum clearance between two non-drawout panels facing each other shall be maintained as 1500mm.
viii) Minimum clearance between wall and end of switchgear shall be maintained as 1000mm.
ix) Minimum clearance between the sides of two switchgears shall be 1000mm.
x) Minimum clearance between LV switchgear to dry type transformer shall be kept as 2000mm.
xi) Access to rooms, doors, etc. to be provided in various floors shall consider movement of the panels during erection and later during maintenance.
xii) Switchgear room/MCC room and cable vault shall be pressurized above the atmospheric pressure to prevent ingress of dust.
xiii) Control room, switchgear room shall be provided with separate entry and exit door. Rating of fire proof door to be provided in cable vault shall be 2 hours.
xiv) Walkways shall be provided for accessing the cable laid on cable trays in all pipe racks & cable racks.
xv) Cable vault floors shall have all openings properly ridged to prevent water drainage into the room below. In addition proper facilities shall be provided at cable vault floor to drain the water in case of operation of sprinkler system.
xvi) Air-conditioned rooms shall be provided with double door.
xvii) During design stage adequate space shall be provided for expansion of board on either side to accommodate addition of panel to take care of unforeseen factors.
xviii) All busducts shall enter the 415V PMCC from top.
xix) Minimum clearance between two HV / MV switchgear facing each other shall be maintained as 3500mm.

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xx) Bottom to roof beam in HT/ LT switchgear room from finished floor level shall be 4.5m when the room has busducts and shall be 4.0m without busduct.

xxi) Cable spreader floors shall have all openings properly ridged to prevent water drainage into the room below. In addition proper facilities shall be provided at cable spreader floor to drain the water in case of operation of sprinkler system.

xxii) Wherever cables are taken out through wall openings, such openings shall be properly sealed with fire sealing compound.

xxiii) Fire isolation wall shall be provided wherever necessary as per fire safety norms. Opening in the fire separation wall shall be properly sealed with fire sealing compound after laying of cables.

xxiv) Major routes in BOP area (BOP Package area) shall be on overhead cable trays either supported from available structures, building structure. Only in specific areas as shall be approved by purchaser/consultant where number of cables are too small compared to the route length and in transformer yard, cable shall be routed in cable trenches.

xxv) The minimum clear height (excluding roof beam) shall be 3.0m.

xxvi) Bottom of roof beam shall be min. 3m

xxvii) In cable vaults clear height in walkway or cross over below the cable trays shall be 2.1m

4.0 EQUIPMENT LAYOUT REQUIREMENT

4.1 Local Pits/trenches in buildings are to be avoided. However pits/sumps which are unavoidable shall be provided with required dewatering arrangements by means of permanently fixed drainage pumps, further treatment of effluent for reuse purposes and piping up to the ETP for FGD Pump. Bidder shall provide required sump pumps/drainage pumps/submersible pumps, effluent treatment equipment/ system & Piping etc.

4.2 Pump shall be permanently fixed in the pits/sumps. If the pit depth is shallow, vertical top mounted sump pumps shall be provided and in deep pits self-priming drainage pumps (horizontal type) at floor level or alternatively submersible type pumps may be provided.

4.3 Each pit/sump shall be provided with two numbers (2x100% Capacity) of respective type pumps so that the entire pit is evacuated within 15-20 minutes and the operation of the pumps shall be interlocked through level measurement devices to be installed in the pit/sump so that the pumps shall start automatically and empty the pit.

4.4 The general design and construction features of Vertical sump pumps and Submersible pumps are furnished elsewhere.

4.5 In addition to the above, suitable drainage arrangement of different floors of plant buildings shall be provided. These drains shall be led to sumps in ground floor as per approved layout. Bidder shall also provide sump pumps of 2x100%

capacity in each sump pit and the sump drainage water shall be led to the ETP for FGD plant. Bidder shall also provide piping's, fittings etc. for taking this drain/oily waste water to ETP.

4.6 Bidder to furnish the detailed erection strategy along with the bid for major equipment's located in FGD area.

4.7 Bidder's shall prepare the detailed layout of FGD plant in the available space in the existing main power block area indicating the location of all major equipment. The layout shall be furnished along with the bids submitted by the Bidder.

4.8 Valves in the Bidder's scope shall be located in accessible positions

4.9 Provision of monorails with chain pulley blocks/HOT cranes along with hoist, as required shall be kept.

4.10 Approach for removal of equipment for maintenance shall be provided.

4.11 A/C and ventilation ducts, Bus ducts, and Critical Piping routes to be identified at conceptual stage.

4.12 No cable trenches, under-ground cable vaults and pipe trenches are acceptable unless otherwise approved by the Purchaser.

4.13 All the pipes and cables within the Plant boundary shall be routed above ground.

4.14 All other safety requirements as per the factories act, shall be observed while developing the layout.

4.15 Battery rooms should be properly ventilated to release the gases produced. An easily accessible wash basin should be provided in the battery room.

4.16 Pipelines shall be routed in such a way to avoid interference with other pipes and their hangers and supports, structure, equipment, electrical conduits, cable trays, ventilation ducts etc. The pipe routing shall also take into account the availability of structural members for providing suitable supports and hangers. Hot and cold premises of the system shall be suitably isolated/ segregated from each other. Also the electrical premises shall be fully segregated from system piping.

4.17 Piping layout shall have adequate flexibility to absorb all thermal expansion without causing undue stress in the pipelines.

4.18 All piping shall be grouped where practicable and shall be routed to present a neat appearance.

4.19 The piping shall be arranged to provide clearance for removal of equipment

ANNEXURE-II

requiring maintenance and for easy access to valves and other piping accessories required for operation and maintenance. Availability of access to valves and specialties shall be properly indicated on the layout drawing.

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SECTION - V

PROTECTIVE COATING AND PAINTING

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SECTION-V

PROTECTIVE COATING AND PAINTING

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification addresses the requirements of all labour, material, and appliances necessary with reference to preparations for lining / painting, application as well as finishing of all lining / painting for all mechanical and electrical equipment, piping and valves, structures etc. included under the scope of this Flue Gas Desulphurisation Plant package.

1.02.00 The bidder shall furnish and apply all lining, primers including wash primers if required, under-coats, finish coats and colour bands as described hereinafter or necessary to complete the work in all respects.

2.00.00 CODES & STANDARDS

2.01.00 The bidder shall follow relevant Indian and international standards wherever applicable in cleaning of surface, selection of lining material / paints and their application. The entire work shall conform to the following standards / specifications (latest revision or as specified).

a)	SSPC SP 10 / NACE 2 / SA 2½	:	Near white blast cleaning
B)	SSPC PA 2	:	Measurement of dry film coating thickness with magnetic gauges.
c)	ASTM D 45	:	Method for pull off strength using portable adhesion tester.
d)	NACE RP 0274 – 2004	:	High-voltage electrical inspection of pipeline coatings.
e)	NACE SP 0188 – 2006	:	Discontinuity (holiday) testing of new protective coatings on conductive substrates.
f)	NACE RP 0169 – 2002	:	Control of external corrosion of underground or submerged metallic piping systems.

g)	AWWA C 210 – 2007	:	Liquid-epoxy coating systems for the interior and exterior of steel water pipelines.
h)	IS 3589:2001 Annexure-b	:	Steel pipes for water and sewage specification.
i)	AWWA C 222-2000	:	Polyurethane coating for the interior and exterior of steel water pipe and fittings.
j)	IS 13213 : 2000	:	Polyurethane full gloss enamel (two pack)
k)	ISC HD 20 (11902)	:	Polyurethane coating for interior and exterior of steel pipe and fittings.
l)	ISC HD 20 (11055)	:	Solvent less liquid epoxy system by application of interior and exterior surface of steel pipeline.
m)	IS 10221	:	Coating and wrapping for buried piping

3.00.00 GENERAL REQUIREMENTS

3.01.00 The bidder shall submit a detailed written description in the form of a manual covering coating equipment, procedures, materials inspection test, and repair etc. to owner/consultant for approval.

3.02.00 The bidder shall also provide certificates from paint/primer manufacturer mentioning the batch numbers, date of manufacture and shelf life etc. of the materials to be used. In addition to that manufacturing quality plan (MQP) and field quality plan (FQP) shall also be submitted prior to commencement of supply of material and field application.

3.03.00 Paint/coating application work at site shall be done either by paint manufacturer or by their authorized applicator. The authorized applicator shall have proper training & certification from manufacturer. Applicator shall possess all the necessary specialized equipment and manpower experienced in similar job.

3.04.00 If necessary, the material may be heated and applied by airless spray / plural component spray system.

3.05.00 Manufacturer's specific recommendation, if any, shall be followed during application of lining / paints.

3.06.00 In areas where there is danger of spotting automobiles or other finally finished equipment or building by wind borne particles from paint spraying, a purchaser approved method shall be adopted.

3.07.00 The colour scheme of the entire FGD Plant equipment and auxiliaries area, covered under this specification shall be approved by the purchaser in advance before application.

3.08.00 All indoor and outdoor piping, insulated as well as uninsulated will have approved colour bands painted on the pipes at conspicuous places throughout the system, as approved by purchaser.

3.09.00 Inside surfaces of vessels / tanks shall be protected by anticorrosive paints or rubber lining as required / specified elsewhere in the specification. External surfaces of all vessels / tanks shall be protected by anti-corrosive painting.

3.10.00 For vessels / tanks requiring lining and anti-corrosive painting all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.

3.11.00 Natural rubber lining shall be provided on the inside of vessels / tanks as required / specified elsewhere in the specification, in three layers resulting in a total thickness not less than 4.5 mm.

3.12.00 Surface hardness of rubber lining shall be 65 +/- 5 deg. A (shore).

3.13.00 After the lining is completed, the vessels / tanks shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation, erection etc. They shall not be stored in direct sunlight. No further lining or burning shall be carried out on the vessel, after application of the lining.

3.14.00 All lining projecting outside of the vessel shall be protected adequately from mechanical damages during shipment, handling storage etc.

3.15.00 Suitable warnings, indicating the special care that must be taken with respect to these lined vessels shall be stenciled on their outside surface with the letters at least 12 mm high.

3.16.00 All insulated piping shall have aluminium sheet jacketing.

4.00.00 SURFACE PREPARATION

4.01.00 Most metallic articles that are usually given protective coatings are heavily contaminated and require, at least, some cleaning treatment before the coating is applied. The importance of surface preparation cannot be over emphasized as many investigations have shown convincingly that the performance and durability of any protective coatings are, to a large extent governed by the thoroughness of surface preparation. Often they concluded

that careful cleaning and preparation of the surface were more important than the quality of the protective coating.

4.02.00 Surface contamination in the form of rust, scale, oil grease and dirt is often obvious. Invisible contamination may also be present and represents, on the whole, a greater hazard. Examples of the latter are soldering fluxes, perspiration in the form of hand marks, chlorides from marine atmosphere and sulfite from industrial atmosphere.

4.03.00 The following table gives a surface preparation specification in the descending order of Effectiveness:

Sl. No.	Methods of cleaning	Specifications NACE/SSPC
1.	White metal blast	NACE # 1, SSPC SP 5-63
2.	Near –white metal blast	NACE # 2, SSPC SP 10-63
4.	Acid Pickling	SSPC SP 8-63
5.	Brush Blast	NACE # 4, SSPC SP 7-63
6.	Flame Clean and Power Sanding	SSPC SP 4-63
7.	Power Tool Cleaning	SSPC SP 3-63
8.	Chip and Hand Wire Brush	SSPC SP 2-63
9.	Solvent Wipe	SSPC SP 1-63

4.04.00 The following table gives the Specifications for sand / shot / grit blasting

Sl. No.	Methods of Cleaning	Specification
1.	NACE # 1	White sand blast
2.	NACE # 2	Near-white sand blast
3.	NACE # 3	Commercial blast
4.	Pickle, phosphate treated	
5.	NACE # 1	Grit
6.	NACE # 1	Shot
7.	NACE # 4	Brush blast
8.	No surface preparation	

4.05.00 Inspection of blasted steel surface

For the purpose of inspecting the blasted steel surface with sand abrasive, the respective “Visual standards” shall be utilized.

The standards used in industry to describe surface preparation are:

i. National association of Corrosion Engineers (NACE)
ii. Steel Structural Painting Council (SSPC)
iii. Swedish Pictorial Standards

White metal blast (SSPC 5-63, NACE No.1, and SA-3)

This is defined as removing all rust, scale, paint etc. to a clean white metal which has a uniform Grey white appearance. Streaks and stains of rust or

other contaminants are not allowed.

Near white metal (SSPC 10-63, NACE No.2, SA – 2.5)

This provides a surface of about 95% as clean as white metal. Light shades and streaks are not allowed.

Commercial blast (SSPC 6-63, NACE No.3, SA –2)

This type of blast is more difficult to describe. It essentially amounts to about 2/3 of a white metal blast, which allows for very slight residues of rust and paint in the form of staining.

Brush of blast (SSPC 7-63, NACE No.4 SA-1)

This preparation calls for removal of loose rust, paint, scales, etc. Tightly adherent paint, rust and scale is permitted to remain.

4.06.00 Pictorial Standards of different surface preparation to be adopted

During surface preparation operations, the surface condition obtained shall be compared with pictorial standards available for getting the specified condition. These pictorial standards are available in steel structural painting Manual (Vol. 1), “Good painting practice “, visual standards of surface cleaning sp 7,6,10 and 5 are described in page No.185 and 186 viz. Fig 9,11,12 and 13.Surface profile gauge and surface compactor could be used to check surface conditions according to NACE standard TM 01 70 of NACE.

4.07.00 PRESSURIZED WATER CLEANING METHODS

These standards provides requirements for the use of high and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only without the addition of solid particles in the stream. These standards define four levels of working pressure:

SSPC-SP WJ-1/NACE WJ-1:	Water-jet cleaning of metals. Clean to bare substrate.
SSPC-SP WJ-2/NACE WJ-2:	Water-jet cleaning of metals. Very thorough cleaning.
SSPC-SPWJ-3/NACEWJ-3:	Water-jet cleaning of metals. Thorough cleaning.
SSPC-SP WJ-4/NACE WJ-4:	Water-jet cleaning of metals. Light cleaning.

This cleaning standard defines 4 levels of cleanliness for visible contamination by water jetting and 3 levels for non-visible contamination, such as chlorides and other soluble salts. See the full standard for complete definitions on the level of cleanliness.

4.08.00 SPECIFICATIONS FOR COPPER SLAG BLASTING:

1. The surface shall be cleaned of all dust and heavier layers of rust by copper slag blasting the entire internal surface to photographic standard SIS: 055900- 1967.

2. The consumption rate of copper slag is 1.6 Kg/Sqm of the blasted area. This has to be ensured strictly.

3. All tools, equipment, base material, hand and power tools for cleaning, including scaffolding material, copper slag blasting equipment, air compressor, etc. shall be arranged by the contractor at site in sufficient quantity.

4. The compressor used shall be of size enough to produce displacement of 5.6 to 7.0 Cum/Min of air at a pressure of 7 Kg/sq.cm. Standard blasting equipment, hoppers, hoses nozzles and attachments shall be used to obtain best test results and to maintain safety standards. The rate of cleaning shall be about 15 sq.mt. per hour at a pressure of 7 kg/sq.cm.

5. The abrasive used shall be of the physical properties as mentioned below and shall be free from oil, loan and mud etc.

6. The blast cleaned surface shall be blasted with dry compressed air before applying primer. This should be done even if the surface appears very clean and white in colour. The white colour may be due to deposition of silicon and reflection of light on the surface.

7. Proper earthing and bonding arrangements shall be made to prevent any damage by sparks produced by static electricity. Bonding shall be done between tank and blast nozzles and hopper and air compressor also. The bonding conductor should not be less than 16 SWG single strand copper cable.

8. The time gap between blast cleaning and application of primer shall not be more than THREE hours. Blast cleaning work shall, commence from top to bottom.

9. The blast cleaning operation shall be carried out keeping the nozzle at an angle of 30 degree to the vertical in order to prevent rebounding abrasive from showing down the abrasives emerging from nozzle and from under cutting the material to be removed.

10. A blast cleaning, the percentage of bare metal obtained shall be between 95% to standards of SA 2 ½ of the Swedish standard referred above. (Pictora) surface preparation standards for painting steel surfaces).

11. Arrangements for inspection of various stages of the job shall be made available by the Contractor so that the entire sand blasted area is available for inspection. Any defective work noticed shall be immediately rectified and even reblasting shall be done if necessary.

5.00.00 PAINT APPLICATION

The coating is a unique product. It is only after application on the substrate a coating becomes valuable and useful. The manufacturer shall produce high performance liquid coatings, yet the product usefulness lies in the hands of the applicator. That is the reason why stress is given for proper and careful application as a key to the success of any coating. Protection by coating mainly depends upon three factors

a) The material
b) The surface preparation
c) The application

If any one of the three is weak, protection value is affected to that extent.

High performance coatings are especially sensitive to misapplication and may fail drastically. Therefore, it is imperative that the instruction for application be followed explicitly, particularly when applying sensitive and expensive high performance coating systems.

The purpose of coating application is to develop a continuous highly adherent film with an even thickness over the substrate. To achieve this, various factors have to be considered such as type of coatings and weather conditions, application methods etc. It is advisable to avoid painting below 10^0C and above 40^0C, if the relative humidity is above 80%, during the rainy weather and wind velocity is above 24km/hr or else freezing will occur before the paint dries.

5.01.00 Application methods

There are a number of methods by which coatings can be applied. The two principal methods are by brush and spray. The other methods are paint pad applications, electrostatic spray, electro-coating, dipping and fluidized bed technique. The latter methods are primarily for in-plant application.

The choice of application methods depends on a number of factors. The first is the type of coating. Most of the oil-based coatings can be easily applied by brush but it is the slowest process. Spray application is the fastest for large flat surfaces. The type of surface is also a factor. For small and intricate areas, brushing is probably the best method. If the surface is used and pitted, application of the first coat by brushing is probably the best method.

Brushing can be done in almost all areas, since the liquid coating is transferred from the brush to the surface. Spraying however, causes problem with toxic solvents as well as a possible fire hazard due to fume build up.

Spraying in small, enclosed areas are usually not suggested. Clean up is also a factor. Cleaning a brush is the least difficult procedure and cleanup of spray equipment is the most time consuming and most complicated procedure.

5.02.00 Storing and handling of paints

Coating materials (paint) as they are packed at the manufacturing plant are thoroughly dispersed, with the pigments fully suspended and of a uniform consistency in terms of both texture and colour. Unfortunately, very few coatings are applied within a short time after manufacture. They may be placed in inventory at the manufacturing plant or sent to a distribution point where they will be held for a period of time. Also, the coating material may be purchased several months before its actual use and again under different conditions. Thus, coatings generally must be remixed and properly re-dispersed prior to actual application.

A pigment, which is usually heavier than the vehicle, tends to settle and may even cake at the bottom of the container. Coatings vary to a wide degree in this particular characteristic. Some may stay suspended for many years; others settle out hard at the bottom of the container. This is a defect. Paints, which gelled in the container or in which the pigment liveried (i.e. become thick and rubbery) are not satisfactory for use and cannot be practically redispersed. The formulation has to contain proper antisettling additive to avoid this defect.

The purpose of remixing and re-dispersion is to make the coating completely homogeneous, so that upon application the pigment and vehicle can produce the film that was intended by the manufacturer. In certain cases, particularly in oil-type vehicles, there may be skin on the surface of the liquid. These should be removed before re-dispersion, since they will not get redispersed into the vehicle.

5.03.00 Mixing

The mixing process is not practically easy, even if the system has not settled hard. This is often neglected by applicators, particularly in coatings, which have settled rather solidly. There have been examples of coatings that were applied with at least half of the pigment remaining at the bottom of the container un-dispersed and later thrown away with the container. This procedure does not allow for the maximum performance of coating properties and normally leads to rapid coating failure.

Mechanical mixing

It is always better to use a mechanical mixer of some type, since mechanical mixing always produces a more uniform coating and does so much more rapidly than manual mixing. Manual mixing should only be done under unavoidable circumstances and only in containers with the maximum of a 20-liter capacity.

Even when the coating has settled rather hard, the propeller-type agitator can break it up and re-disperse it to a point, which is closely equivalent to its original form. Nevertheless, care should be taken in the mixing operation, particularly to ensure that the material at the bottom and lower sides of the container has been well separated from the container and re-dispersed. Some materials form soft sediment, which clings to both the sides of the container and the bottom, making it necessary to scrape these off before they can be properly dispersed. This is usually done by manual operation. The mixing should be done in such a manner that splashing is avoided.

The speed of a mechanical mixer should be as low as possible in order to obtain the re-dispersion of the pigment in the vehicle. The coating should have a slight vortex at the surface. A large vortex tends to mix air into the coating, which can cause pinholes and air bubbles during application.

Manual mixing

If the manual mixing is necessary, the liquid portion of the coating should be separated into a clean container. The lower, thicker part of the coating can then be more readily mixed into a heavy paste, including the material, which is clinging to the sides of the container. Once the heavier material is mixed into a smooth paste, the remainder of the liquid from the second container can be remixed into the original container with the heavy material, making sure that the two are thoroughly mixed into a uniform coating. One way to do this is to pour the material back and forth between the two containers. This is called boxing. The materials should be poured back and forth several times to assure complete uniform mixing.

5.04.00 Two component coatings

In the case of two component coatings, there are two materials that must be checked to determine whether or not they are properly dispersed prior to being mixed together. Two component coatings are extremely common at the present time. They include numerous kinds of epoxy coatings, coal tar epoxy coatings, polyurethane coatings, and inorganic zinc coatings. With two component coatings, it is essential that the two components be separately and thoroughly mixed. Two component materials are designed to react chemically, so that if they are not thoroughly mixed, the chemical reaction may not take place properly. Mechanical blending of the two components is recommended to obtain a thoroughly mixed product. The two component materials often are in different colours so that a satisfactory mixing can be readily identified. The fully mixed coating should have a uniform colour and consistency.

5.05.00 Mixing dry powder and liquid

The primary example of mixing dry powder and liquid components is in the use of inorganic zinc coatings. In-organic zinc coatings are made from liquid component and dry powdered zinc. The first step is to determine whether or not the liquid component is thoroughly mixed and dispersed to a completely

homogeneous liquid. This usually is not difficult since most liquid components are lightly pigmented.

Second, stir the total contents of the powder slowly into the total content of the liquid until it becomes a well dispersed, free flowing material. In the case of inorganic zinc coatings, the manufacturers supply the liquid and the powder in two different containers in the exact amount that should be mixed. It is essential that the total powder and total liquid be used in order to obtain the desired final coating. Mixing small portions of zinc and liquid is not recommended, since correct proportions are seldom measured under field conditions.

5.06.00 Straining

Most coatings are thoroughly strained prior to being placed in their container. When the container is opened, if the contents have not settled to a hard deposit in the bottom, straining in the field may not be necessary. On the other hand, if the pigment has settled hard, if the coating has a skin on the surface, or if the product is a material such as inorganic zinc, straining is recommended. Straining prior to spraying often eliminates considerable downtime due to gun clogging by small particles those blocks the orifice in the gun.

Straining can be done with a fine fly screen with a mesh size 150µm or through nylon stocking. Nylon stocking does not contain any lint and is a very fine mesh that most coating materials can readily pass through. Mosquito netting or similar materials also are used, although they often contain some lint, which can cause problems.

5.07.00 Compatibility of different paints

While applying multicoated system of paint it is always desirable to have a first-hand knowledge of compatibility of different coating systems with one another. A general view of such information is given in the following table. This is only a general view.

Primer	Oleo resinous	Alkyd	Silicone alkyd	Vinyl	Chlorinated rubber	Epoxy (2 pack)	Urethane
Oleoresins	C	C	C	NR	NR	NR	NR
Alkyd	C	C	C	NR	NR	NR	NR
Silicone alkyd	C	C	C	NR	NR	NR	NR
Phenol resin	C	C	C	NR	NR	NR	NR
Vinyl	C	C	NR	C	C	C	NR
Chlorinated rubber	C	C	C	C	C	NR	NR
Epoxy	NR	NR	NR	C	C	C	C
Coal tar epoxy	NR	NR	NR	NR	NR	C	NR

Zinc-rich epoxy	NR	NR	NR	NR	C	C	NR
Inorganic zinc	NR	NR	NR	C	C	C	NR
Urethane	NR	NR	NR	NR	NR	NR	C

NOTE: C-Normally

NOTE: C-Normally compatible; NR- Not recommended due to known or suspected problems. Certain combinations marked "NR" may be used provided a suitable tie coat is applied.

6.00.00 INSPECTION

Inspection techniques shall be applied at various stages i.e. from purchase of coating materials to paint application and evaluation of performance during service. Inspection procedures at various stages before and after the application of coating systems over the oil installations have been described below:

6.01.00 Paint composition

The type of paint system shall be selected depending upon the environmental conditions. Generally primer, undercoat and finish coats are used in protective coating system. The purchased paint materials are used in protective coating system. The purchased paint materials shall be tested for the following properties to ascertain whether the supplied paint conforms to the specifications.

i. Type of film formers present
ii. Type of pigments present
iii. Thickness per coat
iv. Volume solids
v. Pigment volume concentration
vi. Area coverage per liter of the paint
vii. Specific gravity
viii. Drying time and
ix. Main pigment content in total pigmentation

It is the duty of the inspection engineer to get the paint system tested for the above factors. The painting operation shall be started only after the values obtained coincide with the required specification of the paint system.

It is essential to see that the surface is not wet during the application of the paint. Moreover paints should not be applied when the humidity of the environment is above 80%. The atmospheric temperature should not be below 10^{o}C during the painting operation.

6.02.00 Procedure for testing paint samples

The following laboratory test procedures shall be adopted for the characterization of the film-formers, pigments and studying the properties of the paint.

a) Type of film-formers present

The film former shall be separated out of the paint by means of centrifuging. It is then to be analyzed using infrared spectroscopy for identifying the functional group. i.e. the type of film formers.

b) Type of pigments present

After separating the pigment from the paint and proper drying, it shall be subjected x-ray diffraction for identifying the pigment.

c) Thickness per coat

Magnetic thickness gauges are used to measure the thickness of the paint film applied over the iron-substrate. The thickness is measured in micrometer (µm). Some of the thickness gauges operating under magnetic principle are elecometer, posi test and micro test. Thickness gauges operating on eddy current principle are used to measure coating thickness over metals other than steel/magnetic substrates.

d) Volume solids

Paint is a mixture of three major components such as pigment, binder and thinner.

The pigment and film-former will remain in the paint film after the evaporation of the solvent. The pigment and film former together are called as solids. The volume of these together in the liquid paint is called as volume solids. This is determined as follows:

A known volume of the paint is taken. Let it be V1. Distilling the solvent and collecting it in a measuring cylinder determine the volume of the solvent present of the paint. Let it be V2. By subtracting V2 from V1, we can determine the volume solids.

e) Pigment volume concentration (PVC)

Pigment volume concentration is defined as

$$PVC = \frac{\text{Volume of pigment}}{\text{Volume of pigment + Volume of binder}} \times 100$$

By separating out the pigment and binder form the paint and knowing their specific gravity, we can calculate PVC.

f) Area coverage per liter of the paint

This is determined by taking a known volume of the paint and applying it over a surface. The area covered by the known volume of the paint is determined. From this value, area covered by one liter of the paint is calculated.

g) Specific gravity

For determining specific gravity, a cup of known volume is taken. The difference in weight of the cup filled with paint and the empty cup gives the weight of paint of known volume. From this, we can calculate specific gravity.

h) Drying time

i) Touch Dry

In this case, if the coated surface is touched with finger, no finger mark should be found on the coating.

ii) Hard Dry
It is the condition of coating drying very hard. Unless the coating itself is damaged with force, no pressure could mar the coating in this condition. This condition is attained usually after seven days.

i) Flow properties (viscosity) of the paint (Ford cup method)

Ford cup is the mostly used instrument for studying the flow properties of the paint. Ford cups having different orifice sizes are available in the market. The varying orifice sizes are meant for measuring the flow time of different viscosities. Generally, the most viscous liquids require bigger orifice. The results are reported simply as seconds per cup. Number

6.03.00 Spot testing procedures

The following spot tests will be useful to identify the binders (film-formers) qualitatively before application at the site.

a) EPOXY RESIN

i) Filter paper test

This test can be carried out even with paint itself. 0.5 gms of paint part (binder part) / binder is taken in a 100 ml beaker and treated with 1ml concentrated sulfuric acid. The beaker is slightly heated at 60^{o}C for a few minutes. It is again mixed with 5ml of conc.H_2SO_4 until the colour intensity is similar to that of very dilute potassium-di-chromate solution. A drop of the solution is taken in a glass rod and is spread over a filter paper. If Bis-phenol-A-type of epoxy resin is present, a purple colour develops in 1 minute, the colour eventually turns blue.

ii) Formaldehyde Test

Few drops of the sample is dissolved in 1 to 2 ml of concentrated sulphuric acid if necessary by heating to 40°C to 50°C. One to two drops of formaldehyde solution is added in to it. An orange colour, which on dilution with water turns violet to blue indicates the presence of epoxy resins.

b) Chlorinated rubber resin

Few milligrams of the sample is allowed to stand in pyridine at room temperature for few minutes. Few drops of methanolic potassium hydroxide solution is added in to it. If chlorinated rubber resin is present in the solution, a yellow precipitate is formed which gradually darkness to a yellow-brown colour.

c) Isocyanate hardener

The aliphatic nature of isocyanate is confirmed by the following spot test. A small sample of isocyanate hardener is heated in a test tube util white fumes are evolved and these fumes are absorbed on a filter paper. One drop of a solution of 4-nitrobenzene-di-azofluoroborate in methanol (1%) on the filter paper should give any coloration, confirms the presence of aliphatic isocyanate. If any coloration is seen on the filter paper, this will confirm the presence of aromatic isocyanate

The infrared spectra of the aliphatic isocyanate will show peaks at 1370 cm-1 and 2250-2350 cm-1.

Physical, Chemical and Instrumental methods of paint analysis with their relevant standards are given in the following tables.

i) Physical Tests

Paint property	IS Standard	ASTM
Preparation of panels	IS 101 PART1 – SEC3	D 609
Preparation of Tin panels	IS 101 PART1 – SEC3	D 609
Viscosity (KU)	IS 101 PART1 – SEC5	D 562
Weight per Gallon	IS 101 PART1 – SEC 7	D 1475
Fineness of Grind	IS 101 PART3 – SEC 5	D 1210
Water content	IS 101 PART2 –SEC 1	D 95
Coarse particles and skins		D 185
Drying times Set to touch Dry for recoating Dry hard	IS 101 PART3 – SEC 1 & 2	D 1640
Pigment content	IS 101 PART8 – SEC 2	D 2371
Vehicle content		D 2371
Non – volatile content	IS 101 PART2 – SEC2 & PART8 – SEC –2	D 2369
Adhesion	IS 101 PART5 – SEC2	D 3359
Brushing properties	IS 101 PART1 – SEC4	

Exposure tests of paints on metals		D 1014
Salt spray resistance	IS 101 PART6 – SEC1	B 117
Accelerated weathering	IS 101 PART6 – SEC5	D 822
Leafing		D 480
Flexibility	IS 101 PART5 –SEC	D 522

ii) Chemical Tests

PAINT PROPERTY	TEST METHOD (ASTM)
Chemical resistance	D 1308
Liquid dryers	D 564
Aluminum	D 480
Aluminum silicate	D 718
Calcium carbonate	D 34
Extenders in colors	D 126
Iron oxide	D 768, D 50
Leaded zinc oxide	D 34
Red lead	D 49
Water soluble salts	D 2448, D 2455
Zinc oxide	D 34
Zinc powder	D 521
Zinc sulfide	D 34

iii) Instrumental Tests

Paint property	Test method (ASTM)	Instrument
Dry Opacity	A 2805	Reflectometer
Gloss	D 523	Gloss meter
Color	D 2244	Colorimeter
Vehicle Identification	D 3168 D 3271	Infrared spectrophotometer Gas chromatograph
Solvent solids Identification	D 3271	Gas chromatograph
Vehicle solids Identification	D 2621	Infrared spectrophotometer

7.00.00 SPECIFICATION OF COATING SYSTEM

7.01.00 Protective coating for steel structures

Most commonly used coating system for atmospheric zone of blast cleaned steel structures are given below:

7.01.01 System-1

Coating system used for atmospheric open exposure zone is one coat of inorganic zinc-rich primer, one coat of epoxy-Glass flake filled intermediate coating and one coat of aliphatic polyurethane provides better performance in more aggressive services. The coating system for closed atmosphere is also the same system with the replacement of aliphatic urethane with aromatic polyurethane top coat. The surface preparation of this Zinc rich primer requires sand blasted surface or grid blasted surface to the Swedish Specification of Sa 2.5. The coating systems are to be applied by spray method. The specification of the system is as given below:

i. Specification of Inorganic zinc rich primer

Colour	Green Grey
Gloss Level	Matt
Volume Solids	63%
Typical Thickness (DFT)	70-80 microns
Theoretical Coverage	8.40 m²/litre
Method of Application	Airless Spray, Air Spray
Drying Time	One Hour
Volatile Organic Compound	216 g/ Litre
Mix Ratio	Liquid Binder Base part(A) 3: Powder Zinc component part (B)1
Working Pot Life	2-2.5 hours
Shelf Life	1 year

ii. Specification for glass flake filled epoxy coating

Colour	As desired
Finish	Semi-Glossy
Type	Two packs
Application	By brush or spray
Dry film thickness/coat	100– 110 µm
Volume solids	Approx. 90 ± 2 %
Area coverage (theoretical)	8 to 9 sq.m/ litre
Surface dry	4 hrs.
Hard dry	24 hrs.
Over coating	24 hrs.
Recoatability	24 hours.
Full cure	1 week.
Shelf life	12 months

iii. Specification for Aliphatic Polyurethane top coat for open zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8 - 9 m²/litre
Method of Application	Airless Spray, Air Spray
Guiding data for airless spray:	
Nozzle tip (inch/1000)	15-21

Pressure at nozzle (minimum)	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part 1
Working Pot Life	3 hours
Shelf Life	2 years

iv. Specification for Aromatic Polyurethane top coat for closed zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m²/litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray:

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part 1
Working Pot Life	3 hours
Shelf Life	2 years

7.01.01 System-2

The surface preparation is not possible through blast cleaning, then the surface is cleaned with wire brushing or power tool cleaning and coated with two coats of non aluminium epoxy mastic followed by an aliphatic polyurethane coating is recommended.

i. Specification for non aluminium Epoxy mastic paint (High build)

Colour	As desired
Finish	Semi-Glossy
Type	Two pack
Application	By brush or Airless spray
Dry film thickness/coat	100-110 microns
Volume solids	Approx. 80 ±2 %
Area coverage (theoretical)	6 to10 sq.m/litre
Surface dry	4 hrs.
Hard dry	12 hrs.
Recoatability	24 hours.
Full cure	7 days.
Shelf life	months (or as recommended by manufacturer

ii. Specification for Aliphatic Polyurethane top coat for open zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m²/litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part 1
Working Pot Life	3 hours
Shelf Life	2 years

7.02.00 Protective coating system for Pipelines without Cathodic Protection

There are a number of factors to be considered for the selection of an external pipeline coating including physical and chemical stability of the coating in the pipeline environment, adhesion, and resistance to impact. The pipeline should be cleaned and prepare the surface for painting as follows:

The pipeline surface shall be cleaned. The main objective of surface preparation is to ensure that all contamination (rust, mill scale, etc.) is removed to reduce the possibility of initiating corrosion so that a surface profile is created that allows satisfactory adhesion of the paint to be applied. The surface of the pipe is cleaned with a wire brush or power tool cleaning to get the surface of Sa 2/St 3. Thus prepared surface to be cleaned with lint free cloth, which also includes cleaning & dewatering (in case of valve chamber) and drying the surface. After preparing the surface of the pipe for painting, the primer coat, undercoat and finish coat shall be applied. The coating system recommended for the pipeline is high build epoxy mastic coating as primer followed by an epoxy glass flake filled coating with the top coat of aliphatic polyurethane. The specifications of the systems are given below:

i. Specification for Epoxy mastic paint (High build)

Colour	As desired
Finish	Semi-Glossy
Type	Two pack
Application	By brush or Airless spray
Dry film thickness/coat	100-110 microns
Volume solids	Approx. 80 ±2 %
Area coverage (theoretical)	6 to10 sq.m/litre
Surface dry	4 hrs.
Hard dry	12 hrs.
Recoatability	24 hours.

Full cure	7 days.
Shelf life	12 months (or as recommended by manufacturer

ii. Specification for glass flake filled epoxy coating

Colour	As desired
Finish	Semi-Glossy
Type	Two packs
Application	By brush or spray
Dry film thickness/coat	100– 110 µm
Volume solids	Approx. 90 ± 2 %
Area coverage (theoretical)	8 to 9 sq.m/ litre
Surface dry	4 hrs.
Hard dry	24 hrs.
Over coating	24 hrs.
Recoatability	24 hours.
Full cure	1 week.
Shelf life	12 months

iii. Specification for Aliphatic Polyurethane top coat for open zone

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m²/litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray:

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part-1
Working Pot Life	3 hours
Shelf Life	2 years

7.03.00 Protective coating for all other surfaces

The surface shall be cleaned with wire brushing or by power tools (St3). These structures will be protected by three layer system of Epoxy zinc rich primer followed by Glass Flake filled epoxy and aliphatic polyurethane finish coat. The specifications of the coating system are given below:

i. Specification for Epoxy Zinc rich primer

Colour	Grey
Finish	Matt
Type	Two pack
Application	By brush or spray

Pigment (Main)	Zinc dust (30-40% by wt. of the total pigments.)
Type of epoxy	Condensation product of bisphenol-A and Epoxide equivalent Epichlorohydrin with terminal Epoxide groups 450-500
Curing agent	Polyamide (amine value 210-230)
Dry film thickness/coat	50-60 µm
Volume solids	55±2% (volume)
Area coverage (theoretical)	11 to 14 sq.m/litre
Surface dry	2-3 hrs.
Hard dry	24 hrs.
Re-coatability	24 hours.
Full cure	5 days.
Shelf life	6 months under sealed conditions

ii. Specification for Epoxy glass flake paint

Colour	As desired
Finish	Semi-Glossy
Type	Two packs
Application	By brush or spray
Dry film thickness/coat	100–110 µm
Volume solids	Approx. 90 ± 2 %
Area coverage (theoretical)	8 to 9 sq.m/ litre
Surface dry	4 hrs.
Hard dry	24 hrs.
Over coating	24 hrs.
Re-coatability	24 hours.
Full cure	1 week.
Shelf life	12 months

iii. Specification for aliphatic Polyurethane top coat

Colour	Required colour
Gloss Level	Glossy
Volume Solids	63±2%
Typical Thickness (DFT)	50-60 microns
Theoretical Coverage	8-9 m²/litre
Method of Application	Airless Spray, Air Spray

Guiding data for airless spray:

Nozzle tip (inch/1000):	15-21
Pressure at nozzle (minimum):	150 bar/2100 psi
Drying Time	One Hour
Volatile Organic Compound	340 g/ Litre
Mix Ratio	Acrylic Polyol Base part 5: Aliphatic Isocyanate Hardener part-1
Working Pot Life	3 hours
Shelf Life	2 years

7.04.00 Summary of Specification of Coating System

The summary of the coating system shall be as mentioned below:

Area	**Surface preparation**	**Recommended coating scheme**
Directly exposed to Sunlight- Steel structures	Copper shot blasting to Sa2.5	Scheme I
	Power tool cleaning to St3	Scheme II
Indoor –Steel Structures	Copper shot blasting to Sa2.5	Scheme III
	Power tool cleaning to St3	Scheme IV
Pipelines (over ground)	Power tool cleaning to St3	Scheme V
All other surfaces	Wire brushing / Power tool cleaning to St3	Scheme VI

7.04.01 Scheme-I: For blast cleaned structures and exposed to sunlight

For new steel structures/Existing steel structures	Exposed to sun light Outdoor)	
Surface preparation	Copper slag blasting to Sa2.5	
Primer	Zinc ethyl silicate	50 – 60µm
Undercoat	Epoxy Glass flake (high build)	100 – 110 µm
Top Coat	Aliphatic polyurethane (TiO_2) rutile	50 – 60µm
Total dry film thickness (DFT)		200 –230µm

7.04.02 Scheme-II: For under prepared structures and exposed to sunlight

For new steel structures/Existing steel structures	Exposed to sun light (Outdoor)	
Surface preparation	Power tool cleaning St-3/Paint strippers	
Primer	Epoxy mastic(non aluminium)	100 – 110µm
Undercoat	Epoxy mastic(non aluminium)	100 – 110 µm
Top Coat	Aliphatic polyurethane (TiO_2) rutile	50 – 60µm
Total dry film thickness (DFT)		250 –280µm

7.04.03 Scheme- III: For blast cleaned structures and not exposed to sunlight

For new steel structures/Existing steel structures	Not exposed to sunlight (Indoor)	
Surface preparation	Blast Cleaning to Sa2.5	
Primer	Zinc Ethyl Silicate	50 – 60µm
Undercoat	Epoxy Glass flake (high build)	100 – 110 µm
Top Coat	Aromatic polyurethane TiO_2 (rutile)	50 – 60µm
Total dry film thickness (DFT)		200 –230µm

7.04.04 Scheme-IV: For under prepared structures and not exposed to sunlight

Surface preparation	Mechanical chipping / Power tool cleaning St-3/Wire brushing St-2	
Primer	Self-priming epoxy mastic	100 – 150µm
Under coat	Self-priming epoxy mastic	100-110 µm
Top Coat	Aromatic polyurethane TiO_2 (rutile)	50 – 60µm
Total dry film thickness (DFT)		250 –320µm

7.04.05 Scheme- V: For pipelines (above ground)

Surface preparation	Mechanical chipping / Power tool cleaning St-3/Wire brushing St-2	
Primer	Self-priming epoxy	100 – 150µm
Under coat	Epoxy Glass flake (high build)	100-110 µm
Top Coat	Aliphatic polyurethane TiO_2 (rutile)	50 – 60µm
Total dry film thickness (DFT)		250 –320µm

7.04.06 Scheme-VI: Coating specifications for all other surfaces

Surface preparation	Power tool cleaning St-3/ Paint strippers	
Primer	Epoxy Zinc rich	50 – 60µm
Under coat	Epoxy glass flake	100-110µm
Top Coat	Aliphatic polyurethane TiO_2 (rutile)	50 – 60µm
Total dry film thickness (DFT)		200–230µm

8.00.00 TESTING REQUIREMENTS

8.01.00 Measurement of dry film thickness

Measurement of dry film thickness of coating: coating thickness shall be in the range of ±20% and as per SSPC PA 2.

8.01.01 Apparatus / instrument

The instrument used for dry film thickness may be type 1 pull of gauges or type 2 electronic gauges.

8.01.02 Procedures

a) Number of measurements

For 100 square feet (9.29 square meters), five (5) spots per test area (each spot is 3.8 cm) in diameter. Three gauge readings per spot (average becomes the spot measurement).

b) If the structure is less than 300 square feet, each 100 square feet should be measured.

c) If the structure is between 300 and 1000 sq ft, select 3 random 100 square feet test areas and measure.

d) For structure exceeding 1000 square feet, select 3 random 100 square feet testing areas for the first 1000 sq ft and select 1 random 100 square feet testing area for each additional 1000 square feet

e) Coating thickness tolerance: individual reading taken to get a representative measurement for the spot are unrestricted (usually low or high readings are discarded). Spot measurements (the average of 3 gauge readings) must be within 80% of the minimum thickness and 120% of the maximum thickness.

Area measurement must be within specified range.

8.02.00 Electrical inspection (holiday) test

8.02.01 All the coated / lined pipes shall be tested with an approved high voltage holiday detector preferably equipped with an audio visual signaling device to indicate any faults, holes, breaks or conductive particles in the protective coating.

8.02.02 The applied output voltage of holiday detector shall have a spark discharge of thickness equal to at least twice the thickness of the coating to assure adequate inspection voltage and compensate for any variation in coating thickness. The electrode shall be passed over the coated surface at approximately half the spark discharge distance from the coated surface only one time at the rate of approximately 10 to 20m/min. The edge effect shall be ignored. Excessive voltage shall be avoided as it tends to induce holiday in the coated surface thereby giving erroneous readings.

8.02.03 While selecting test voltages, consideration should be given to the tolerance on coating thickness and voltage should be selected on the basis of maximum coating thickness likely to be encountered during testing of a particular pipe.

The testing voltage shall be calculated by using following formula. (as per NACE 0274 : 2004)

Testing voltage $v=7900\sqrt{t}\pm10\%$ where t=the average coating thickness, mm.

8.02.04 Any audio visual sound or spark leads to indicate pinhole, break or conductive particle.

8.03.00 Adhesion pull off test

After holiday the coated surface is subjected to adhesion pull off test as per ASTM D 4541.

8.03.01 Apparatus / instrument: adhesion tester consists of three basic components:

A hand wheel, a black column containing a dragging indicator pin and scale in the middle and a base containing three legs and a pulling “jaw” at the bottom and also dollies.

8.03.02 Prepare the test surface

Once test area is selected, test area shall be free of grease, oil, dirt, water. The area should be flat surfaces and large enough to accommodate the specified number of replicate test.

8.03.03 Prepare dolly (test pull stub)

The dolly is a round, two sided aluminium fixture. Both sides of the dolly looks same, however, one side sloped on top surface while flat on bottom surface. As the surface of the dolly is polished aluminium, roughen the same using a coarse sand paper.

8.03.04 Select an adhesive

Use araldite, a 100% solid epoxy adhesive. This adhesive requires at least 24 hours at room temperature to cure.

8.03.05 Attach the dolly to the surface

a) Using a wooden stick, apply an even layer of adhesive to the entire contact surface area of the dolly.

b) Carefully remove the excessive adhesive by using a cotton swab. Allow the adhesive to fully cure before performing the adhesion test.

c) Attach the dolly to the coated surface and gently push downward to

displace any excessive adhesive.

d) Push the dolly inward against the surface, and then apply tape across the head of the dolly.

8.03.06 Adhesion test procedure

a) Attach the adhesion tester to the dolly by rotating the hand wheel counter clockwise to lower the jaw of the device.

b) Slide the jaw completely under the head of the dolly. Position the three legs of the instruments so that they are sitting flat on the coated surface.

c) Slide the dragging indicator pin on the black column to zero by pushing it downward.

d) Firmly hold the base of the instrument in one hand and rotate the hand wheel clockwise to raise the jaw of the device that is attached to the head of the dolly. The dragging indicator pin will move upward on the black column as the force is increased and will hold the reading. Apply the tension using a moderate speed. Continue to increase the tension on the head of the dolly until (a) the minimum psi/mpa/kg/cm² required by project specification is exceeded and the test is discontinued, (b) the maximum psi/mpa/kg/cm² of adhesion tester has been achieved and dolly is still attached, (c) the force applied by the adhesion tester causes the dolly to dislodge.

e) Read the scale and record the adhesion value.

8.04.00 Coating repair

Defective coating shall be repaired in accordance with the following subsections.

8.04.01 Surface preparation

Accessible areas of pipe requiring coating repairs shall be cleaned to remove debris and damaged coating using surface grinders or other means. The adjacent coating shall be feathered by sanding, grinding or other method. Accumulated debris shall be removed by blowing with contaminant free air or wiping with clean rags.

8.04.02 Areas not accessible for coating repair such as interior surfaces of small diameter pipe shall be reprocessed and recoated.

8.04.03 Coating application

The coating system shall be applied to the prepared areas in accordance with procedure.

8.04.04 Repair inspection:

Repaired portion shall be electrically inspected using a holiday detector.

8.05.00 Welded field joints

8.05.01 Preparation

The weld joints shall be cleaned so as to be free from mud, oil, grease, welding flux, weld spatter and other foreign contaminants. The cleaned metal surfaces of the weld joint shall then be blasted or abraded using rotary abrading pads. The adjacent liquid epoxy / pu coating shall be feathered by abrading the coating surface for a distance of 25 mm.

8.05.02 Electrical inspection

After curing the coating system applied to the welding joints shall be holiday tested. Any holidays indicated by the detector shall be marked with chalk to identify the area of repair.

9.00.00 INFORMATION / DATA REQUIRED

The bidder shall submit complete list of paints and primers proposed, giving detail information, such as, chemical composition, drying time etc. And also unit rates for application of each type of paint along with supply shall be furnished.

ANNEXURE-I
MARKET AVAILABLE COATING SYSTEMS AS PER SPECIFICATION

Sl.No.	Specification	ASIAN PAINTS	BOMBAY PAINTS GRAUER & WEIL Paints	BERGER PAINTS	GRAND POLYCOTS	International Protective Coatings	KRISHNA CONCHEM
1.	Zinc Ethyl Silicate Primer	Apcosil 605 ZS	Zinc–o-sil 75	Zinc Anode 304	GP Prime 402	InterZinc 22	-
2.	Epoxy Zinc rich Primer	Apcodur CP 686			GP Prime 205	Inter Zinc 42	
3.	Self Priming Epoxy Mastic Paints	Rust-O-Cap	Penthdur Mastic 5527	Berger protecto Mastic	GP Prime guard 235	Interplus 256	-
4.	Epoxy Glass Flake Paint	Apcodur EP glass Flake	Pentadur Glass Flake 3580	Epilux Super Build ST Glass Flake Coating	GP SUPERGUARD GLASS-FLAKE	Interzone 505	Karaikote 100 S
5.	Aliphatic Polyurethane Paint	Apcothane CP 674	Pentathane 4512 (M)	Polyurethane Coating	GP Bond 141	Interthane990	-
6..	Aromatic Polyurethane Paint	---	--	--	GP COAT 131	---	

7.	Moisture Compatible anti Corrosion system			Epilux Durebild WSE Coating			Karaikote-6545
8.	Epoxy red oxide primer	AP CODUR Epoxy polyamide primer					
9.	Epoxy MIO Under coat	AP CODUR Epoxy MIO Under coat					
10.	Epoxy TiO2 Under coat	AP CODUR Epoxy 420HS					

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ENGINEERING SERVICES

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SECTION-VI

ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 As part of the overall project management activity, the Successful Bidder shall be responsible for proper Owner's Engineering and co-ordination of activities during various phases of execution of the contract. The Successful Bidder shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Owner's Engineer or the Review Consultant shall interact on matters related to Owner's Engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Successful Bidder and shall be responsible for all Owner's Engineering co-ordination. The Owner /Consultant /Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Successful Bidder or on matters involving the Successful Bidder, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the Successful Bidders. However such interaction will not, under any circumstance, dilute the responsibility of the Successful Bidder to provide a fully Owner's Engineered and coordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of Owner's Engineering information will be mutually agreed and finalized between the Owner and the Successful Bidder.

2.00.00 DESIGN COORDINATION MEETING

The Successful Bidder and his sub-vendors will be called upon to attend design co-ordination meetings with the Owner's Engineer, other Successful Bidders and the Consultants of the Owner during the period of execution of contract. The Successful Bidder including his sub-vendors shall attend such meetings at their own cost at Owner's office in Neyveli or Consultant's office in Kolkata/ or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 CO-OPERATION WITH OTHER BIDDERS AND CONSULTING OWNER'S ENGINEERS

The Successful Bidder shall agree to cooperate with the Owner's other Bidders and Consulting Owner's Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Owner's Engineer shall be provided with copies of all correspondences addressed by the Successful Bidder to other Sub- Vendors and Consulting

Owner's Engineers in respect of such exchange of technical information.

4.00.00 GUIDELINES FOR OWNER'S ENGINEERING SERVICES

4.01.00 Prior to commencement of the Owner's Engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed Owner's Engineering work.

4.02.00 Owner's Engineering work shall be performed on modern and proven concepts and internationally accepted good Owner's Engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the Owner's Engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Successful Bidder.

4.03.00 At any stage during the performance of assignment, the Successful Bidder may be required to make certain changes/modification/improvements in design/ drawing/other documents, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the FGD Plant Equipment & auxiliaries and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution/operation of similar units. Such changes/ modifications/improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and Scope of the Successful Bidder.

4.04.00 During the course of review of detailed Owner's Engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.

4.05.00 During the course of review of detailed Owner's Engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants Owner's Engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.

4.06.00 It is not the intent to give details of every single task covered in the total Owner's Engineering work to be carried out by Successful Bidder, however, all Owner's Engineering work required for the satisfactory completion of the FGD Plant Equipment & auxiliaries as specified shall be carried out by the Successful Bidder. Broadly, the following are the minimum requirements in respect of scope of major items of work:

4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (FGD Plant area layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations/ floor levels) covering all mechanical, electrical,

C&I, civil and structural items, equipment, systems and facilities.

Drawings and Schedules prepared by the Successful Bidder from time to time, as detailed designs are developed, shall be submitted for Owner's/ Consultant's approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.

4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-Vendors.

4.06.03 Review of sub-Vendor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.

4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments, etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.

4.06.05 Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the FGD Plant package.

4.06.06 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the FGD Plant package including dampers, steam traps, strainers, instrumentations, ducting.

4.06.07 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support Owner’s Engineering.

4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.

4.06.09 Certification and submission of final as-built drawings for all areas.

4.06.10 Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.

4.06.11 All erection and assembly drawings which may be required at site.

5.00.00 INSTRUCTION MANUALS

5.01.00 The Bidder shall provide all necessary instruction manuals for the Owner’s

review, comment, and final acceptance as required in the contract. The instruction manual shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies.

5.02.00 **Erection Manuals**

5.02.01 The erection manuals shall be submitted at least three (3) months prior to commencement of erection activities of particular equipment/system. The manuals shall contain the following as a minimum:

a) Erection strategy.

b) Sequence of erection.

c) List of tools, tackles, heavy equipments like cranes, dozers etc required for erection.

d) Bill of Materials.

e) Safety precautions to be followed during erection.

f) Erection instructions.

g) Critical checks and permissible deviation/tolerances.

h) Check-list for pre-commissioning activities

i) Check-list for commissioning of the system.

j) Procedure for initial checking, testing and acceptance norms.

5.03.00 **Operation & Maintenance Manuals**

5.03.01 The operating and maintenance instructions together with drawings of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble, and adjust all parts of the equipment. They shall outline a step-by-step procedure for all operations likely to be carried out during the life of the FGD Plant Equipment & auxiliaries. Each manual shall include a complete set of drawings together with performance/ rating curves of the equipment and test certificates wherever applicable.

5.03.02 If after commissioning and initial operation of the FGD Plant Equipment & auxiliaries, the manuals require any modification/ additions in the view of the Owner or Bidder, the same shall be incorporated and the updated final manuals shall be submitted to the Owner.

5.03.03 The manuals shall include the following:

a) List of spare parts along with their drawing and catalogue and Pro-

forma for ordering spares.

b) Location and identification guide for bearings of various equipments and lubrication schedule including charts showing lubrication checking, testing and replacement procedure.

c) Wherever applicable, fault location charts shall be included to facilitate fault detection.

d) Detailed specification for all consumables (including lubricating oils, greases, chemicals etc.) required for each equipment.

6.00.00 PLANT HANDBOOK FOR FGD PLANT EQUIPMENT & AUXILIARIES

The Bidder shall provide the plant handbook for FGD Plant Equipment & auxiliaries to the Owner as per provision of the contract.

The Plant Handbook shall contain the following as a minimum:

a) Design and performance data

b) Process & instrumentation diagrams

c) Single line diagrams

d) Sequence & Protection interlock schemes

e) Alarm and trip values

f) Performance curves

g) General layout plan and layout of TG building and auxiliary buildings

h) Important Do's and Don'ts.

7.00.00 TENDER STAGE DOCUMENT SUBMISSION

7.01.00 The Bidder shall submit along with his bid all documents/drawings as specified in specification and respective sections of the Technical Specifications in Vol-II and Vol-III. The documents shall include but not be limited to the following:

a) All Bid proposal sheets duly filled up.

b) Detailed experience list and financial resources of the Prime Bidder his collaborators/associates in this bid as well as the sub-vendors proposed.

c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.

d) List of terminal points of the package offered together with quality and

quantity of various input (i.e. steam, water, air, electricity etc.) as required from the Owner at such interfaces.

e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.

f) High level project schedule network indicating target dates for intermediate milestones and final commissioning of FGD Plant Equipment & auxiliaries; This network shall be supplemented by a detailed write-up on proposed sequence and method of execution for project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

g) Subvendor List for the Equipment, as mentioned in Annexure-1, for approval by Owner/Consultant.

8.00.00 CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE

8.01.00 Owner's Engineering schedule shall be submitted by the Bidder as indicated in the specification. Owner's Engineering schedule shall be developed in format as desired by the Owner/consultant.

The documents shall be divided into two categories: a) for approval and b) for information/further Owner's Engineering and co-ordination by the Consultant.

In preparing this schedule, the Bidder shall allow one (1) week from date of receipt for review and comments by the Consultant for each submission of a document.

This document submission schedule shall require acceptance by the Owner/Consultant.

Bidder shall also develop and submit a Master drawing list to the Owner/consultant.

8.02.00 All contract documents shall be marked with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

8.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval/information of the Owner/Consultant.

8.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Consultant:

a) System scheme and Process & instrumentation Diagrams (P & IDs).

b) Design basis documents / memoranda / calculations justifying sizing and selection of equipment, vessels, tanks, piping, valves & specialities as well as the process parameters.

c) Equipment data sheets and general arrangement drawings.

d) Materials of construction.

e) General Arrangement and Layout drawings.

f) Typical control schemes, circuit diagrams, drive/ feeder-wise control scheme showing all external interfaces.

g) Control System Configuration

h) Shop Inspection and Testing Procedures, Test Set-up & Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.

i) Performance Test Procedures, Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.

j) Schedules covering equipment delivery schedules, erection, testing and commissioning schedules at L1 and L2 levels.

8.05.00 Unless specified otherwise, the following categories of documents / drawings would be treated for information/further Owner's Engineering by the Owner/Consultant. The Bidder shall, however, incorporate all additional information and clarifications in these documents/ drawings as and when desired by the Owner/ Consultant.

a) Equipment foundation drawings.

b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.

c) Predicted performance curves of equipment.

d) Various bills of quantity, schedules etc.

e) Piping fabrication drawings, isometrics etc.

f) Panel wiring diagrams.

g) Instruction/Operation manuals.

h) Service manuals and trouble shooting guide for C & I system including field instruments.

i) Operation logic diagrams.

j) Cable schedule and interconnection chart.

In essence, the Bidder is solely responsible for corrections and adequacy of design & Owner's Engineering for documents under this category.

8.06.00 Upon review, the Consultant shall put his remarks and one of the following action stamps on the drawing / document:

1) Approved.

2) Approved as noted, resubmission required.

3) Commented, resubmission required.

4) For information/reference only.

For action stamps in category (2) & (3), documents must be resubmitted for review by the Owner/Consultant.

Except for action stamp under category (3), the Bidder can proceed with manufacturing and other sequential activities for those areas of a drawing/document. .

The Consultant may accord approval in category (2) or (3) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Bidder shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds.

The Bidder's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Consultant.

8.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

8.08.00 For review by the Consultant, the Bidder shall furnish three (3) prints of each drawing (only for first submission). There upon all transaction of drawings including reviewed comments and stamping shall be done in soft. All transaction of drawings shall be accompanied by a reference letter mentioning the date, revision no. and document status. Only on receiving the Approval Stamping, bidder shall distribute 6 sets of drawings (2 at NLCIL corporate office and 4 sets at NLCIL site office). The Bidder shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

8.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the more stringent stipulations shall prevail.

ANNEXURE-1

FINALIZATION OF SUB VENDORS

General

a. The successful Bidder is responsible for performance/guarantee of the complete package including bought out items and out sourced processes. The Bidder will supply the equipment/component/system from the Purchaser/Consultant approved sub vendors only.

b. The Bidder has to necessarily indicate in their bid, their proposed sub vendors for the items listed below. Sufficient number of sub vendors may be proposed to meet their need.

c. The proposed list of sub vendors furnished by the Bidder will be reviewed during Techno Commercial/Pre-award discussions by Purchaser/Consultant and the sub vendors will be categorized as below.

   i. **Category – I: Sub vendors accepted.** The acceptance will be based on past experience of Purchaser/Consultant.

   ii. **Category – II: Sub vendors enlisted for future acceptance**. Such acceptance will be based on the various details regarding capacity, capability, experience etc of the sub-vendor proposed by the successful Bidder. It is the responsibility of the successful Bidder to get the details of the sub vendors under category II, compiled and submitted to Purchaser/consultant for scrutiny and acceptance. The acceptance criteria are mentioned below. However, Purchaser reserves the right to accept or reject any of the proposed vendors based on information available with them.

d. The consolidated list of sub vendors under category I and category II will be made available to all the qualified Bidders before price cover opening.

e. Purchaser may consider the Bidder's proposal for inclusion of new sub vendors, if any during post award stage for approval, based on merits, in the overall interest of the Package, after establishing that the sub vendors proposed meet the acceptance criteria specified. However, price advantage if any, arising out of inclusion of new sub vendors will be passed on to the Purchaser.

f. Subsequent to approval of main sub vendor for main system after verifying the acceptance criteria, the main sub vendor will be allowed to choose his sub vendors for the sub system provided they meet the technical stipulation as per the contract requirements.

g. For all other components/equipments/systems which are not figuring in the following list or in the additional list furnished by the Bidder in their bid, Bidder's standard practice of selection of vendors may be carried out.

Acceptance Criteria for Sub Vendors:

i) For all Mechanical, Electrical, Control and Instrumentation (Except for items mentioned under ii and iii below)

For Class I Items:

Bidder to furnish documentary evidence to show that similar or higher capacity component/equipment / system has been supplied by the vendor or their associate/collaborator and the same has been operating satisfactorily for two years. The documentary evidence will be in the form of Performance certificates furnished by the end user.

For Class II Items:

Bidder to furnish documentary evidence to show that similar or higher capacity component/equipment / system has been supplied by the vendor The documentary evidence will be in the form of Material Receipt Certificate or Site Inspection Report, etc from the end user for having received the material by the end user.

The component/equipment / system covered under Class I and Class II are furnished below for Mechanical, Electrical, Control and Instrumentation.

ii) For FGD integral control system

(a) In case the Bidder is the Manufacturer of **control system**

1. The offered control system must have been successfully supplied, erected, tested and commissioned in power plant. The system offered should be same as has been rendered to the unit running successfully as mentioned above with proven performance and/ or improved version of the same
2. Bidder shall furnish all required information to fully satisfy Purchaser / Consultant regarding successful operation and high reliability of products / systems furnished.

(b) In case the Bidder is not a Manufacturer of control system, he shall associate with a Vendor who shall satisfy the Clause (a) above.

iii) For Programmable Logic Controller (PLC) / Control System

(a) In case the Bidder is the Manufacturer of PLC:

1. The offered PLC must have been successfully supplied, erected, tested and commissioned for one such system having minimum capacity of 1000 digital inputs in power plants and which should have been in satisfactory operation for not less than two years as on the original date of tender opening.

2. Bidder shall furnish all required information to fully satisfy Purchaser / Consultant regarding successful operation and

high reliability of products / systems furnished.

(b) In case the Bidder is not a Manufacturer of PLC, he shall associate with a Vendor who shall satisfy the above Clause (a)

iv) For all civil items

(a) It should confirm to relevant Indian/international Standards.

(b) It should be of reputed makes supplied to similar construction / infrastructure projects.

(c) The Bidder should furnish documentary evidence to prove (a) and (b) above

v) For Cement:

(a) It should confirm to relevant Indian /International Standards.

(b) It should be of reputed makes supplied to similar construction/infrastructure projects.

(c) For Cement, minimum quantity of supply shall be 2500 MT for single project.

(d) The Bidder should furnish documentary evidence to prove (a), (b) and (c) above.

vi) For structural steel & reinforcement steel:

(a) The quality shall confirm to Indian Standard/International Standards.

(b) The Firm should have been in the market for a minimum period of 3 years as on the original date of Tender opening and should have supplied & used the structural steel/reinforced steel in any industrial project.

(c) For reinforcement steel- minimum quantity of supply & used shall be 1000MT for a single project.

(d) The Bidder should furnish documentary evidence to prove (a) (b) and (c) above

vii) For Structural steel (for use in civil & structural buildings only):

(a) The quality shall confirm to relevant Indian Standard/International standards.

(b) The firm should have been in the market for a minimum period of 3 years as on the original date of tender opening and should have supplied & used the structural steel in any industrial project.

(c) For Structural steel- minimum quantity of supply & used shall be 1000 MT for a single project.

(d) The Bidder should furnish documentary evidence to prove (a),(b) and (c) above.

viii) For Welding Electrodes:

(a) The welding electrodes should be confirming to AWS and related BIS.
(b) The Firm should have executed orders for the supply of electrodes for an order value not less than Rs. 3 lakhs in a calendar year for any or all sizes of the subject electrode within last three(3) years as on the original scheduled date of tender opening..
(c) The Bidder should furnish documentary evidence to prove (a) & (b) above

ACCEPTANCE CRITERIA FOR SUB CONTRACTORS

ix) For Mechanical and Electrical works:

Contractor to furnish documentary evidence to prove that similar mechanical / electrical erection and installation work had been carried out by the Sub contractor.

x) For Control and Instrumentation works:

(a) In case the C&I vendor is engaging a sub contractor for C&I works Documentation proof shall be furnished in the form of Bid award copy and performance certificate (End user's certificate) to show that similar C&I erection & installation activities were carried out and the job completed satisfactorily by the C&I sub contractor.

(b) For Control Room Architecture: The sub-contractor shall have already executed at least three (3) FGD plant Control Rooms for super critical units in India or abroad with similar operating parameters. Documentary proof shall be furnished for the same.

xi) For Civil & Structural works:

The main Contractor may engage one or more sub contractor for carrying out Civil & Structural works. However, the Civil sub-contractor shall have the following qualifying requirements.

For Civil Works:

a) He shall have experience in carrying out civil engineering works for Industrial buildings / equipment foundations / high-rise buildings (3 storeys and more) etc.,

b) He should have executed not less than 10000 Cu.M of R.C.C work in a single agreement.

c) The work in Sl. Nos (a) & (b) should have been completed within the past 7 years, as on the original scheduled date of tender opening.

d) Bidder to furnish necessary documentary evidence to prove the above requirements and get approval from the Purchaser, prior to engaging them for civil works.

For Structural works:

a) He shall have experience in carrying out structural engineering works for Industrial buildings / Power plant structures / high-rise buildings etc.,

b) Any structural steel works of quantity not less than 2000 MT in a single agreement.

c) The work in Sl. Nos (a) to (b) should have been completed within the past 7 years, as on the original scheduled date of tender opening.

d) Bidder to furnish necessary documentary evidence to prove the above requirements and get approval from the Purchaser, prior to engaging them for structural works.

LIST OF EQUIPMENTS – Mechanical

i) Class I items: Items for which Performance certificates shall be furnished for approval of Category II sub vendors during detail engineering

(a) Technological Items

Sl.No	Item Description	Sub Vendors
1.	Limestone Crusher	
2.	Bucket Elevator	
3.	Wet Ball Mills	
4.	Flue Gas Booster fans	
5.	Absorbers	
6.	Oxidation Air Compressors	
7.	All types of Limestone and Gypsum Slurry Pumps	
8.	Ball charging devices	
9.	All types of Hydrocyclones	
10.	Vacuum Belt filter	
11.	Vacuum Pumps	
12.	All types water, waste water and filtrate pumps	
13.	Limestone and Gypsum conveyor components	
14.	Waste water treatment system components	
15.	Seal Air Fans	

16.	All types of Vacuum/Pressure vessels	
17.	Mist Eliminator	
18.	Vibration Isolation System	

(b) Air Conditioning & Ventilation System

Sl. No	Item Description	Sub Vendors
1.	Air Conditioning System	
2.	Ventilation System	

(c) Handling & Hoisting

Sl. No	Item Description	Sub Vendors
1.	Elevators	
2.	Double Girder EOT Cranes	
3.	Single Girder Underslung Crane/EOT crane	

(d) DG Set

Sl. No	Item Description	Sub Vendors
1.	DG Set Assemblers.	

ii) Class II items: The documentary evidence for approval of Category II sub vendors shall be in the form of Material Receipt Certificate or Site Inspection Report, etc from the end user for having received the material by the end user.

(a) Technological Items

Sl. No	Item Description	Sub Vendors
1.	Flue Gas Dampers / Gates	
2.	Air and Flue Gas Ducting	
3.	Vibrating Feeders	
4.	Suspended Magnets	
5.	Belt Weighers	
6.	Weigh Belt feeders	
7.	Dry Fog Dust Suppression system	
8.	Dust Extraction system	
9.	Dust Suppression with Plain Water	
10.	Diesel engine	
11.	Slurry Tanks	
12.	Misc. Tanks	

13.	Ball Valves	
14.	Butterfly Valves	
15.	Steam Trap	
16.	Gate/Globe/ Non Return Valves	
17.	Rubber Expansion Joints	
18.	Safety Valve	
19.	Piping	
20.	Agitators	
21.	Strainers	
22.	Submersible Pumps	
23.	Sump Pumps	
24.	Air Release Valves	
25.	Aluminium sheet	
26.	Thermal Insulation	
27.	Welding electrodes	

(b) HANDLING & HOISTING

Sl. No	Item Description	Sub Vendors
1	Electric Hoists	
2.	Manual Hoists	

(c) Ventilation and Air conditioning

Sl. No	Item Description	Sub Vendors
1.	Split Air Conditioner/Package air conditioner.	

LIST OF EQUIPMENTS –Electrical

Class I items:

Sl. No	Item Description	Sub Vendors
1.	63MVA, 220/11KV FGD Transformer	
2.	Auxiliary Transformers (Oil Filled)	
3.	415 V Switchgear (PCC/PMCC/ MCC)	
4.	ACB	
5.	Auxiliary Relays	
6.	Battery Charger (FC/FCBC)	
7.	Electrical Actuators	
8.	Electro Mechanical Relays	
9.	H.T. Motors	
10.	H.T. Power Cables (XLPE)	
11.	HT Busduct (Segregated Phase)	
12.	HT Switchboard 11KV, 3.3KV	

13.	L.T. Motors (AC & DC)	
14.	Lighting Transformer	
15.	LT Busduct (Non-Segregated Phase)	
16.	LT Control Cables	
17.	LT Power Cables(XLPE)	
18.	LT Trailing Cables	
19.	LT Transformer (Dry Type)	
20.	MLDB/PDB/ACDB/WDB/ELDB / DCDB / LCP / LPBS / DCLDB	
21.	Neutral Grounding Resistors (NGR)	
22.	Numerical Protection Relays	
23.	Plante Battery	
24.	UPS	
25.	Variable Frequency Drive (VFD)	
26.	VCB	

II) Class II items:

Sl. No	Item Description	Sub Vendors
1.	AC/DC Control Contactors	
2.	AC/DC Power Contactors	
3.	Cable Glands	
4.	Cable Lugs	
5.	Cable Termination & Jointing Kits	
6.	Cable Trays	
7.	Control Transformers	
8.	Current Measuring Modules	
9.	Energy Meters/Multi Function Meters	
10.	High Mast	
11.	Intelligent Controllers	
12.	LED Lighting	
13.	Lighting Fixtures (Flame Proof)	
14.	Lighting Fixtures (General)	
15.	MCCB/MPCB/MCB	
16.	Meters (Analog/Digital)	
17.	Street Light Poles	
18.	Transducer	
19.	CT/PT	

LIST OF EQUIPMENTS – CONTROL & INSTRUMENTATION

Class – I items:

Sl. No	Item Description	Sub Vendors
1.	DDCMIS/PLC System	
2.	Vibration Monitoring System	
3.	Operating stations/Work Stations	
4.	Printers	
5.	Industrial Grade Ethernet Switches	
6.	Smart Transmitter (P, L, F, DP)	

Sl. No	Item Description	Sub Vendors
7.	Temperature Transmitter	
8.	Thermocouples/ RTDs	
9.	Level Transmitters (Displacer Type)	
10.	Level Transmitters (Ultrasonic, Radar type)	
11.	Flow Elements	
12.	pH Analyser	
13.	Sulphur Dioxide (SO_2) Analyzer	
14.	Instrument Cables	
15.	Thermocouple cable	
16.	Fibre optic cable	
17.	Control Valves with Smart Positioner	

Class II items:

Sl. No	Item Description	Sub Vendors
1.	Junction Boxes	
2.	LIE / LIR	
3.	Panels/ cabinets	
4.	Control desk, workstation tables, printer tables and chairs, file racks, document storages	
5.	Terminal Blocks	
6.	AC to DC Convertor (for Control cabinets)	
7.	Interposing Relays	
8.	Proximity sensor/switch	
9.	Pressure Gauges/DP Gauge	
10.	Temperature Gauges	
11.	Pressure & Differential Pressure Switches, Temperature Switches	
12.	Level Switches (Float , Displacer Type, Capacitance) & Level Gauges	
13.	Level Switches (RF type)	
14.	Level Switches (Conductivity type)	
15.	Flow Switch	
16.	Flow Meters (All type)	
17.	Sight Flow Indicator/Rota Meter	
18.	I/P Converters	
19.	Air Filter Regulator	
20.	Solenoid Valves	
21.	Power Cylinders	
22.	Industrial grade Firewall	
23.	Bulk Material Handling Switches like Pull cord, Zero speed, Belt sway, Chute block, etc.	

LIST OF EQUIPMENTS – Civil & Structural Supply Portion

a. Building Materials

Sl. No	Item Description	Sub Vendors
1.	Flush doors	
2.	Plywood products, particle boards	
3.	Steel doors, windows and ventilators / Pressed door, including accessories	
4.	Aluminium doors, windows, partitions	
5.	FRP Doors including all accessories	
6.	Water proofing compounds/construction chemicals	
7.	Paints and distempers	
8.	Hardware Fittings & Fixtures	
9.	Metallic Floor Hardener	
10.	Water Stops – (PVC/Rubber)	
11.	Expansion Joints	
12.	Water proof cement paints and exterior emulsion paints	
13	Metal cladding system & Metal deck plate for supporting RCC roof	
14	Glazing glass / Wired glass	
15.	Tiles	
16.	Hardeners	
17	PU Coating	
18	Plasticizer	
19	SS Pipes	
20	Door Closer	

b. Sanitary and Water Supply Work

Sl. No	Item Description	Sub Vendors
1.	PVC Pipes & UPVC Pipes and Specials	
2.	G.I. Pipes & Specials	

Sl. No	Item Description	Sub Vendors
3.	W.C. Pan Wash Basin, Urinals Sink Low down flushing Cistern & EWC	
4.	Colour/White Glazed Tiles, Heavy Duty Ceramic tiles and Vitrified Tiles.	

c. RCC Items

Sl. No	Item Description	Sub Vendors
1.	Cement	
2.	Reinforcement Steel	

d. Structural Steel

Sl. No	Item Description	Sub Vendors
1.	Structural Steel	

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SECTION-VII

QUALITY ASSURANCE REQUIREMENTS

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SECTION-VII

QUALITY ASSURANCE REQUIREMENTS

1.00.00 QUALITY ASSURANCE PROGRAMME

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Successful Bidder's works or at his Sub-Vendor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Successful Bidder shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Successful Bidder and shall be finally accepted by the Owner/ Authorised representative after discussions before the award of contract. A quality assurance programme of the Successful Bidder shall generally cover the following:

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

b) Documentation control system.

c) Qualification data for Bidder's key personnel.

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

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

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

g) Inspection and test procedure both for manufacture and all site related works.

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

i) System for quality audit.

j) System for indication and appraisal of inspection status.

k) System for authorising release of manufactured product to the Owner.

l) System for handling storage and delivery.

m) System for maintenance of records.

n) 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 format enclosed at Annexure-I to this section.

2.00.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured and tested at all the stages, as well as Services provided for erection, commissioning and testing shall be as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder 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 Bidder's responsibility to draw up and implement such programme and reviewed by by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Owner's representative for review. Schedule of finalisation of such quality plans will be finalised before award.

2.02.00 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 Bidder'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.

2.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's site Quality Control organisation, during various stages of site activities from receipt of materials/equipment at site.

After pipe lines have been laid and joined, the same shall be tested hydrostatically as specified in this section. Additionally, random inspection of UT shall be carried out by a certified third party agency for 10% of welded joints in addition to 10% Radiography test (RT) , 100% Ultrasonic Test (UT) on all welded joints.

All the longitudinal and circumferential welded seams shall be subjected to chalk and kerosene test prior to hydraulic testing. This shall be done at the presence of the Owner. In addition to this, test coupons shall have to be provided for each longitudinal seams for mechanical tests (tensile and bend), if considered necessary by the Owner. The test coupons are to be broken in presence of the Owner. Bidder shall satisfy the Owner that work is being carried out in accordance with the specification drawings and other conditions. Owner shall have full access to the Bidder's working area.

Bidder's scope of supply for fabrication, erection, cleaning, testing and commissioning of the piping systems installed by him shall include the following:-

All welding consumables like welding electrodes, filler rods and wires; gases like oxygen, acetylenes, argon, carbon-dioxide, propane, backing rings etc.

Films for radiographic examination of welds.

X-ray and Gamma -ray equipment including isotopes, dye penetrants, and other required non-destructive testing materials and equipment (all to be taken back by the Bidder after completion of work).

All heating and stress relieving equipment, thermocouples asbestos blankets, cables, temperature recorders, charts heat sensitive chalks and crayons etc. (All to be taken back by bidder after completion of work).

All machinery, equipment tools and tackles as required for transportation handling, fabrication and erection (All to be taken back by Bidder after completion of work).

All equipment/ materials as required for cleaning, flushing, blowing out and hydro testing of the piping systems; these shall include but not be limited to pumps and compressors with prime movers, instruments, pipe work with supports, valves, strainers and other specialties, blanks, plugs, spool pieces, dummy plates, electrical accessories, etc. (All to be taken back by Bidder after completion of work).

All scaffolding materials and false work (To be taken back by Bidder after completion of work).

2.04.00 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 Consultant's approval without which manufacture shall not proceed. In these approved quality plans, Owner/Authorised representative/Consultant shall identify Customer Hold Points (CHP), test/checks which shall be carried out in presence of the Owner/Consultant/Owners Owner's Engineer or his Authorised Representative and beyond which the work will not proceed without consent of Owner/Authorised representative/Consultant in writing.

All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner/Authorised Representative/Consultant for acceptance and dispositioning.

2.05.00 The Bidder shall provide adequate notice to the Owner for inspection before the material is dispatched as per the provisions of the Contract. No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Owner's Engineer/Authorised

representative, and duly authorised for despatch issuance of Material Despatch Clearance Certificate (MDCC).

2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.07.00 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

2.08.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

2.09.00 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 Owner.

All brazers, welders etc. employed on any part of the contract at Bidder's/Sub-Vendor's works or at site shall be qualified as per ASME Section-IX or BS-4871 or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner/his authorised representative.

For welding of pressure parts and high pressure piping the requirements of IBR shall also be complied with.

Under no circumstances any repair or welding of castings be carried out without the consent of the Owner. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner.

All pressure parts shall be subjected to hydraulic testing as per the requirements of IBR. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than thirty (30) minutes.

2.10.00 All non-destructive examination (NDT) shall be carried out in accordance with approved international standard. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT shall be properly recorded and submitted for acceptance.

All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the

applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by Bidder. Bidder's scope and responsibility shall also include preparation and submission of all necessary documents in the specific formats and manner stipulated by the statutory bodies, coordination and follow up for above approvals.

2.11.00 All the Sub-Vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Bidder and finalised with the Owner shall be subject to Owner's review. Quality Plans of the successful Sub-Vendors shall be discussed, finalised and accepted by the Owner/Authorised representative and form part of the Purchase Order between the Bidder and the Sub-Vendor.

2.12.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Bidder and finalised with the Owner shall be furnished to the Owner for comments and subsequent acceptance before orders are placed.

Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Bidder's or their Sub-Vendor's quality management and control activities. The Bidder shall provide all necessary assistance to enable the Owner carry out such audit and surveillance.

Quality audit/acceptance of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Bidder in earning satisfactory performance of equipment as per specification.

2.13.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.14.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the acceptance of the Owner.

2.15.00 For quality assurance of all civil works refer to the specifications for civil works.

3.00.00 QUALITY ASSURANCE DOCUMENTS

3.01.00 The Bidder shall be required to submit two (2) copies and two (2) sets of microfilms of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

a) Material mill test reports on components as specified by the specification.
b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.

c) Non-destructive examination results /reports including radiography interpretation reports.

d) Factory tests results for testing required as per applicable codes and standards referred in the specification.

e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.

f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

g) Stress relief time temperature charts.

h) Inspection reports duly signed by QA personnel of the Owner and Bidder for the agreed inspection hold points. During the course of inspection, the following will also be recorded :

i) When some important repair work is involved to make the job acceptable.

ii) The repair work remains part of the accepted product quality.

i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 INSPECTION, TESTING AND INSPECTION CERTIFICATES

4.01.00 The Successful Bidder shall give the Owner's Engineer/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Successful Bidder's account except for the expenses of the Inspector. The Owner's Engineer/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection failing which the Successful Bidder 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 six (6) copies.

4.02.00 The Owner's Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Successful Bidder, 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 Successful Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Owner's Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

4.03.00 When the factory tests have been completed at the Bidder's or sub-Vendor's works, the Owner/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Owner/ Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Owner/Inspector. Failure of the

Owner/Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.

4.04.00 The Bidder 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.

ANNEXURE-I : FORMAT OF QUALITY ASSURANCE PROGRAMME

Name of Company/ Successful Bidder	NAME OF CONTRACT PACKAGE			QUALITY PLAN FOR						
	Package No. : _____ Bidderr : _____			QP No. : _____ Date _____ Rev.No.: _____ Date _____						
Sl. No.	Component & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Record	Agency	Remarks

ANNEXURE-II: MANUFACTURING QUALITY PLAN

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN	PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER :
		ITEM : SUB-SYSTEM:	QP NO.: REV. NO.: DATE: 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	L	
1.	2.	3.	4.	5.	6.	7.	8.	9.	D*	10.			11.

LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) WILL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
** **M:** MANUFACTURER/SUB-SUPPLIER
C: SUPPLIER/NOMINATED INSPECTION AGENCY, L: PURCHASER
P: PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE,

CHP: PURCHASER WILL IDENTIFIED IN COLUM "N"

DOC. NO.: REV……
CAT…..

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	FOR PURCHASER USE			
SIGNATURE			REVIEWED BY	APPROVED BY	APPROVAL SEAL

MFGR.'s LOGO	SUPPLIER'S NAME AND ADDRESS	ANNEXURE – III: FIELD QUALITY PLAN		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM :	QP NO.: REV.NO.: DATE: 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	D*	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.		10.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) WILL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;** **'A'** WILL BE WITNESSED BY PURCHASER FQA, **'B'** WILL BE WITNESSED BY PURCHASER ERECTION / CONSTRUCTION DEPTT. AND **'C'** WILL BE WITNESSED BY CONTRACTOR (A & B CHECK WILL BE PURCHASER CHP STAGE)	FOR PURCHASER USE	DOC. NO.: REV……		
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

FORMAT NO.:	1/1	Engg. Div. / QA&I

ANNEXURE-IV : FIELD WELDING SCHEDULE

PROJECT	:	FWS NO	:
BIDDER	:	REV NO.	:
PACKAGE	:	FIELD WELDING CODE	:
SYSTEM	:	PAGE NO.	:

Sl No.	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Preheat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method Quantum	NDT Specification Number	Accep-tance Norm Ref.	Remarks

The Field Welding Schedule should be submitted for :

- Pressure Parts
- Tanks/Vessels
- Piping
- Heavy/Important Structural Steel
- Heat Exchangers
- Bus Ducts

VOLUME : II-A

SECTION - VIII

REQUIREMENTS OF SPARES, TOOLS & TACKLES

CONTENTS

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ATTACHMENTS

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REQUIREMENTS OF SPARES, TOOLS & TACKLES

1.0 Scope

This section covers the general requirements regarding the spares and tools & tackle for all the equipment and systems in the Flue Gas Desulphurisation Plant.

2.0 Mandatory Spares

The Bidder shall supply in his scope mandatory spares as listed in Annexure I of this Section.

The supply of mandatory spares shall be started with the consignments of the first unit and completed before the provisional takeover of the first unit and common facilities. However, the spares shall not be dispatched before the dispatch of the main equipment.

3.0 Tools and Tackle

1. The Contractor shall supply with the equipment one complete set of all special tools and tackles and other instruments required 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 along with the offer. The price of each tool / tackle shall be furnished in Price schedule, Volume I.

2. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are new and not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Purchaser.

3. The supply of special tools and tackles shall be started with the consignment of first unit and completed before the provisional takeover of the first unit. However, the tools and tackles shall not be dispatched before the dispatch of the main equipment.

4.0 Guidelines for Mandatory Spares and Tools and Tackle

1. The bidder shall supply the mandatory spares and tools and tackles as listed in Annexure I below.

2. The bidder shall give itemized unit price for the spare parts, tools and tackles while submitting the bid. The Purchaser reserves the right to modify or delete the items/quantity of the spares/tools & tackles. The quoted price for taxes & duties, transport, insurance etc. shall get reduced proportionately to the extent of the value of ordered spares/tools and

tackles. The list of such spares/tools and tackles to be ordered by the Purchaser shall be finalized by the Purchaser before signing of the Contract.

3. In case the description / nomenclature of any of the items of spares/tools and tackles is differing from the description / nomenclature indicated in the list of mandatory spares/tools and tackles, the bidder shall offer functionally equivalent part in lieu of the listed item.

4. In case if such items of spares/tools & tackles indicated as "not applicable", are found applicable at a later date during execution of the project, such items of spares/tools & tackles are to be supplied within the ordered cost of the mandatory spares.

5. If any of the items of spares/tools & tackles ordered is found to be not applicable during detailed engineering stage/execution stage, the bidder shall have to supply alternative items of spares/tools & tackles. The alternative items of spares/tools & tackles are to be mutually agreed between the PURCHASER and BIDDER.

6. In respect of quantity mentioned as 'Set' means the total quantity of all the components/items used in particular equipment unless otherwise specified.

Example-1

One set of spare part which is having four different items of which first item is having 2 similar parts, second one is having 3 similar parts and other two are having one part each, then one set means, combination of 2 similar parts of first item and 3 similar parts of second and one each of 3rd & 4th items.

Example-2

If the quantity of particular spare part is more than one, set means the total no. of similar parts.

7. Wherever % is indicated for the mandatory spares, the quantity shall be calculated for % of supply for total quantity for 2 units of 2 x 500 MW, unless otherwise specified

8. All relevant drawings to identify of spares/tools & tackles are to be furnished when called for by the PURCHASER

5.0 Recommended Spares

1. In addition to the spare parts mentioned above, the Contractor shall also provide a list of recommended spares for three (3) years of normal operation of the plant and indicate the list and total prices in relevant schedule. The list shall take into consideration the mandatory spares specified and should be independent of the list of the mandatory spares. The purchaser reserves the right to buy any or all of the recommended spares. The recommended spares shall be delivered at project site at least

two months before the scheduled date of initial operation of first unit. However, the spares shall not be dispatched before the dispatch of the main equipment.

2. Prices of recommended spares will not be used for evaluation of the bids. The price of these spares will remain valid up to execution of the contract. However, the Contractor shall be liable to provide necessary justification for the quoted prices for these spares if desired by the purchaser.

6.0 Start up and Commissioning Spares

Start up and commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system till the commercial operation of the Plant. The Contractor shall provide all such start up and commissioning spares and keep an adequate stock of the same to be brought by him to the site for the plant erection and commissioning. These must be available at site before the equipment are energized. The unused spares, if any, should be removed from there only after commercial operation of the plant. All start up spares which remain unused at the time shall remain the property of the Contractor.

7.0 General Requirements of Spares

1. The Contractor shall indicate the service expectancy period for the spares parts (both mandatory and recommended) under normal operating conditions before replacement is necessary.

2. All spares supplied under this contract shall be strictly inter-changeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site e.g. small items shall be packed in sealed transparent plastic with desiccator packs as necessary.

3. All the spares (both recommended and mandatory) shall be manufactured along with the main equipment components as a continuous operation as per same specification and quality plan.

4. The contractor will provide purchaser with cross-sectional drawings, catalogues, assembly drawings and other relevant documents so as to enable the purchaser to identify and finalise order for recommended spares.

5. Each spare part shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packed in a single case, a general description of the content shall be shown on the outside of such case and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

6. All cases, containers or other packages are to be opened for such examination as may be considered necessary by the purchaser.

7. The Contractor will provide the purchaser with all the addresses and particulars of his sub-suppliers while placing the order on vendors for items/ components/

equipment covered under Contract and will further ensure with his vendors that the purchaser, if so desires, will have the right to place order for spares directly on them on mutually agreed terms based on offers of such vendors.

8. The Contractor shall warrant that all spares supplied will be new and in accordance with the Contract documents and will be free from defects in design, material and workmanship.

9. In addition to the recommended spares listed by the Contractor, if the purchaser further identifies certain particular items of spares, the Contractor shall submit the prices and delivery quotation for such spares within 30 days of receipt of such request for consideration by the purchaser and placement of order for additional spares if the purchaser so desires.

10. The Contractor shall guarantee the long term availability of spares to the purchaser for the full life of the equipment covered in the Contract. The Contractor shall guarantee that before going out of production of spare parts of the equipment covered under the Contract, he shall give the purchaser at least 2 years advance notice so that the latter may order his bulk requirement of spares, if he so desires. The same provision will also be applicable to Sub-contractors. Further, in case of discontinuance of manufacture of any spares by the Contractor and/or his sub-contractors, Contractor will provide the purchaser, two years in advance, with full manufacturing drawings, material specifications and technical information including information on alternative equipment makes required by the purchaser for the purpose of manufacture/procurement of such items.

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
A. Mechanical			
1. **Gates/ Dampers in Flue Gas System**			
i)	Seals		1 Set of each type (Set means complete replacement for one gate)
ii)	Actuator		1 no. of each type
iii)	Expansion joints		1 no. of each type and size
2. **Absorber Nozzle, Piping, Lining etc.**			
i)	Nozzles for limestone slurry spray		10% of total requirement for both the absorbers
ii)	Mist eliminator		10% of total requirement for both the absorbers
iii)	Mist eliminator wash nozzles		10% of total requirement for both the absorbers
iv)	Water distribution piping & other internals		10% as required for both the absorbers
3.	**Limestone slurry valves**		
	i)	Complete valves assembly	Two (2) Nos. for each type and size
	ii)	Seat, disc, spindle with nuts & bolts	Two (2) Nos. for each type and size
	iii)	Diaphragms for valves	Five (5) Nos. for each type and size
	iv)	Flaps for non-return valves	Two (2) Nos. for each type and size
	v)	Actuator for control/isolation	Two (2) Nos. for each type and size
4.	**Absorber System Agitators**		
	i)	Impeller assembly	1 Nos. for each type and size
	ii)	Bearings	2 Sets for each type and size
	iii)	Shaft assembly	1 Sets for each type and size
	iv)	Shaft seal	1 Sets for each type and size
	v)	Gear box, if applicable	1 no. of each type and size
	vi)	Complete agitator assembly	1 no. of each type and size
5.	**Oxidation Air Blowers (for each type and**		
	i)	Casing	2 Nos.
	ii)	Impeller/Vane/Lubes	2 Sets
	iii)	Shaft bearings driving end	2 Sets.
	iv)	Shaft bearings Non-driving end	2 Sets.
6.	**Oxidation Air Distributor**		
	i)	Distributor header	2 Nos.
	ii)	Nozzles for complete air distribution	2 Sets

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
7.	**Conveyor Belt**		
	i)	Carrying idler rollers	15% of total requirements of rollers
	ii)	Impact idler rollers	10% of total requirements of rollers
	iii)	Return idler rollers	10% of total requirements of rollers
	iv)	Troughing training idler complete	4 Nos.
	v)	Return training idler complete	2 Nos.
	vi)	Transient idler complete	2 Nos.
	vii)	Conveyor belting	20% of each type & rating of the belt and thickness.
	viii)	Brake	2 Sets for each conveyor
	ix)	Brake shoes	2 Sets for each conveyor
8.	**Pulleys**		
	i)	Drive pulley without bearings and plummer blocks	2 Nos.
	ii)	Non drive pulley without bearings & plummer blocks	4 Nos.
	iii)	Spherical roller bearings for pulleys of different sizes without plummer blocks	3 Nos. for each size
	iv)	Plummer blocks complete with bearings	2 Nos. of each type & size
9.	**Carriage wheel assembly**		
	i)	Bearings	2 Nos. of each size and type
	ii)	Plummer block	2 Nos. of each size and type
	iii)	Oil seals	2 Nos. of each size and type
	iv)	Carriage wheel with shaft (without plummer blocks)	1 Set
	v)	Transverse drive assembly including motor, gear box, coupling etc.	1 Set
10.	**Gear Couplings**		
	i)	Complete gear couplings	2 Nos. of each size and type
	ii)	Bolts & nuts	2 Sets
	iii)	Seal kit	2 Sets
11.	**Fluid Couplings**		
	i)	Complete fluid coupling	1 Nos. of each size and type
	ii)	Multi disc assembly	4 Nos. of each size and type
	iii)	Bearings	1 Set for each size and type
	iv)	Seal kit	2 Sets for each size and type
	v)	Resilient drive plate assembly	2 Nos. of each size and type

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
	vi)	Fusible plugs	10 Nos. of each size and type
	vii)	Complete actuator assembly including motor, gear box etc.	1 Nos. of each size and type
	viii)	Oil filters	5 Nos. of each size and type
12.	**Gear Boxes**		
	i)	Bearings	1 Set for each type and size
	ii)	Oil seal for gear box	2 Sets
	iii)	Worm/Pinion for gear box	1 No. of each size
	iv)	Bolts for gear coupling	1 Set for each size
	v)	Complete gear box assembly	1 No. of each type & rating
13.	**Belt Cleaner & Skirt Board**		
	i)	Modular segments for belt cleaner	10% of total population for each type & size
	ii)	Modular segments for skirt board	10% of total population for each type & size
	iii)	Skirt rubber	10% of total population for each type & size
	iv)	Complete belt cleaner (internal/ external)	5% of total population for each type & size
14.	**Magnetic Separators**		
	i)	Cleated conveyor belt	1 Set
	ii)	Drive assembly including motor & gear box	1 Set
	iii)	Pulleys with plummer block &	1 Set of each type & size
	iv)	Sheaves	1 Set of each type & size
	v)	V- belts	2 Set of each type & size
15.	**Rack and Pinion Gates**		
	i)	Plate	10 Nos.
	ii)	Gland and Packing	10 Sets
16.	**Vibrating Feeders**		
	i)	Unbalanced motor	2 Nos.
	ii)	Base mounting springs	2 Sets.
17.	**Unloading & Telescopic Chute**		
	i)	Gear Box	
		a) Bearing	2 Set
		b) Winch drum roller bearing	2 Set
	ii)	Limit switches	2 Nos.
	iii)	U clamps	4 Nos.
	iv)	Set of drive & driven sprocket	2 Sets
18.	**Limestone Sampler**		

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
	i)	Plumber block	1 No. of each type and size
	ii)	Hammers	1 Set of each type and size
	iii)	Liner plate	1 Set
	iv)	Cutter lip	1 No.
	v)	Cutter seal	1 No.
	vi)	V-belts (for crusher)	1 Set
	vii)	Hammer pins	1 Sets of each type and size
	viii)	Pulley	1 No. of each type and size
	ix)	Conveyor belt	1.2 times length of each type and rating
	x)	Gear Box assembly for conveyor	1 No. of each type and rating
	xi)	Gear box drive assy, for primary and secondary samplers	1 Set of each type and rating
	xii)	Hydraulic pump with motor and	1 Set of each type
	xiii)	Hydraulic motor	1 Set of each type
	xiv)	Hydraulic cylinder	1 Set of each type
	xv)	Cylinder sealing kit	2 Sets of each type
	xvi)	Set of hoses	2 Sets of each type
	xvii)	Coupling with grid for primary sampler	2 Sets
	xviii)	Screw conveyor gear box assembly	1 Set
19.	**Limestone Crusher**		
	i)	Plummer Block assembly complete including bearing, lock nut, lock washer etc. (DE+NDE)	2 Sets
	ii)	Shaft seal	4 Sets
	iii)	Hammer Sets	10 Sets (1 set means
	iv)	Rotor assembly complete consisting	1 Set
	v)	Cage bars/Perforated screen plates	4 Sets
	vi)	Breaker plate	4 Sets
	vii)	Liners	2 Sets
	viii)	Suspension bars	4 Sets
	ix)	Kick-off plate	4 Sets
	x)	Screen plate upper & lower	4 Nos. each
	xi)	Tramp iron pick up plate	2 Nos. each
	xii)	Fluid coupling	
	a)	Fluid coupling complete	1 Set
	b)	Bearings	2 Sets
	c)	Seal kit (sealing rings)	2 Sets
	d)	Fusible plugs	8 Nos.
	e)	Oil pump motor Set (if applicable)	1 Set of each type

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
	f)	Oil filter	3 Sets
	g)	Complete actuator and engaging assembly (including motor, gear	1 Set
	h)	Cooler assembly (if applicable)	1 No.
	i)	Oil/Water valves	2 nos. of each type
	j)	Gear coupling/other flexible coupling of crusher drive along with bolts and	2 Sets
	k)	Multi Disc assembly (for fluid coupling)	2 Sets of each type and rating
	l)	Resilient Drive plate assy.	2 Sets of each type and rating
20.	**Dust Extraction System**		
	i)	Filter bags	10% of total Qty.
	ii)	V-belt	1 Sets of each type and size
	iii)	Bearing	1 No of each type & size
	iv)	Flexible connection between fan &	1 Set of each size
21.	**Bucket Elevator**		
	i)	Buckets	20% of total quantity (complete bucket assembly)
	ii)	Belt	20% of total length
	iii)	Linkages	20% of total quantity
22.	**Limestone Feeders**		
	i)	Belt	2 Sets
	ii)	Belt drive motor	1 No.
	iii)	Belt drive reducer	1 no.
	iv)	Speed reducer assembly	1 no.
	v)	Weighing Instruments	1 Set
	vi)	Feeder weighing roll	1 no.
	vii)	Gravimetric feeder gate actuator assembly	1 no.
	viii)	Counter assembly of feeder complete	1 no.
	ix)	Feeder head pulley assembly	1 no.
23.	**Wet Ball Mills**		
	i)	Mill Wear Parts (Liners) & Grinding element	1 Sets
		Note : One Set of Mill Wear Parts (Liners) above is defined as under 1 Set = (Grinding elements needed for complete replacement of one mill) X (8000 x 1) / GWL, rounded off to nearest higher whole number. Where	

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
		GWI- =Guaranteed wear life of Mill Wear Parts as offered by the bidder.	
	ii)	Mill Motor	1 no.
	iii)	Auxiliary Motor	1 no.
	iv)	Gear box internals (including Bearings	2 Sets
	v)	Complete Gear Box	1 Sets
	vi)	Mill motor Bearings	1 Sets
	vii)	Lube Oil / Grease System	
		Pump assembly	1 nos. of each type
		Motor	1 nos. of each type
		Pressure regulator	1 nos. of each type
		Filters	2 nos. of each type
		Pump & Motor coupling	1 nos. of each type
	vii)	Speed reducer	
		a) Complete assembly	2 Nos.
		b) Bearings	1 Set.
		c) Oil seal for gear box	1 Set.
		d) Gear Set	2 Nos.
24.	**Limestone Slurry Handling Horizontal Centrifugal Pumps (for each type & size)**		
	i)	Impeller	4 Nos.
	ii)	Casings	2 Nos.
	iii)	Shaft	2 Nos.
	iv)	Shaft sleeves	2 Sets.
	v)	Impeller/ casing liner	2 Sets
	vi)	Seals	2 Sets.
	vii)	Pump & motor bearing	2 Sets.
	viii)	Gear box	1 No.
	ix)	Pump- motor coupling	1 No.
25.	**Other Horizontal Centrifugal Pumps (for each type & size)**		
	i)	Impeller	1 No.
	ii)	Casing	1 No.
	iii)	Shaft	1 No.
	iv)	Shaft sleeves	1 Set
	v)	Impeller/ casing liner	1 No.
	vi)	Seals	1 Set
	vii)	Pump & motor bearing	2 Set
	viii)	Gear box	1 No.
	ix)	Pump- motor coupling	1 No.

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
26.	**Vertical Centrifugal Pumps (for each type & size), if applicable**		
	i)	Suction bell with strainer	1 No.
	ii)	Bowl Assembly	1 Set
	iii)	Cutless rubber bearing	1 Set
	iv)	Pump shaft/ line shaft	1 Set
	v)	Bearings	2 Sets
	vi)	Motor bearing (one at each end)	2 Sets
	vii)	Thrust bearing	2 Nos
27.	**Sump Pumps (for each type & size)**		
	i)	Impeller, with key and nut	1 No
	ii)	Suction bell with strainer	1 No.
	iii)	Bowl assembly	1 Set
	iv)	Pump shaft	1 Set
	v)	Pump & motor bearings	1 No of each size
	vi)	Oil seal	1 No of each size
28.	**Limestone Slurry Pipes and Fittings**		
	i)	Limestone slurry pipe	20% of total length requirement for the system
	ii)	Limestone slurry pipe bends & fittings	4 Nos. for each type & size
29.	**Hydro Cyclones (for each type & size)**		
	i)	Hydrocyclones	1 Set
	ii)	Feed vessel	1Set
	iii)	Lining for vessel	1 Set
	iv)	Complete vessel assembly	1 No.
	v)	Valves	1 Nos. of each type & size
	vi)	Pressure gauge	1 Nos.
	vii)	Measuring nozzle	1 Set
	viii)	Flanges for cycles	1 Se
	ix)	Over flow & underflow pipes and	1 Set
	x)	Filters	1 Set
	xi)	Vortex finder and apex inserts	1 Set
30.	**Vacuum Belt Filters**		
	i)	Filter Cloth	1Nos.
	ii)	Belt (if applicable)	1 Sets.
	iii)	Vacuum Box Seals	1 Nos.
	iv)	Drive Motor (if applicable)	2 Sets.
31.	**Vacuum Pumps**		
		Pump Impeller Assembly	1 no.
		Pump Bearings	1 Set

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
		Motor Bearings	1 Set
		Seals	1 Set
32.	**Vacuum Breaker Valves**		
		Valve Assembly	1 no.
		Actuator	1 no.
33.	**Miscellaneous Agitators**		
	i)	Impeller assembly	1 Nos. for each type and size
	ii)	Bearings	2 Sets for each type and size
	iii)	Shaft assembly	1 Sets for each type and size
	iv)	Shaft seal	1 Sets for each type and size
	v)	Gear box, if applicable	1 no. of each type and size
	vi)	Complete agitator assembly	1 no. of each type and size
34.	**Knife Gate Valve**		
	i)	Slide	1 Nos.
	ii)	Complete assembly	
		a) Cylinder operated	1Nos.
		b) Manual operated	1 Nos.
	iii)	Solenoid Valves	1 Nos. each type
35.	**Other Valves**		
	i)	Complete valves for each type and	2 Sets
	ii)	Seat, disc, spindle with nut for each type	2 Sets
	iii)	Diaphragms for each type and size of diaphragm type valves	5 Sets
	iv)	Flats of each type and size of non-return valves	1 Set
36.	**Hoists & Cranes**		
	i)	Long travel wheel	1 No.
	ii)	Cross travel wheel	1 No.
	iii)	Bearings for each gear box	1 Set
	iv)	Bearings for long travel wheels	1 Set
	v)	Bearings for cross travel wheels	1 Set
	vi)	Oil seals for each gear box	1 Set
	vii)	Pins & rubber bushes for the flexible coupling for each motor	1 Set
	viii)	Wire rope for hoist	1 length
	ix)	Brake linings for all brakes	1 Set
	x)	Brake spring for all brakes	1 Set
	xi)	Trustors with cups and seals for	1 Set

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
	xii)	Limit switches for all motions	1 Set
	xiii)	Contact for main and reversing	1 Set
	xiv)	Carbon brushes and brush holders for all slip ring type motors	1 Set
	xv)	Solenoid coils for all the electro-mechanical brakes	1 Set
	xvi)	Make and trip coils	1 Set
	xvii)	Fuse links for each motor	1 Set
	xviii)	Overload relays	1 Set for each crane
	xix)	Push buttons	1 Set for each crane
	xx)	Indicating lamps	1 Set for each crane
37.	**Goods Cum Passenger Elevator**		
	i)	Friction block	2 nos.
	ii)	Guide roller of each type	20% of total population or 3 nos. whichever is higher
	iii)	Contactors of each type	2 nos.
	iv)	Control transformer	1 no. of each type
	v)	Time device	2 nos. of each type
	vi)	Rectifiers	2 nos. of each type
	vii)	Overcurrent relay	2 nos. of each type
	viii)	Auxiliary relay	2 nos. of each type
	ix)	Resistor	20% of the total population or 3 nos. whichever is maximum
	x)	Fuses of each rating	20% of the total population or 3 nos. whichever is maximum
	xi)	Limit switches of each type	3 nos. of each type
	xii)	Push button	2 nos. of each type
	xiii)	Contact device (if applicable)	2 nos. of each type
	xiv)	Brake motor	2 nos.
	xv)	Transmitters	2 nos. of each type
	xvi)	Switches of each type	2 nos.
	xvii)	Receiver	3 nos.
	xviii)	Bearings of each type & size	2 Nos.
	xix)	Roller of each type	3 nos.
	xx)	Bushings (for front door)	2 Sets

ANNEXURE I			
LIST OF MANDATORY SPARES			
Sl. No.	**Equipment/Package Name**		**Quantity to be supplied**
	xxi)	Brake	
		Fans	2 Nos.
		Brake pads	2 Sets
		Brake discs	2 Sets
		Magnetic coils	2 Sets
	xxii)	Worm gear 'O' ring, sealing rings	3 Sets
	xxiii)	Pinion	2 nos. of each type
	xxiv)	Elevator motor with VVVF drive	1 No.
38.	**Exhaust Fans**		
	(i)	Set of Bearings for Air Washer Fans	1Set for each Type of Fan
	(ii)	Set of Bearings for U.A.F. Fans	1Set for each Type of Fan
	(iii)	Impeller for the Fan	1Set for each Type of Fan
	(iv)	Drive Motor	1No. for each Type of Fan
	(v)	Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list
39.	**Flue Gas Booster Fans (Axial type)**		
i)	a) Fan rotating element including impeller & shaft		1 set
	b) Fan bearings		2 sets
ii)	Motor bearings		2 sets
iii)	Oil rings/seal/gaskets/packings/ bushes, metallic rings		4 sets
iv)	Nuts and bolts		2 sets
v)	Couplings between fan and motor		1 no
vi)	Fan Blades		1 set
vii)	Inlet guide vanes (IGV), if applicable		1 set
viii)	Casing and impeller wearing elements, if applicable		1 set
ix)	Lube oil system		
	a) Pump assembly		1 nos. of each type
	b) Pressure regulator		2 nos.
	c) Filters		4 Sets
	d) Coupling for oil pump & motor		1 no.
	e) Oil coolers		1 Set
40.	**Compressed Air System**		

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
(i)	Dry Air Intake Filter	2Nos.
(ii)	Complete set of Loading- unloading valve assembly	1Sets (one set means complete replacement for one compressor)
(iii)	Low Pressure Compressor element (Screw) with Drive end & Non-drive end Bearings for Male & Female Elements	1Sets (one set means complete replacement for one compressor)
(iv)	High Pressure Compressor element (Screw) with Drive end & Non-drive end Bearings for Male & Female Elements	1Sets (one set means complete replacement for one compressor)
(v)	Plug for Inter cooler Tube Bunch	3Nos
(vi)	Plug for After Cooler Tube Bunch	3Nos
(vii)	Automatic Purge Drain Valve for Inter cooler and After cooler	1Sets (one set means complete replacement for one compressor)
(viii)	Air Outlet Check Valve	1Nos.
(ix)	Air Outlet Compensator	1Set (one set means complete replacement for one compressor)
(x)	Lub oil filter	2Nos.
(xi)	Lub oil Pressure Regulating valve	1No.
(xii)	Different oil seals/O-ring for Lub oil system	2Sets (one set means complete replacement for one compressor)
(xiii)	Cooling water Inlet and Outlet connection bellows	1Sets (one set means complete replacement for one compressor)
(xiv)	Gear Box Unit Complete	1Set (one set means complete replacement for one compressor)
(xv)	Gear Box Component	
(a)	Different Oil Seals/O-ring	1Sets (one set means complete replacement for one compressor)
(b)	Set Of Bearings	1Set (one set means complete replacement for one compressor)
(c)	Breathing Unit	1Nos
(xvi)	Component of L.P Cylinder	
(a)	Gear sets	1Set (one set means complete replacement for one compressor)
(b)	Set of bearings	1Set (one set means complete replacement for one compressor)
(c)	Mechanical Seal & O-ring	1Set (one set means complete replacement for one compressor)

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
(xvii)	Component of HP Cylinder	
(a)	Gear sets	1Set (one set means complete replacement for one compressor)
(b)	Set of bearings	1Set (one set means complete replacement for one compressor)
(c)	Mechanical Seal & O-ring	1Set (one set means complete replacement for one compressor)
(d)	Different Safety Valves	1Set (one set means complete replacement for one compressor)
(e)	Coupling	
(1)	Complete Set of Coupling (Motor to Compressor)	1Set (one set means complete replacement for one compressor)
(2)	Flexible Rubber for Coupling	2Nos.
(xviii)	Drain Moisture Trap	1Sets (one set means complete replacement for one compressor)
(xix)	Safety Valve's Springs & Gasket for LP Stage	1Set (one set means complete replacement for one safety valve)
(xx)	Safety Valve's Springs & Gasket for HP Stage	1Set (one set means complete replacement for one safety valve)
(xxi)	Oil Pump & Motor Complete Assembly	1Set
(xxii)	Drive Motor	1No.
(xxiii)	Other Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list
(xxiv)	Compressed Air Line Valves	As applicable
(xxv)	C&I Items	
(a)	PLC with MMI System	Applicable Item & Quantity
(b)	Field Instruments & Others as applicable as per the C&I List	Applicable Item & Quantity
(xxvi)	Air Drying Plant (HOC Type)	
(a)	Pre-filter Elements	1Sets (one set means complete replacement for one drier filter)
(b)	After-filter Elements	1Sets (one set means complete replacement for one drier filter)
41.	**Plate Type Heat Exchanger**	
(i)	Plate	5% (Rounded off to the next higher integer) of each type used in the system
(ii)	Valve	1No. for each type, size and Pressure rating
(iii)	Gaskets	30% (Rounded off to the next higher integer) of total requirement of each type & size
(iv)	Fasteners	10% (Rounded off to the next higher integer) of each type used in the system

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
42.	**Cooling Tower**	
	Spray nozzles	1Set (one set means complete replacement for one cooling tower)
	Set of fills	10% (ronded off to the next higher integer) of total quantity used one Tower
	Valves	1No. for each type, Class and size
	Electrical Spares as applicable as per the Electrical List	Applicable Item & Quantity same as indicated in Electrical list
	Field Instruments & Others as applicable as per the C&I List	Applicable Item & Quantity same as indicated in C&I list
	PLC Spares as applicable as per the C&I List	Applicable Item & Quantity same as indicated in C&I list
43.	**Fire protection and detection system spares**	
A	**Deluge Valve Assemblies**	
i)	Complete deluge valve assembly along with internals and accessories	10% or 1 No. of each type, class, size and model whichever is more
ii)	Clapper assembly complete (consisting of clapper seat rubber, screws etc.)	10% or 1 No. of each type, class, size and model whichever is more
iii)	Butterfly valve	10% or 1 No. of each type, class, size and model whichever is more
iv)	Disc. for Butterfly valve	10% or 1 No. of each type, class, size and model whichever is more
v)	Stem for Butterfly Valve	10% or 1 No. of each type, class, size and model whichever is more
vi)	Gasket for Butterfly Valve	10% or 1 No. of each type, class, size and model whichever is more
vii)	Bushing/Bearing (butterfly valve)	10% or 1 No. of each type, class, size and model whichever is more
viii)	Strainer elements with O-rings and stiffeners	10% or 1 No. of each type, class, size and model whichever is more
ix)	Y-Type strainer	10% or 1 No. of each type, class, size and model whichever is more
B	**MVW Spray System**	
i)	Spray Nozzles	10% or 10 No. of each type, class, size and model whichever is more
ii)	QB Detectors	10% or 20 No. of each type, class, size and model whichever is more
C	**HVW Spray System**	
i)	Spray Nozzles	10% or 10 No. of each type, class, size and model whichever is more
ii)	QB Detectors	10% or 20 No. of each type, class, size and model whichever is more
D	**Fire Detectors**	
i)	Multisensor detectors (Addressable)	10% or 10 No. of each type, class, size

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		and model whichever is more
ii)	Indicators assembly for smoke detectors provided in false ceiling (Response indicator)	10% or 10 No. of each type, class, size and model whichever is more
iii)	LHS cable for conveyors	10% or 10 No. of each type, class, size and model whichever is more
B. Electrical		
1.	***HT Auxiliary Transformer (11/3.45KV) & 220 / 11KV*** ***Following spares shall be supplied for each type, make and rating of the transformers***	
1.1	Bushing	
a.	HV Bushing with metal parts, connectors and gaskets	2Nos.
b.	LV bushing with metal parts, connectors and gaskets	2Nos.
c.	LV neutral bushing with metal parts, connectors and gaskets	1No.
1.2	Bushing CT (HV for winding temperature indicator)	1 Set (1 set consists of quantities required for 1 complete transformer)
1.3	Bushing CT (LV for winding temperature indicator)	1 Set (1 set consists of quantities required for 1 complete transformer)
1.4	Neutral Bushing CT (LV)	1 No.
1.5	Complete set of gaskets	1 Set
1.6	Winding Temperature Indicator with with all accessories	1No.
1.7	Dial type Oil Temperature Indicator with with all accessories	1No.
1.8	Pressure Relief Device	1No.
1.9	Magnetic Oil Level Gauge	1No.
1.10	Buchholz Relay	1No.
1.11	Silica Gel Breather	1No.
1.12	Prismatic Oil level gauge	1No.
1.13	Power Contactor	1No.
1.14	Control Contactor	1No.
1.15	Set of valves	1Set (1 set consists of quantities required for 1 complete transformer)
2.	***3.3KV Bus Duct (FOR EACH TYPE,***	

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
	MAKE AND RATING OF 3.3 KV BUS-DUCT)	
2.1	Bus Support Insulator	5% (rounded off to the next higher integer) of total nos. or minimum 3 nos. whichever is higher.
2.2	Set of seal-off bushings with hardware	1 Set of each type & rating (1 set means all 3 phases)
2.3	Set of Aluminium flexible with hardware	1 Set of each type and rating (1 set means all 3 phases)
2.4	Set of Copper flexible with hardware	1 Set of each type and rating (1 set means all 3 phases)
2.5	Drain plug with cap	2Nos.
2.6	Silica Gel Breathers	1No.
2.7	Gaskets of each type (20 mtrs. Set)	1Set.
2.8	Belleville washers	50Nos.
2.9	Rubber/Expansion bellows with hardware	1 Set of each type.
2.10	Space heaters	2sets.
3.	***415 V Bus Duct (FOR EACH TYPE, MAKE AND RATING OF 415V BUS-DUCT)***	
3.1	Bus support insulator	15 Sets. each type and rating
3.2	Rigid joint with hardware	05 Nos. each type and rating
3.3	Copper/Aluminum flexible for main run and tap offs bus ducts with hardware	1 Set of each type and rating per phase
3.4	Seal off bushing for main run and tap offs bus ducts	1 Set of each type and rating per phase
3.5	Jumpers(if applicable)	2 Set. of each type
3.6	Rubber bellow for main run and tap offs bus ducts with hardware	1 Set of each type and rating
3.7	Silica gel breather	1 No.
	11KV & 3.3KV System	
4.	***11KV & 3.3 kV Switch Gear (FOR EACH MAKE, TYPE, RATING OF 11 KV SWITCHGEAR)***	
4.1	Breaker Complete Pole assembly with vacuum interrupter	2 set (1 set consists of 3 nos.) of each rating
4.2	Aux. Switch assembly, limit switch etc. with complete mechanism.	20% (rounded off to the next higher integer) of total nos. or minimum 5

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		nos. whichever is higher for each type and rating used in each switchgear.
4.3	Spring Charging Motor	20% (rounded off to the next higher integer)of total nos. or minimum 5 nos whichever is higher for each type and rating used in each switchgear.
4.4	Shunt trip coil	10% (rounded off to the next higher integer)of total nos. or minimum 10 nos. whichever is higher for each type and rating used in each switchgear.
4.5	Closing Coil	10% (rounded off to the next higher integer) of total nos. or minimum 10 nos. whichever is higher for each type and rating used in each switchgear.
4.6	Current transformer of each type, rating & ratio	3 nos of each type, , rating & ratio
4.7	Potential transformer of each type & ratio	1 no of each type & ratio
4.8	Relays (Other than numerical relay):	
4.9	each type & rating (anti-pumping relay also included)	1 no of each type & rating
4.10	Numerical relays of each type	1 no.
4.11	Aux. relays & Lock out relays & TIMERS	2 nos of each type &rating
4.12	Interposing relay for PLC each type	1 no.
4.13	Check synchronizing relay	1 no.
4.14	Timer each type	1 no.
4.15	Vacuum Interrupter with moving and fixed contact assembly	20% (rounded off to the next higher integer) of total nos. or minimum 5 nos. whichever is higher for each type and rating used in each switchgear.
4.16	Bus seal-off bushings	2 nos of each type
4.17	Bus bar support insulators	10% (rounded off to the next higher integer)of total nos. for each type and rating used in each switchgear
4.18	Limit switches along with mechanism of each type FOR Service and Test position	10% (rounded off to the next higher integer) of total nos. or minimum 5 nos. whichever is higher for each type and rating used in each

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		switchgear
4.19	Closing spring	20% of total no. of breakers
4.20	Tripping spring	.20% of total no. of breakers
4.21	Breaker Control switches	3 nos of each type.
4.22	Selector switches	
4.23	Selector Switch(Local/Remote)	3 nos of each type.
4.24	Selector switches (Switch gear / Trial / Normal Switch)	3 nos of each type.
4.25	Ammeter Selector Switch	3 nos of each type.
4.26	Voltmeter Selector Switch	3 nos of each type.
4.27	Isolation switch for the control supply (AC Supply On / Off Switch, DC Supply On / Off Switch, Motor Heater On /Off Switch etc.)	3 nos of each type.
4.28	Operating mechanism rod for each rating	3 nos
4.29	Set of gaskets of each rating	2 sets
4.30	Ammeter of each type & range	2 no of each type & range
4.31	Voltmeter of each type & range	1 no of each type &range
4.32	Circuit breaker aux. contact assembly:-	10% of total nos. or minimum 5 nos whichever is higher for each type and rating used in each switchgear
4.33	Indicating Lamps	
	Clustered type LED of each type/ colour	10% of total number
4.34	MCB of each type & rating	5 nos of each.
4.35	Fuses of each type and rating	20 Nos.
4.36	Maintenance tools and accessories for maintenance (bidder to list)	1 set.
4.37	Breaker jaw contact (Bus -end & breaker-end) assembly	2 sets (1 set consists of 3 nos.)of each rating
4.38	Non-disconnecting type Terminal blocks	5 nos. of each type and rating
4.39	Disconnecting type terminal block for CT wiring	5 nos.
4.40	Multiple pin plug contact assy. with cables (male & female)	5 sets
4.41	Guide for moving contact set	6 sets (complete)
4.42	Interphase barrier	3 nos. for each type
4.43	Contactors with HRC fuses	10 % (rounded off to the next higher integer)of each type and rating
4.44	Aux. contactors	10 % (rounded off to the next higher

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		integer) of each type and rating
4.45	Control supply transformers (If applicable)	1 no of each type.
4.46	Dash pot complete assembly	1 no. with each type
4.47	Surge Arrester	5 nos. of each type and rating
4.48	Transducer	2 nos. for each type and Rating
4.49	Energy Meter	1 no of each type and rating
4.50	HT fuse of PT	3 nos. of each type and rating
	415V System	
5.	***11/0.415KV Transformer (for Each make, type and rating of Transformer)***	
5.1	Door Limit Switch complete set	1 set (1 set means total requirement for one Transformer)
5.2	CTs of each type and rating	1 no of each type and rating
5.3	Temperature scanner	1 no.
5.4	Thermistor & Temperature surveillance unit	2Sets.
5.5	HV Bushing with metal parts, connectors and gaskets	3 No
5.6	LV Bushing with metal parts, connectors and gaskets	3 No
5.7	LV neutral Bushing with metal parts, connectors and gaskets	1 No
5.8	Support Insulator	2 sets (1 set means total requirement for one Transformer)
5.9	Limb of complete LT & HT of temperature sensing devices	1 Set (1 set means total requirement for one Transformer)
5.10	Winding temperature indicating equipment	1Set (1 set means total requirement for one Transformer)
6.	***PCC (To be repeated for each type & rating)***	
6.1	Main power contact (Fixed and moving) Complete assembly	2 sets of each make, type and rating
6.2	Auxiliary contact assembly of breaker	
a.	Test position	3 sets of each type
b.	Service position	3 sets of each type
6.3	Closing and tripping coil	3 nos. of each type
6.4	Spring charging motor	2 nos. of each type
6.5	Arc chute for CBs	5 nos. of each type
6.6	Arching contacts (for fixed)	3 nos. of each rating
6.7	Arching contacts (for moving)	3 nos. of each rating

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
6.8	Main bus bar supporting insulators	10 nos. of each type
6.9	Dropper bus bar supporting insulators	5 nos. of each type
6.10	CTs	3 nos. for each type and ratio
6.11	PTs	3 nos. for each type and ratio
6.12	Meters	
a.	Voltmeter	2 nos. of each type
b.	Ammeter	2 nos. of each type per board
6.13	Numerical Protection relays	1 no. of each type per board
6.14	Auxiliary relays	2 nos. of each type per board
6.15	Interposing relays	2 Nos. of each type
6.16	Check synchronizing relay	1no
6.17	MCB	1no. of each rating
6.18	Timers	2 nos. of each type per board
6.19	Misc. items	
a.	Push button with contact element	5 nos. of each type
b.	Selector switch	5 nos. of each type
c.	Voltmeter selector switch	5 nos. of each type
d.	Ammeter selector switch	5 nos. of each type
e.	Local-remote selector switch	3 nos. of each type
f.	Indicating lamp of LED (LVGP type)	10 nos.
g.	Terminal blocks	10 nos
h.	Breaker Test/Service limit switch	5 sets for each type
i.	Power and control circuit fuses	10 nos. of each type
j.	Control Transformer	1 no. each rating
7.	***PMCC (To be repeated for each type & rating)***	
7.1	Sliding Main power contact (Fixed and moving) Complete assembly	2 sets of each make, type and rating
7.2	Auxiliary contact assembly of breaker	
a.	Test position	3 sets of each type
b.	Service position	3 sets of each type
7.3	Closing and tripping coil	3 nos. of each type
7.4	Spring charging motor	2 nos. of each type
7.5	Arc chute for CBs	5 nos. of each type
7.6	Arching contacts (for fixed)	3 nos. of each rating
7.7	Arching contacts (for moving)	3 nos. of each rating
7.8	Main bus bar supporting insulators	10 nos. of each type
7.9	Dropper bus bar supporting insulators	5 nos. of each type
7.10	CTs	3 nos. for each type and ratio

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
7.11	PTs	3 nos. for each type and ratio
7.12	Meters	
a.	Voltmeter	2 nos. of each type
b.	Ammeter	2 nos. of each type per board
7.13	Numerical Protection relays	1 no. of each type per board
7.14	Auxiliary relays	2 nos. of each type per board
7.15	Interposing relays	2 Nos. of each type
7.16	Check synchronizing relay	1no
7.17	MCB	1no. of each rating
7.18	Timers	2 nos. of each type per board
7.19	Misc. items	
a.	Push button with contact element	5 nos. of each type
b.	Selector switch	5 nos. of each type
c.	Voltmeter selector switch	5 nos. of each type
d.	Ammeter selector switch	5 nos. of each type
e.	Local-remote selector switch	3 nos. of each type
f.	Indicating lamp of LED (LVGP type)	10 nos.
g.	Terminal blocks	10 nos
h.	Breaker Test/Service limit switch	5 sets for each type
i.	Power and control circuit fuses	10 nos. of each type
j.	Control Transformer	1 no. each rating
7.20	Electronic overload relays with single phase preventors	1 no. of each type
7.21	Auxiliary relay	2 nos. of each type
7.22	Indicating Lamp assembly (LED LVGP type)	10 nos. of each type & colour
7.23	Phase sequence meter	2 nos.
7.24	MPCB	1 no of each type and rating
7.25	MCCB	1 no of each type and rating
7.26	Single phase control transformer (415/110V)	1 no. of each type
7.27	Interposing relay	1 no. of each type
7.28	Push button with contact element	1 no. of each type
7.29	Meters	1 no. of each type
8	***MCC (To be repeated for each type & rating)***	
8.1	Bus bar support insulators	10 nos. of each type
8.2	Current transformers	1no. of each type & rating
8.3	Potential transformers 415/110V	1 no.

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
8.4	Male contact of ACB (main and aux.)	1 set
8.5	Female contact of ACB (main and aux.)	1 set
8.6	Limit switch of ACB	3 nos.
8.7	Spring charging motor of ACB	3 nos.
8.8	Closing coil of ACB	2 nos.
8.9	Tripping coil of ACB	2 nos.
8.10	Breaker control switch	2 nos.
8.11	Numerical Protection Relays	1no. of each type
8.12	Electronic overload relays with single phase preventors	1 no. of each type
8.13	Auxiliary relay	2 nos. of each type
8.14	Indicating Lamp assembly (LED LVGP type)	10 nos. of each type & colour
8.15	Phase sequence meter	2 nos.
8.16	MPCB	1no of each type and rating
8.17	MCCB	1no of each type and rating
8.18	Single phase control transformer (415/110V)	1 no. of each type
8.19	Interposing relay	1 no. of each type
8.20	Push button with contact element	1 no. of each type
8.21	Meters	1 no. of each type
9.0	***ACDB/PDB/LDB/SLDB/Auxiliary PDB/Distribution Panels (To be repeated for each type & rating)***	
9.1	Bus bar support insulators	3 nos. of each type
9.2	MCCB / SFU	2 nos. of each rating
9.3	MCB	2 nos. of each rating
9.4	Control switch	2 nos. of each type
10.0	***DC Starter Panel (For each type and rating of DC motor/equipment)***	
1.01	DC Power Contactor	
a.	Power Contactor Complete Assembly	1 no for each make, type and rating
b.	Power Contactor spare kits	1 no for each make, type and rating
c.	Power Contactor Coils	1 no for each make, type and rating
10.2	Switch Fuse Unit Complete assembly	1 no for each make, type and rating
10.3	Fuse	5 nos for each make, type and rating
10.4	Selector Switch	1 no for each make, type and rating
10.5	Push Button	1 no for each make, type and rating
10.6	Timer	1 no for each make, type and rating

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
10.7	Ammeter	1 no for each make, type and rating
10.8	Voltmeter	1 no for each make, type and rating
10.9	Overload Relay	1 no for each make, type and rating
10.10	Transducer	1 no for each make, type and rating
10.11	Aux. Relay	1 no for each make, type and rating
10.12	Control Contactor	
10.13	Control Contactor complete	1 no for each make, type and rating
10.14	Control Contactor spare kits	1 no for each make, type and rating
10.15	Control Contactor Coils	1 no for each make, type and rating
10.16	Variable resistor	1 no for each make, type and rating
10.17	Indicating Lamps complete assembly	
a.	Red	1 no for each make, type and rating
b.	Amber	1 no for each make, type and rating
c.	Green	1 no for each make, type and rating
11.00	Protective Relaying system	
a.	*11KV PROTECTIVE RELAYING SYSTEM-NUMERICAL TYPE*	
	Incomer Protection Relay	2 no. for each make, type and rating
	Transformer Protection Relay	2 no. for each make, type and rating
	Motor Protection Relay	2 no. for each make, type and rating
	Out-going feeders Relay	2 no. for each make, type and rating
	Bus PT & Line PT Relay	2 no. for each make, type and rating
b.	*3.3 KV PROTECTIVE RELAYING SYSTEM-NUMERICAL TYPE*	
	Incomer Protection Relay	2 no. for each make, type and rating
	Transformer Protection Relay	2 no. for each make, type and rating
	Motor Protection Relay	5 no. for each make, type and rating
	Out-going feeders Relay	2 no. for each make, type and rating
	Bus PT & Line PT Relay	2 no. for each make, type and rating
c.	*415V PROTECTIVE RELAYING SYSTEM-* NUMERICAL TYPE	
	Incomer Protection Relay	2 no. for each make, type and rating
	Transformer Protection Relay	2 no. for each make, type and rating
	Motor Protection Relay	2 no. for each make, type and rating
	Out-going feeders Relay	2 no. for each make, type and rating
	Bus PT & Line PT Relay	2 no. for each make, type and rating
12.00	***UPS (PLC System)***	(applicable only for above 3KVA rating, for UPS rating equal to or less than 3 KVA one complete set shall be supplied for each area.)

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
12.1	Semi-conductor Fuse/HRC Fuse	3 (Three) times of total quantity of each type of fuses used in the system
12.2	SCR (if applicable)	100% of total quantity of each type used in the system
12.3	Diode	100% of total quantity of each type used in the system
12.4	IGBT	100% of total quantity of each type used in the system
12.5	Electronic Module/ PCB	
12.6	Static Switch	2(two) Nos. each type of Electronic Card/PCB/modules used in the system
12.7	Inverter	2(two) Nos. each type of Electronic Card/PCB/modules used in the system
12.8	Static voltage Regulator	2(two) Nos. each type of Electronic Card/PCB/modules used in the system
12.9	Charger	2(two) Nos. each type of Electronic Card/PCB/modules used in the system
12.10	Control Panel/Desk Mounted Items	
a.	Push Button Complete assembly	10Nos for each colour
b.	Push Button Contact Element (1NO + 1NC) Block	20Nos.
c.	Selector Switch	10Nos. for each type and rating
d.	Meter (Analog and Digital)	
e.	Ammeter	2Nos. for each type and range
f.	Voltmeter	2Nos. for each type and range
g.	Frequency	2Nos. for each type and range
h.	MW	2Nos. for each type and range
i.	MVAR	2Nos. for each type and range
j.	Power Factor	2Nos. for each type and range
k.	Synchroscope	1No. for each type and range
l.	Synchro-check Relay complete set	1No. for each type and range
m.	Transducer	1No. for each type and range
n.	Indicating Lamps complete assembly	20Nos. for each Colour and type
o.	Mimic Lamps	10Nos. for each Colour and type
p.	MCB	5Nos. for each type and rating
q.	Door Limit Switch	5Nos.

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
12.11	Annunciation system	
a.	Lamp Box with Facia & Lamps (LED type)	25Nos.
b.	Hooter	1No.
c.	Each type of PCB (for non-PLC driven system)	1(one) no.
13.0	***Actuator***	
13.1	Complete set of Actuator	2Nos. for each type, make and rating, 1 no. for H2 cooler Temperature controller and 1 no. for stator water temperature controller
13.2	Power Unit for Modulating Actuator	4Nos. of each type
13.3	DC-DC Power Pack Unit	4Nos. of each type
13.4	Electronic cards	4Nos. of each type
13.5	Position Feed Back Transmitters	4Nos. of each type
13.6	Control Unit	4Nos. of each type
13.7	Limit Switch Assembly	2 Nos each type and rating
13.8	Torque Switch Assembly	2 Nos each type and rating
13.9	Power Contactor	5Nos. for each type and rating
13.10	Auxiliary Contactor	5Nos. for each type and rating
13.11	Thermal Over Load Relay	2Nos. for each type and rating
13.12	Motor	1No. each type and rating
13.13	Complete Seal kit	2Sets for each type and rating
13.14	Complete O-Ring Set	2Sets for each type and rating
14.0	***Illumination***	
14.1	Fittings	2 sets of each type
14.2	Lamps (LED Type)	10 nos. of each type
14.3	MCCB	5 Nos for each make, type and rating .
14.4	MCB	20 Nos for each make, type and rating .
14.5	Control gear box complete	5 sets of each type
14.5	Switches	5 Nos for each make, type and rating .
14.6	Timer/photo cell (wherever applicable)	2 nos
14.7	Receptacles with plug	5 Nos for each make, type and rating
14.8	Lighting Transformer	1 no for each make, type and rating .
15.0	**Not used**	
16.0	***Neutral Grounding Registor***	
16.1	NGR complete with all accessories	1 set of each make, type and rating

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
16.2	Insulator	2 nos for each make, type, rating and size
16.3	Neutral CT(if applicable)	1 no of each type and rating
17.0	***DG Set***	
17.1	Diesel Engine	
17.2	Element Corrosion Resistor	8Nos.
17.3	Element lub oil Filter	8Nos.
17.4	Element lub oil by pass Filter	8Nos.
17.5	Element Fuel Filter	16Nos.
17.6	Plate corrosion Resistor	16Nos.
17.7	Element Air cleaner outer	2Nos.
17.8	Element Air cleaner Inner	2Nos.
17.9	Fuel Oil Pump	1No.
17.10	Turbo-charger	2Nos.
17.11	Engine - starter Motor	1No.
17.12	Lub Oil Pump	1No.
17.13	Injector	2Nos.
17.14	Piston rings & liner set	16Nos.
17.15	Cooler Pump with motor (complete assembly)	1No.
17.16	V-belt for radiator fan	6 Nos.
17.17	Alternator and Control panel	
a.	Rotating Rectifier complete set with diodes, varistors .	1 set.
b.	DG Set Controller complete set	1 no
c.	current transformers	2 no of each type and rating
d.	set of instruments of each range	One (1)
e.	set of relays of each type	One (1)
f.	set of timers	One (1)
g.	sets of indicating light	One (1)
h.	sets of fuses of each rating	One (1)
i.	set of terminal blocks	One (1)
j.	Exciter PCB	2Nos.
17.18	***AMF Panel***	
a.	Protective relay	1 No of each type
b.	Auxiliary relay	2 No of each type
c.	Timer	1 No of each type
d.	Meters	1 No of each type
e.	Transducer	1 No of each type
f.	Selector Switch	1 no of each type

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
g.	Control Switch	1 no of each type
h.	Current transformer(if applicable)	1 no of each type and rating
i.	Power and Aux. Contactor	1 no of each type and rating
j.	Converter/Solid state potentiometer complete set	1 no of each type
k.	Level Controller complete set	1 no of each type
l.	Push button complete set	1 no of each type
m.	Temperature Scanner	1 no.
n.	Annunciation window	1No.
o.	Indicating Lamps complete assembly	2 Nos of each type.
18.0	***Battery & Battery charger***	applicable items mentioned in Sl No.7.18.02 of this document shall be followed.
	220V DC System	
18.1	Battery (For each make, Type and Rating)	
18.2	Hydrometer	2 Nos. of each type
18.3	Vent plugs	5 Nos. of each type
18.4	Inter-cell, connector	5 Nos. of each type
18.5	Set of nuts, bolts and washer	5 Nos. of each type
18.6	Insulated socket spanner with handle	2 Nos. of each type
18.7	Thermometer	2 Nos. of each type
18.8	Rubber gloves	1pair
18.9	Voltmeter for measuring cell voltage (Center zero type)	1No.
	Float -cum- Boost Charger (For each make, Type and Rating)	
18.10	Electronic Module, PCB, Cards of each type and rating (with all components mounted)	2 Set
18.11	Fuses/ MCB of each type and rating	100% of total quantity.
18.12	MCCB of each rating	2 nos.
18.13	SCR of each type and rating	2 Nos.
18.14	Blocking Diode of each type and rating	5 Nos. of each type
18.15	Potentiometer of each type and rating	1 Set
18.16	Pulse transformer	1 Set of each type
18.17	Main and Aux. transformer	1 no of each type and rating
18.18	Capacitor	2 no of each type and rating
18.19	Meters (DC Ammeter, DC Voltmeter, AC Ammeter, AC Voltmeter)	1 No of each type
18.20	Transducer	1 No of each type
18.21	Selector Switch	1 no of each type

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
18.22	Control Switch	1 no of each type
18.23	Current transformer(if applicable)	1 no of each type and rating
18.24	Push button complete set	1 no of each type
18.25	Annunciation window	1No.
18.26	Indicating Lamps (LED)	2 Nos of each type.
18.27	Contactors of each type	5 Nos.
18.28	Coils for each type of Contactor	5 Nos.
18.29	Main & Aux Contact sets	5 Nos
18.30	Over load relays of each type	1 No.
18.31	Filter condenser and Filter Fuses	2 sets
18.32	Current Regulators of each Type	1 set
	Motor	
19.0	***11 KV & 3.3 KV Motor***	
19.1	Motor of each type and rating (Note : motors covered in mechanical spare items need not to be included here again)	10% of the installed quantity or minimum 1 number whichever be higher
19.2	Neutral End Terminal Bushing with Fasteners	1 no. for each type and rating of Motor
19.3	Bearing Temperature Gauge Driving & Non-Driving End	1 set for each type and rating of Motor
19.4	Phase segregated terminal boxes	2 Nos. for each type and rating of Motor
19.5	Heaters	2 sets for each type and rating of Motor
19.6	Complete Set of Coupling	1 set for each type and rating of Motor
19.7	Bearings (DE) for each type and rating of motors	2 sets for each type and rating of Motor
19.8	Bearings (NDE) for each type and rating of motors	2 sets for each type and rating of Motor
19.9	Cooling Fan Internal & External	1 set for each type and rating of Motor
19.10	Neutral CT for differential protection (For motor rating >1000 KW)	2 no of each type and rating.
19.11	End Termination kits	2 Nos. of each type and rating
19.12	Indicating Instruments/gauges other then Bearing temperature gauge (as applicable)	1 set for each type and rating of Motor
19.13	Phase side Bushing and Insulator	1Set for each type and rating of Motor

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
19.14	Oil Seal Ring (as applicable)	1Set for each type and rating of Motor
20.0	***415 Volt Motor***	
20.1	Motor of each type and rating (Note : motors covered in mechanical spare items need not to be included here again) 10% of the installed quantity or minimum 1 number whichever be higher	10% of the installed quantity or minimum 1 number whichever be higher
20.2	End Shield Cover Driving & Non-Driving End	1 set for each type and rating of Motor
20.3	Heaters	2 sets for each type and rating of motor
20.4	Bearings (DE and NDE) for each type and rating of motor	2 sets
20.5	Cooling Fan for all type and rating of LT motors	One (1) set
20.6	Dust seals and gaskets for each type of motors	1 Set
20.7	Motor Terminal Block	1 no. for each type and rating of Motor
20.8	Complete Set of Coupling	1 set for each type and rating
21.0	***DC Motor***	
21.1	Motor of each type and rating (Note : motors covered in mechanical spare items need not to be included here again)	10% of the installed quantity or minimum 1 number whichever be higher
21.2	Carbon brushes	2 sets for each type and rating of Motor
21.3	Brush assemblies	2 sets for each type and rating of Motor
21.4	Terminal blocks	1 set for each type and rating of Motor
21.5	Heaters	1 set for each type and rating of Motor
21.6	Complete Set of Coupling	1 set for each type and rating of Motor
21.7	Bearings (DE and NDE) for each type and rating of motor	1 set for each type and rating of Motor
21.8	Cooling Fan	1 set for each type and rating of Motor
22.0	***Local Control Station***	
22.1	Local Control Station Complete Set for all	2 nos for each make, type and rating

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
	type of drives	
22.2	Push button complete set	5 nos for each make, type and rating
C. **INSTRUMENTATION & CONTROL**		
	PLC, Microprocessor based control system, and any other Control System / Sub-system listed in NIT.	
	All types of electronic modules, controllers, function modules, communication / Network Interface cards, terminal boards, relay boards, power supply cards etc. for above mentioned system and other Control System / Sub-systems and any other type of PCB not covered above.	10% of qty. installed of each category / model / type or at least 2 nos. of each type / model (Whichever is more).
	I/O Cards	
	Binary Input Module	10% of qty. installed or minimum 2 nos. whichever is more.
	Binary Input Module for SOE Inputs	10% of qty. installed or minimum 2 nos. whichever is more.
	Analog Input Module (4 to 20mA input type)	10% of qty. installed or minimum 2 nos. whichever is more.
	Analog Input Module (Thermocouple input type)	10% of qty. installed or minimum 2 nos. whichever is more.
	Analog Input Module (3-wire RTD input type)	10% of qty. installed or minimum 2 nos. whichever is more.
	Analog Output Module (4 to 20mA output type)	10% of qty. installed or minimum 2 nos. whichever is more.
	Binary Output (contact) Module	10% of qty. installed or minimum 2 nos. whichever is more.
	Binary Output (Voltage) Module	10% of qty. installed or minimum 2 nos. whichever is more.
	Any other system specific Module / Cards used in the system but not mentioned in this list	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and model.
	Interposing / Coupling Relays	10% of qty. installed of each type/ rating or minimum 10 nos. whichever is more.
	Output Relay modules / Relay Board & Auxiliary Relay	10% of qty. installed of each type/ rating or minimum 4 nos. whichever is more.
	Cubicle power supply packs and power supply modules (AC to DC converters)	10% of qty. installed or minimum 2 nos. whichever is more for each type/

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		rating.
	MCB, MCCB of each current rating required for the project	10% of qty. installed or minimum 10 nos. whichever is more for each type and rating.
	Power supply fuses	50% of qty. Installed of each type.
	Racks for housing I/O & Processor Modules	1 no. each type used in the system.
	Cooling fans for power supply and cabinets	10% or minimum 1 no. whichever is more for each type/ model.
	Hooters / Buzzers	10% or minimum 2 nos. whichever is more for each type.
	Cables & Connectors	
	Backup cable for Redundant Processor Modules with end connectors	2 nos. each type used in the system.
	Network communication cable with end connectors (from the Processor module)	10% of qty. installed or minimum 4 nos. whichever is more for each type.
	I/O Connector with Prefab interconnecting cable	10% of qty. installed or minimum 4 nos. whichever is more for each type and length.
	Power supply cords / cables & VGA cables - for workstations, servers, laptops, printers etc.	10% of qty. installed or minimum 10 nos. whichever is more for each type.
	Interface / Data highway Cables & Connectors	
	FO Cable	500 mtrs. of each type of Cables
	Other Cable (Viz. Co-axial Cable, UTP Cable etc.) as applicable	500 mtrs. for each type and rating.
	Network Items	
	Managed Switch	10% of qty. installed for each type/ model or minimum 1 no. whichever is more.
	Un-managed Switch	10% of qty. installed for each type/ model or minimum 2 nos. whichever is more.
	Transceiver (Optical to UTP converter)	10% of qty. installed for each type/ model or minimum 2 nos. whichever is more.
	Fibre-optic Patch Cords	10% of qty. installed for each type/ model or minimum 2 nos. whichever is more.
	Fibre-optic Patch Box/Patch Panel	10% of qty. installed for each type/ model or minimum 2 nos. whichever

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		is more.
	Routers, modems, firewalls & other network hardware etc.	10% of qty. installed for each type/ model or minimum 2 nos. whichever is more.
	RS232 to RS485/RS422 Converter or any other media Converter (if applicable)	10% of qty. installed for each type/ model or minimum 2 nos. whichever is more.
	HMI	
	Plug-in type Keyboard & Mouse	2 nos. (Keyboard) 4 nos. (Mouse)
	OWS with licensed software loaded along with monitor / LVS workstation	1 set
	24” LED monitors	1 no
	GUI	10% of qty. installed for each type or minimum two (2) nos. whichever is more.
	Printer toners for all printers	Ten (% of qty. installed or 3 nos. of each type printer toners (whichever is more).
	DVD/ CD	10 boxes of each type/ rating.
	Hard Disk Drive for the work Station	1 no. complete set.
	RAM Backup Battery	10% of qty. installed qty. or minimum 2 nos. whichever is more.
	MCB	1No. for each type and rating
	Special Fuse for the Cards	Each type / rating of fuse, 50% of total nos. used in the system or minimum 25 nos. whichever is more.
	Terminal Blocks	10% of qty. installed for each type / model
	Large Video Screen	
	Lamp for Large Video Screen Display (DLP type)	15 (fifteen) nos.
	Electronic cards of each type for LVS	20% or 1 no. whichever is more.
	Interfacing module /component.	1No. each type and model
	Power Supply Module	20% or 2 nos. whichever is more for each type.
	Microprocessor based Control System	

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
	Complete set including integral microprocessor based control system along with system & application software and special cable	1 Set
	Measuring & Field Instruments	
	Electronic Transmitters	
	Pressure Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Differential Pressure Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Level Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Speed Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Flow Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Position Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Radar type Level Transmitter	1 number for each model, rating and type
	Electro-magnetic Flowmeter	1 number for each model, rating and type
	Mass Flowmeter	1 number for each model, rating and

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		type
	Ultrasonic Flowmeter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Ultrasonic Level Transmitter	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Temperature Transmitters	10% of total number of instruments offered for each model and type, rating or a minimum of 1 number for each model, rating and type, whichever is more.
	Different type of Switches	
	Pressure Switch	5% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Differential Pressure Switch	5% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Level Switch	5% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Flow Switch	5% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Temperature Switch	5% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type,

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
		whichever is more.
	Safety Protection Switch	5% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Temperature Elements and Thermowells	
	Thermocouple	10% of total nos. of duplex thermocouple assemblies (with head assembly, terminal block & nipple) of each type and length or two (2) nos. whichever is more.
	RTD	10% of total nos. of duplex RTD assemblies (with head assembly, terminal block & nipple) of each type and length or two (2) nos. whichever is more.
	Thermowell	10% for each type of temperature sensors or a minimum of two (2) nos. for each type & size, whichever is more.
	Local Gauges	
	Pressure Gauge	10% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Differential Pressure Gauge	10% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	Temperature Gauge	10% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.
	All type of Rotameters & Sight Flow Indicator	10% of total number of instruments offered for each model and type, rating or a minimum of one number for each model, rating and type, whichever is more.

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
	Impact Head type Flow Element (Annubar)	20% or 2 nos. of each make & type whichever is more.
	Level Gauges	1 no. of each type and size.
	Erection Hardware mounted in field, LIE & LIR	
	Instrument Manifold	10% of total nos. used in the system or minimum 2 nos. whichever is more for each type, rating,/model and size used in the system.
	Impulse Line Root/Source valve	10% of total nos. used in the system or minimum 4 nos. whichever is more for each type, rating,/model and size used in the system.
	Impulse Line Isolation valve	10% of total nos. used in the system or minimum 4 nos. whichever is more for each type, rating,/model and size used in the system.
	Impulse Line Drain valve	10% of total nos. used in the system or minimum 4 nos. whichever is more for each type, rating,/model and size used in the system.
	Impulse Line fittings	Each type/size 10Nos.
	Impulse Pipe	Each type/size 50Mtrs.
	Copper / SS Tube	Each type/size 50Mtrs.
	Fittings for Copper / SS Tube	Each type/size 25Nos.
	Air Filter Regulator including moisture separator complete set with pressure gauges	2 nos.
	MCB and power sockets used in LIE / LIR	10% of each type
	Fuses used in LIE / LIR	50% of each type
	Cables	
	Thermocouple Cable	500 Mtrs. Of each type, size & rating of Cables
	Control & Instrumentation Cable	500 Mtrs. Of each type, size & rating of Cables
	Water Analyzers	
	Critical Electronic spare part	1(one) no. each type
	Electronic Transmitter unit with sensor	1 set
	Pre-fabricated cable with connector	1 set
	Pneumatic Control Valve & Power Cylinder (Applicable for all Modulating Type & On-	

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
	Off/Isolating Type)	
	Control Valve	
	Pneumatic Diaphragm for Diaphragm actuated valve	2(two) nos. for each type of Actuator
	Actuator Seal Kit for Pneumatic Cylinder actuated valve	2(two) nos. for each type of Actuator
	Gland Packing	1(one) set for each type of Control Valve
	Stem	1(one) No. for each type of Control Valve
	Smart Positioner of the Valve	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
	Seal Kit for the Positioner	2(two) Sets. For each type of Positioner
	Position Feedback Transmitter (applicable if it is not integral with the Smart Positioner)	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
	Complete Set of Solenoid Valve for Pneumatic type On/Off Valve	2Nos. for each type & ratings
	Solenoid Coil for Pneumatic type On/Off Valve	5Nos. for each type & ratings
	Power Cylinder	
	Actuator Seal Kit	2(two) nos. for each type of Power Cylinder
	Gasket	2(two) Sets. For each type of Power Cylinder
	Complete Set of Power Cylinder	1(one) no. each type for all application
	Smart Positioner of the Valve	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.
	Seal Kit for the Positioner	2(two) Sets. For each type of Positioner
	Position Feedback Transmitter (applicable if it is not integral with the Smart Positioner)	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.

ANNEXURE I		
LIST OF MANDATORY SPARES		
Sl. No.	**Equipment/Package Name**	**Quantity to be supplied**
	Complete Set of Solenoid Valve for Pneumatic type On/Off Power Cylinder	2Nos. for each type & ratings
	Control Panel and Local / Remote Control Desk	
	Devices mounted on Control desk	10% or 2 nos. (whichever is more) of each type
	LEDs for indicating lights	50%
	Control circuit fuses	100% spare replacement of each current rating required
	MCB / MCCB	10% spare replacement of each current rating required
	Blank Mosaic Grid Tiles.	10% or 20 nos. (whichever is more) of each type
	Push buttons, ILPBs. (complete with contact elements)	10% or 2 nos. (Whichever is more) of each type and color.
	Cooling Fans	20% or 2 nos. (whichever is more) of each type, model and rating.
	Power supply modules.	10% or 2 nos. (whichever is more) of each type
	Any other items as per Manufacturer's recommendation for 3 years continuous operation or minimum quantities indicated as above (whichever is more)	
	Items not covered above (sensor/ instrument / analyzers / special instruments / electronic card, etc.)	10% or 1 no. whichever is more of each type
	1. If percentage comes as fraction next higher integer should be considered for the purpose of quantity required. **2.** In the event of conflict between any two clauses of this specification / document in respect of the requirements of Mandatory Spares specified, the more stringent requirements as per the interpretation of the Owner shall apply. Bidder shall also include in his proposal and shall furnish List of Mandatory Spares of other equipment / devices / items which may not be specifically stated herein but are needed for completeness of the equipment / systems to be supplied by the Bidder.	

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SECTION-IX

SALIENT DESIGN DATA

[TABLE I TO TABLE-VII]

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TABLE-III	DESIGN DM WATER ANALYSIS	3
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TABLE-VII	PROPERTIES OF LIMESTONE	7

TABLE-I

DESIGN SEA WATER ANALYSIS

Sl. No.	Parameter	Unit	Design Quality
1.	Alkalinity	ppm	122
2.	TH	ppm	6800
3.	Ca Hardness	ppm	1000
4.	Mg hardness	ppm	5800
5.	Cl^-	ppm	20226
6.	$P0_4^{3-}$	ppm	0.15
7.	Fe	ppm	0.22
8.	SiO_2	ppm	2.21
9.	Totals Dissolved Solid(TDS)	ppm	41275
10.	Temperature(^{0}C)	--	26
11.	pH	--	7.47
12.	Conductivity	µs/cm	63500
13.	Turbidity	NTU	500
14.	Total suspended Solids	ppm	500
15.	Total residual Chlorine	ppm	21593 down to 0.1 to 0.5 by Hypo chlorination.*
16.	BOD	ppm	Nil
17.	COD	ppm	Nil
18.	Oil & Grease	ppm	Nil

NOTE- The above water analysis shall be adjusted based on design injection level of chemicals limit of removal of suspended solid in Sea water Pretreatment system to arrive at feed water analysis for Desalination system.

*Further de-chlorination shall be done by the process vendor (if felt necessary) for the RO membrane sustainability.

TABLE-II

TREATED WATER/ FGD PROCESS WATER QUALITY

Sr. Number	Item	Unit	Value
1.	**TDS of permeate from Desalination RO System**	ppm	<500
2.	Total Suspended solids	ppm	Nil
3.	Iron as Fe	ppm as Fe	<0.1
4.	Reactive Silica as SiO2	ppm as SiO2	<1.0
5.	Chloride as Cl	ppm as Cl	<200
6.	Sodium	ppm as Na	<150
7.	pH at 25 deg C	---	6.0-7.0

TABLE-III

DESIGN DM WATER ANALYSIS

Sl. No.	Description	Max. Limit
1.00	Total Electrolyte	0.1 ppm, max.
2.00	Total SiO_2	0.01 ppm, max.
3.00	Iron as Fe	Nil
4.00	Free CO_2 ppm as CO_2	Nil
5.00	Total Hardness	Nil
6.00	pH value at 25 Deg.C	6.8 – 7.2
7.00	Conductivity, micro mho/cm	Less than 0.1 at 25 Deg. C

TABLE-IV

COAL AND ASH ANALYSIS

A) COAL ANALYSIS

Sl.No	Description	Unit	Talabira coal-RT-III @0.6 Sulphur
Proximate Analysis (As received basis)			
1	Total moisture	%	4.4
2	Ash	%	44
3	Volatile matter	%	21.1
4	Fixed carbon	%	30.5
Ultimate Analysis (As received basis)			
1	Carbon	C%	44.21
2	Hydrogen	H2%	2.5
3	Nitrogen	N2%	0.94
4	Oxygen (By difference)	O2%	3.35
5	Sulphur	S%	0.6
6	Total Moisture	H2O%	4.4
7	Ash	%	44
8	Gross Calorific Value	kcal/kg	3774

B) ASH ANALYSIS (Provisional)*

Sl. No.	Parameters	Value
a)	LOI	9.84
b)	SiO_2	42.94
c)	Fe_2O_3	6.97
d)	Al_2O_3	28.65
e)	CaO	5.58
f)	MgO	2.98
g)	SO_4	3.04

*** Ash Analysis is provisional. Final Ash Analysis shall be provided during Detailed Engineering.**

TABLE V

PROPERTIES OF LIGHT DIESEL OIL

SL. NO.	PARAMETERS	VALUE
1.	Specification	IS-15770
2.	Acidity (Inorganic)	Nil
3.	Ash content by mass	0.02% (max.)
4.	Copper strip corrosion for 3 hr at 100^0C	Not worse than no.2
5.	Flash Point (Pensky-Martens)	66 °C(minimum)
6.	Pour Point (Winter)	12 °C(maximum)
7.	Pour Point (Summer)	18 °C(maximum)
8.	Kinematic Viscosity at 40°C	2.5 to 15.0 Centistokes
9.	Sediment by mass	0.10% (maximum)
10.	Water content by volume	0.25% (maximum)
11.	Total Sulphur by mass	1.5% (maximum)
12.	Carbon Residue (Ramsbottom) by mass	1.5% (maximum)
13.	Gross Calorific Value	10,300 Kcal/kg.
14.	Density at 15 °C	0.85 kg/m^3

Note : Values indicated against Sl. 13 and 14 are typical and are not covered under IS-15770.

TABLE-VI

PROPERTIES OF HEAVY FUEL OIL (HFO)

SL. NO.	PARAMETERS	VALUE
1.	Specification	IS-1593 1971 Heavy Grade
2.	Viscosity at 50ºC max.	370 CS
3.	Density at 15ºC (approx.)	0.02% (max.)
4.	Flash Point (Pensky-Martens)	66°C(minimum)
5.	Pour Point	50°C(maximum)
6.	Water content by volume	1.0% (maximum)
8.	Sediment by weight	0.25% (maximum)
9.	Sulphur content by weight	4.5% (maximum)
10.	Ash content by weight	0.1% (maximum)
11.	Total Sulphur by weight	1.5% (maximum)
12.	Carbon Residue (Ramsbottom) by weight	-
13.	Gross Calorific Value	10,000 Kcal/kg
14.	Acidity (inorganic)	Nil

Note : For calculation, in case of HFO, 30% wax content with latent heat of fusion 54 Kcal/kg has been assumed.

TABLE-VII

PROPERTIES OF LIMESTONE

Limestone is proposed to be brought by Trucks to the plant. The limestone size is expected to be (-) 250 mm.

1.	CaO	%	47.5-51.0
2.	MgO	%	0.9-2.0
3.	Fe_2O_3	%	0.45-1.0
4.	Al_2O_3	%	1.19-2.1
5.	Si_2O_3	%	2.1-4.5
6.	Mn_2O_3	%	<0.12
7.	P_2O_5	%	Traces
8.	Cl_2	%	<0.015
9.	Na_2O	%	<0.16
10.	K_20	%	<0.01
11.	TiO_2	%	<0.02
12.	Total Sulphur	%	<0.1
13.	LOI	%	39.0-41.3

Physical Properties:

1.	Bond Index	kWh/t	13
2.	Granule size		Medium

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SECTION - I

GENERAL

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SECTION-I

GENERAL

1.00.00 INTRODUCTION

This specification covers site survey, soil investigation, site development works, design and construction of Civil, Structural & Architectural works for the new FGD (Flue Gas De-sulpherisation) package for presently operating thermal power plant having two units of 500 MW capacity each, in Tuticorin, Tamil Nadu for NLC Tamil Nadu Power Limited (NTPL). The scope of works covers complete Civil, Structural and architectural Works including supply of all materials, labour, tools and plants as required for successful execution of the FGD package.

This Section-I of Volume: II-G/1 of this specification lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. Documents to be submitted have also been brought out in this section along with the procedure to be followed for the same.

In case of any contradiction between any parts of the Bid Document with the other, requirement of most stringent one shall be applicable and in the event of conflict between requirement of any two clauses of this specification, or different codes / standards, the more stringent requirement as per the interpretation of Owner / Consultant is to be followed by bidder.

2.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions / Technical Specifications as appropriate. Unless otherwise stated, the latest editions/ revision of following codes and standards along with addendums/ amendments, if any, shall be followed:

2.01.00 General

a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.

b) National Building Code of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1256 : Code of Practice for Building Byelaws.

2.01.01 **Earthwork**

a) IS-1498 : Classification and identification of soils for General Engineering purposes.

b) IS-3764 : Safety Code for excavation work.

c) IS-7293 : Safety Code for working with construction machinery.

d) IS-4081 : Safety Code for blasting and related drilling operation

e) Indian Explosives Rule 2008

.

f) IS-9759 : Guidelines for Dewatering during construction.

2.01.02 **Concrete**

a) IS-269 : Specification for 33 grade Ordinary Portland Cement.

b) IS-383 : Coarse and fine aggregate from natural sources for concrete.

c) IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

d) IS-455 : Portland Slag Cement.

e) IS-456 : Code of Practice for Plain and reinforced concrete.

f) IS-460 : Test Sieves (all parts).

g) IS-516 : Methods of test for strength of concrete.

h) IS-1199 : Methods of sampling and analysis of concrete.

i) IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.

j) IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.

k) IS 1489 : Part 1: Specification for Portland pozzolana cement Part 1 Fly ash based

l) IS-1834 : Hot applied sealing compounds for joints in concrete.

m) IS-2386 : Methods of test for aggregates for concrete (all

parts).

n)	IS-2502	:	Code of practice for bending and fixing of bars for concrete reinforcement.
o)	IS-3370	:	Code of practice for concrete structures for storage of liquids (all parts).
p)	IS-3414	:	Code of practice for design and installation of joints in buildings.
q)	IS-4948	:	Welded steel wire fabrics for general use.
r)	IS-7320	:	Concrete slump test apparatus.
s)	IS-7861	:	Code of practice for extreme weather concreting (all parts).
t)	IS-8041	:	Rapid Hardening Portland Cement.
u)	IS-8112	:	Specification for 43 Grade ordinary Portland Cement.
v)	IS-12269	:	Specification for 53 Grade ordinary Portland Cement.
w)	IS-10262	:	Recommended guidelines for concrete mix design.

2.01.03 **Foundations**

a)	IS-1904	:	Code of practice for design and construction of foundations in soils: general requirements. .
b)	IS-2950	:	Code of practice for design and construction of raft foundations.
c)	IS-2974	:	Code of practice for design and construction of Machine foundations (All Parts).
d)	IS 2911	:	Code of practice for Design and Construction of Pile Foundation (All Parts).

2.01.04 **Loading**

a)	IS-875	:	Code of practice for design loads (other than earthquake) for buildings and structures.
b)	IRS	:	Bridge Rules of Government of India, Ministry of Railways (Railway Board).

2.01.05 **Masonry**

a)	IS-712	:	Building limes.
b)	IS-1077	:	Common Burnt Clay Building Bricks.
c)	IS-1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
d)	IS-1528	:	Methods of sampling and physical tests for refractory materials.
e)	IS-1597	:	Code of practice for construction of stone masonry (all parts).
f)	IS-2212	:	Code of practice for brickwork.
g)	IS-2116	:	Sand for masonry mortars
h)	IS-2185	:	Concrete masonry units. (all parts - Hollow and Solid concrete blocks).
i)	IS-2250	:	Code of practice for preparation and use of masonry mortars.
j)	IS-2572	:	Code of practice for construction of hollow and solid concrete block masonry.
k)	IS-2691	:	Burnt clay facing bricks.
l)	IS-3414	:	Code of practice for design and installation of joints in buildings.
m)	IS-3495	:	Methods of tests of burnt clay building bricks.
n)	IS-4441	:	Code of practice for use of Silicate type chemical resistant mortars.
o)	IS-4860	:	Acid Resistant Bricks.
p)	IS 13757	:	Specification for burnt clay fly ash building bricks

2.01.06 **Doors, Windows & Ventilators**

a)	IS-399	:	Classification of commercial timbers and their zonal distribution.
b)	IS-883	:	Code of practice for design of structural timber in building.
c)	IS-1003	:	Timber paneled and glazed shutters (all parts).

	d)	IS-1038	:	Steel doors, windows and ventilators.
	e)	IS-1081	:	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
	f)	IS-1361	:	Steel windows for industrial buildings.
	g)	IS-2835	:	Flat Transparent sheet glass
	h)	IS-1948	:	Aluminium doors windows and ventilators.
	i)	IS-1949	:	Aluminium windows for industrial building.
	j)	IS-2191	:	Wooden flush door shutters (Cellular and hollow core type).
	k)	IS-2202	:	Wooden flush door shutters (solid core type).
	l)	IS-3103	:	Code of practice for Industrial ventilation.
	m)	IS-3548	:	Code of practice for glazing in buildings.
	n)	IS-3614	:	Specification for metallic and non-metallic Fire check doors (all parts).
	o)	IS-4021	:	Timber door, windows and ventilator frames.
	p)	IS-4351	:	Steel door frames.
	q)	IS-6248	:	Metal rolling shutters and rolling grills.

2.01.07 **Roof & Flooring**

a)	IS-2204	:	Code of practice for construction of reinforced concrete shell roof.
b)	IS-3201	:	Criteria for the design and construction of precast concrete trusses and purlins.
c)	IS-2210	:	Criteria for Design of R.C. shell structures and folded plates.
d)	IS-809	:	Rubber flooring materials for general purposes.
e)	IS-1195	:	Bitumen mastic for flooring.
f)	IS-1196	:	Code of practice for laying bitumen mastic flooring.
g)	IS-1198	:	Code of practice for laying, fixing and maintenance of linoleum floors.

	h)	IS-1237	:	Cement concrete flooring tiles.
	i)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
	j)	IS-2114	:	Code of practice for laying in situ terrazzo floor finish.
	k)	IS-2571	:	Code of practice for laying in situ cement concrete flooring.
	l)	IS-5491	:	Code of practice for laying in situ granolithic concrete floor topping.
	m)	IS-5766	:	Code of practice for laying burnt clay brick flooring.
	n)	IS-1197	:	Code of practice for laying of rubber floors.
	o)	IS-2441	:	Code of practice for fixing ceiling coverings.

2.01.08 **Waterproofing**

a)	IS-1322	:	Bitumen felts for waterproofing and damp proofing.
b)	IS-1346	:	Code of practice for waterproofing of roofs with bitumen felts.
c)	IS-1609	:	Code of practice for laying damp proof treatment using bituminous felts.
d)	IS-3036	:	Code of practice for laying lime concrete for a waterproofed roof finish.
e)	IS-3037	:	Bitumen mastic for use in waterproofing of roofs.
f)	IS-3067	:	Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.
g)	IS-3384	:	Bitumen primer for use in water proofing and damp proofing.
h)	IS-4365	:	Code of practice for application of bitumen mastic for waterproofing of roofs.

2.01.09 **Membrane Waterproofing**

a)	ASTMD-1076	:	Solid Content
b)	ASTMD-1475	:	Specific Gravity

	c)	ASTMD-412	:	Elongation
	d)	ASTMD-2240	:	Hardness
	e)	ASTMD-822	:	Water vapour transmission resistance

2.01.10 **Soil Engineering**

	a)	IS-1498	:	Classification and identification of soils for general Engineering purposes.
	b)	IS-1892	:	Code of practice for sub-surface investigation for foundations.
	c)	IS-2131	:	Method for standard penetration test for soils.
	d)	IS-2720	:	Methods of test for soils (all parts).
	e)	IS-10379	:	Code of practice for Field Control of Moisture and compaction of soils for embankment and subgrade.

2.01.11 **Water Supply, Drainage & Sewerage**

	a)	IS-404	:	Lead pipes
	b)	IS-458	:	Pre-cast Concrete pipes (with and without reinforcements)
	c)	IS-651	:	Salt glazed stoneware pipes and fittings.
	d)	IS-771	:	Glazed fire-clay sanitary appliances (all parts).
	e)	IS-774	:	Flushing cisterns for water closets and urinals other than plastic cisterns.
	f)	IS-783	:	Code of practice for laying of concrete pipes.
	g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
	h)	IS-1626	:	Asbestos cement building pipes and pipe fittings, gutters and gutter fittings and roofing fittings (all parts).
	i)	IS-1742	:	Code of practice for building drainage.
	j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
	k)	IS-2065	:	Code of practice for water supply in buildings.

l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
q)	IS-1537	:	Vertically cast iron pressure pipe for water, gas and sewage.
r)	IS-3486	:	Cast iron spigot and socket drain pipes .
s)	IS-5329	:	Code of practice for sanitary pipe work above ground for buildings.
t)	IS-3076	:	Low density polyethylene pipes for potable water supplies.
u)	IS-1538	:	Cast iron fittings for pressure pipes for water, gas and sewage.
v)	IS- 1729	:	Cast Iron/Ductile Iron Drainage Pipes and Pipe Fittings for Over Ground Non-Pressure pipe line Socket and Spigot series.
w)	IS-784	:	Prestressed concrete pipes (including fittings).
x)	IS-1726	:	Cast iron manhole covers and frames.
y)	IS-5961	:	Cast iron grating for drainage purposes.
z)	IS-5219	:	Specification for cast copper alloys traps: (Part I) 'P' and 'S' traps
aa)	IS-772	:	General requirements for enamelled cast iron sanitary appliances.
bb)	IS-775	:	Cast iron brackets and supports for wash basins and sinks.
cc)	IS-777	:	Glazed earthenware wall tiles.
dd)	IS-2548	:	Plastic water closet seats and covers (all parts).

ee) IS-2527 : Code of practice for fixing rainwater gutters and down pipes for roof drainage.

2.01.12 **Paving & Road Works**

a) IS-73 : Paving bitumen

b) IS-702 : Industrial Bitumen

c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220

d) Practice followed by Indian Road Congress (all parts).

2.01.13 **Earthquake Resistant Design**

a) IS-1893 : Criteria for earthquake resistant design of structures.

b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

2.01.14 **Structural Steelwork**

a) IS-800 : Code of practice for general construction in steel.

b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line Towers (all parts).

c) IS-806 : Code of practice for use of steel tubes in general building construction.

d) IS-808 : Dimensions for hot Rolled steel beam, column, channel and angle sections.

e) IS-813 : Scheme of symbols for welding.

f) IS-814 : Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.

g) IS-816 : Code of practice for use of metal arc welding for general construction in mild steel.

h) IS-817 : Code of practice for training and testing of metal arc welders.

i) IS-818 : Code of practice for safety and health requirements in electric and gas welding and cutting operation.

j) IS-819 : Code of practice for Resistance spot welding for

light assemblies in Mild Steel.

k)	IS-919	:	Recommendations for limits and fits for Engineering.
l)	IS-1024	:	Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.
m)	IS-1161	:	Steel tubes for structural purposes.
n)	IS-1182	:	Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.
o)	IS-1239	:	Mild steel tubes, tubulars and other wrought steel fittings (all parts).
p)	IS-1363	:	Black hexagonal bolts, nuts and locknuts (dia. 6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
q)	IS-1364	:	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
r)	IS-1365	:	Slotted countersunk flat head screws (Common head style) -Product Grade A
s)	IS-1367	:	Technical supply conditions for threaded steel fasteners.
t)	IS-1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
u)	IS-1608	:	Method for tensile testing of steel products.
v)	IS-1730	:	Steel plates, sheets, strips and flats for structural and general Engineering purposes - Dimensions
w)	IS-1731	:	Dimensions for steel flats for structural and general Engineering purposes.
x)	IS-1852	:	Rolling and cutting tolerances for hot rolled steel products.
y)	IS-2016	:	Plain Washers
z)	IS-2062	:	Hot rolled medium and high tensile structural Steel - Specification
aa)	IS-2074	:	Ready mixed paint, air drying, red oxide

zinc-chrome, priming.

bb)	IS-2633	:	Methods of testing uniformity of coating of zinc coated articles.
cc)	IS-3613	:	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
dd)	IS-3664	:	Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
ee)	IS-3757	:	High strength structural bolts.
ff)	IS-4000	:	High strength bolts in steel structures.
gg)	IS-4759	:	Hot dip zinc coatings on structural steel and other allied products.
hh)	IS-5334	:	Code of practice for Magnetic Particle Flaw detection of welds.
ii)	IS-7215	:	Tolerances for fabrication of steel structures.
jj)	IS-7280	:	Bare wire electrodes for submerged arc welding of structural steels.
kk)	IS-7318 [Part-I]	:	Approval test for welders when welding procedure approval is not required.
ll)	IS-8500	:	Structural steel – micro-alloyed (medium and high strength qualities).
mm)	IS-9595	:	Recommendation for metal arc welding of carbon and carbon manganese steels.
nn)	AWS D.1.1	:	Structural Welding Code.

2.01.15 **Painting**

a)	IS-348	:	Specification for French Polish.
b)	IS-427	:	Specification for Distemper, dry colour as required.
c)	IS-428	:	Specification for Distemper, oil emulsion, colour as required.
d)	IS-1477 [I & II]	:	Code of practice for painting of ferrous metal in buildings.
e)	IS-2338 [I & II]	:	Code of practice for finishing of wood and wood based materials.

f) IS-2339 : Specification for Aluminum Paints for general purposes in dual containers.

g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.

h) IS-2932 : Specification for enamel, synthetic, exterior - a) undercoating, b) finishing.

i) IS-2933 : Specification for enamel, exterior - a) undercoating, b) finishing.

j) IS-5410 : Specification for cement paint.

2.01.16 a) Indian Road Congress (IRC) Bridge Codes

b) Indian Railway Standard Bridge Rules

2.01.17 **Environmental Protection**

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

3.00.00 SCOPE OF CIVIL WORKS

The scope of civil work comprises all necessary investigations, survey, Complete Design, engineering and construction of foundations, building, superstructures and infrastructure required for the complete operating FGD package.

The work under this Section consists of all Civil & Structural and Architectural works but not limited to items mentioned below.

- Micro grading, leveling & dressing (finished grade levels shall be as mentioned elsewhere in this Section)
- Geo-Technical investigation
- ~~Demolition of existing structures / facilities, if any, and site clearance (The bidder may visit the site to access before quoting)~~ Demolition of existing structures / facilities **including one workshop building and RCC drains and other structures,** if any, and site clearance(The bidder may visit the site to access before quoting) (As the work is to be carried out inside the existing plant)
- Complete Design, engineering and construction
- ~~Piling work, if required based on the soil investigation report.~~ Piling work, based on the soil investigation report. (As per the existing plant soil condition no option is permitted.)
- Plant Roads and RCC Box Culverts within the Battery limit of FGD Package of this specification and as shown in the Plot Plan.
- Boundary walls/Fencing in buildings, if required from statutory point of view

TBG SCOPE:
- In order to accommodate the FGD Transformer in the existing 220KV Switchyard, the following civil works are included in the scope of the Successful bidder :-
1. Laying of Rail road from the maintenance bay up to the FGD Transformer location as per Electrical GA and all other miscellaneous associated works thereof. Any damage to the existing RCC paving and storm water drains Fire pipeline pedestals over trenches and jacking pads, anchor blocks etc., in the Transformer yard shall be made good to suit the old arrangements.
2. The scope of works also includes FGD Transformer foundation, Fire protection trenches/pedestals as the case may be and all other works such as RCC paving all around the FGD Transformer, fencing as per Electrical GA requirements providing storm water drain and connecting it to the nearest existing storm water system , jacking pads etc.,
3. Any left out civil works not specifically mentioned and above but are required to complete the Electrical /Civil requirement as per owner's interpretation is Final and deemed to be included in the scope of work.
4. Burnt oil pit from the new FGD Transformer shall be connected to the existing common pit located inside the existing NTPL 220KV Switchyard by the Successful bidder.

- Storm water Drainage network within the battery limit of the FGD package area and connecting the same to the plant storm water drainage system of Main plant drainage system.

- Water supply, drainage and sewerage works within FGD package.

- All the roads and drains in this FGD package shall be connected to the main plant roads and drains.

Major building and facilities

All Civil & Structural works for the following buildings/structures to be completed:

- Absorber pump house and oxidation blower house
- FGD control Building
- Limestone Slurry Preparation building
- Limestone storage shed
- Crusher house annex to Lime stone slurry preparation Building
- Gypsum Dewatering Building with Elevator
- Gypsum storage shed
- Waste Water Treatment Plant Building for FGD
- All pipe and cable racks and related supporting structures including foundations, pipe & cable trenches, duct bank etc., as applicable
- Sewerage system
- Conveyor gallery, trestle as necessary to provide to meet the functional requirements
- Foundations of all technological structures and equipment
- Approach roads to all the buildings, structures, facilities for this FGD package shall be provided by the successful bidder.
- All RCC road works with RCC storm water drains and provision of RCC box culvert at interconnecting locations of other plant roads, RCC pavement within the battery limit & construction of manholes & sewer lines including RCC manholes within the battery limit and connecting the same to the nearest plant main sewerage system.
- All plant main roads within FGD battery limit shall be connected to owner's plant main road by providing RCC box culvert at the intersection point. Wherever FGD road meets the plant main road, RCC

box culvert shall be provided by FGD package bidder. All the storm water drains inside the battery limit shall be RCC.

- All plumbing and water supply fittings & fixtures, rainwater drainage of plants of any building / premises / open area in the scope of this package. All the sewerage shall be collected from FGD battery limit and the same shall be interconnected to the Main Plant Sewer System as per requirement. All the buildings will be provided with rain water harvesting arrangement locally and charged to the ground. Scheme for the rain water harvesting as mentioned above shall be submitted by the successful bidder for approval by the Owner/consultant.
- ~~Crusher foundation arrangement shall be as per OEM proven practice.~~

Crusher foundation arrangement shall be on VIS and in separate foundation isolated from the building. (As per the proven practice followed in other NLCIL projects.)

- Civil scope of works shall cover design, supply, fabrication, galvanizing, erection of galvanized structural steel work for 220KV GIS, intermediate gantry at SWYD, LA, Post Insulator etc. The scope of work covered under this specification is as follows:

  - Towers
  - Beams
  - Equipment Supporting Structure (Pipe, Lattice Type Supports) & Lighting Towers etc.
  - Miscellaneous items like all types of Bolts, Nuts, Hangers, Shackles, Clamps, Anti-Climbing Devices, Bird Guard, Step-Bolts/Ladder, Number Plates, Insert Plates etc.

The work shall involve complete design, supply, fabrication, galvanizing, erection of galvanized rolled sections and pipes, as well as sections fabricated out of plates in base plates, cleats, erection bolts and nuts etc. involving cutting, fabrication, welding, bolting, shop painting, galvanizing etc. The bidder will be completely responsible for safety of structures from design, fabrication and erection aspects.

Design will be done as per IS: 802 for transformer yard / switchyard Structure.

4.00.00 REQUIREMENTS FOR STRUCTURES & OTHER COMPONENTS

4.01.00 Pipe/Cable Trestles and Foundations

All cables & pipes in outdoor area shall run above ground over steel trestles or other supporting structures wherever erection of trestles are not possible for easy inspection & maintenance within battery limit of FGD package. All the pipe/cable racks falling in the battery limit of FGD package shall be suitably connected to the pipe/cable racks of other packages as per the piping / electrical requirements. In some localized area, Pipe/Cable can run in R.C.C. trenches. In case over ground routing is not feasible due to site constraints, the pipe/cable to be routed through duct-banks, subject to the approval of the Owner.

A minimum clearance (clear head room) of 8.0m shall be kept for all over ground pipe/cable trestles for all road/rail crossings. In other areas the clear height shall be 4.0m (minimum) from finished grade level. All trestles shall be provided with continuous walkway of minimum 750mm width with handrail and toe-guards all along the length of the trestle along with approach ladders near roads, passageways etc. Walkway shall be provided with chequered plate of 8mm thick. The racks can be multi-tiered. Cable shall normally be laid above the pipes. Pipe racks for all connections from the existing station, existing pipe racks is to be used with necessary modification (or) new rack is to be erected. For actual width of the pipe rack, no. of pipes/cables etc. will be as per Mechanical drawings.

Before and after the rail/road crossing, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8.0m) etc. up to the pipe/cable rack trestles.

Trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals. Four legged trestles are to be provided mainly at intercepting location of branch pipe rack (maximum distance shall be 100m) Crossover, operating platform & necessary trussed resisting arrangement at pipe bend shall be provided as required. Necessary expansion joints in the structure shall be provided as per IS: 800 (Latest Revision). The trestles shall generally be provided using rolled sections only.

4.02.00 Miscellaneous Plant Buildings

The following plant buildings are generally required for operation

- Absorber pump house and oxidation blower house
- FGD control Building
- Limestone Slurry Preparation building

- Limestone storage shed
- Crusher house annex to Lime stone slurry preparation Building
- Gypsum Dewatering Building with Elevator
- Gypsum storage shed
- Waste Water Treatment Plant Building for FGD

All Buildings / Structures to be constructed as per the process / functional requirements. Different functional requirements like Mechanical, Electrical, C&I, HVAC etc. (which have been mentioned elsewhere in the specification in respective Mechanical / Electrical / HVAC / C&I volumes) to be fulfilled while designing the building / facilities sizes and other details. All Codal stipulations should be maintained.

Architectural requirements shall be as per Sec-IV.

Other buildings / facilities not specifically mentioned above or in Vol: II-G/1, Section-IV, but required for the operation of the plant shall be constructed by the bidder.

The FGD package bidder may add extra facilities/buildings as may be required for operation of plant subject to prior approval of Owner/Consultant.

Above list of Buildings is not exhaustive. Buildings necessary for the smooth operation of the FGD process shall be within this scope of work.

4.03.00 **Design of infrastructural facilities**

4.03.01 ~~4.04.01~~ **Roads**

The sub base over the well compacted subgrade of all plant service roads within the battery limit of FGD package will initially be made of well graded granular material like locally available crushed stone (63mm downgraded) with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement. (As the code is not relevant to this)

All roads under this package are RCC roads.

~~The sub base over the well compacted subgrade of all plant service roads within the battery limit of FGD package will initially be made of well graded granular material like locally available crushed stone or laterite (63mm downgraded) as per IRC 63 with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement.~~

All roads around the plant to FOPHS, boiler area and where there is heavy vehicle movement shall also be of RC concrete roads with hard RC shoulder.

All main plant (RCC) roads within battery limit of FGD package shall have rectangular RCC side drain along both sides.

All RCC Roads and parking area shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice and MOST

specification (MORT&H) for movement of heavy equipment.

The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design shall be laid over a laterite or crushed stone sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.

All the roads within the battery limit of FGD Package shall be under the scope of the bidder including formation of sub-grade, sub-base and laying of RCC.

All the roads in the plant area within the battery limits of FGD package and connecting the same with the plant main roads will be executed by successful bidder. All roads included in FGD Package as shown in Plot Plan shall be constructed by the successful bidder as per the basic design and layout.

The additional roads and access to individual buildings/structures/facilities within scope of this specification which are not specifically shown in layout but required from functional requirement shall be considered by the Bidder.

Minimum RCC carriageway and shoulder width shall be as listed below. Shoulders width shall be added to the carriageway widths to obtain minimum roadway widths.

This table is considered as deleted.
(As the roads are to be matched with the existing plant roads)

~~Road Type~~	~~Classification~~	~~Carriageway Width (m)~~	~~Shoulder (m)~~	~~Roadway Width (m)~~
~~1.~~	~~Primary Road with Access of crane~~	~~10.0~~	~~1.5~~	~~13.0~~
~~2.~~	~~Primary Road without access of crane (internal double lane Road)~~	~~7.5~~	~~1.5~~	~~10.5~~
~~3.~~	~~Primary Road without access of crane (internal single lane Road)~~	~~4.0~~	~~1.2~~	~~6.4~~

Finished top (crest) of roads shall be 250 mm above the surrounding grad

~~Access within the plant site as well as to building / structures shall be provided as a system of roadwork. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.~~

Access within the plant site as well as to building / structures shall be provided as a system of roadwork. **Width and** Finished top (crest) of roads shall **match with the existing/connecting roads. Shoulder and drains shall also match with the existing ones. (**As the roads are to be matched with the existing plant roads)

4.03.02 **Surface Treatment**

The **entire** FGD area **within the FGD package battery limits shall** be paved with reinforced cement concrete with 200 mm thickness minimum and sloped to drains.

~~The FGD area will be paved with reinforced cement concrete with 200 mm thickness minimum and sloped to drains.~~

The RCC paving shall be M-35 except road portions with double layer of reinforcement min 10 mm tor 250 c/c bothways (top & bottom) over 75mm thick lean PCC M10 on 230 mm thick compacted rubble stone /laterite soling interstices filled with sand/gravel. ~~Finished paving level shall be 300mm above FGL.~~ All reference shall be taken from plant 0.00 only. Elevation of all structures and buildings shall be measured with reference to the plant 0.00 only.

Finished paving level shall **match with the existing adjacent pavement**. (As the work is to be carried out within the existing plant)

Maintenance access roads of minimum 7.5m wide shall be provided to all major

equipment. Roadways shall be clearly identified with kerbs and painting. All drain / trench covers in these areas shall be designed to withstand truck loading of class IRC.

The drainage of the entire FGD area shall be properly planned. Network of RCC drains with RCC cover with slotted holes / Galvanized MS grills shall be provided covering the entire area which leads the storm as well as process leakage water to the peripheral drains, which in turn will lead to plant network of plant RCC storm water drain system. All structural steel columns in the area shall be provided with encasing to a height of minimum 200 mm above paving level and in addition the bases also need encasing if base plates are below paving level.

4.03.03 **Micro Area Grading**

This is an existing site. However, as per the present condition, necessary micro leveling, grading and dressing is to be done by the successful Bidder as required.

Final Site leveling and micro-grading for the plant area in FGD package shall be within scope of this contract. Work shall have to be carried out as per grading layout plan approved by the Owner / Owner's Engineer. All existing drains/channels in the plant and other areas associated with the plant shall be suitably diverted before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding in adjoining areas.

4.03.04 **Storm water & Drainage System**

RCC rectangular Drains shall be designed as a network covering the plant area within the battery limit of FGD package. All the storm water collected inside the FGD battery limit shall be connected to the plant main storm water network is in the scope of FGD package.

All the sewerage shall be collected from FGD battery limit and the same shall be interconnected to the Main plant Sewer System at the first RCC man hole of sewerage conveying.

Attempts will be made to convert construction drains into main drain as far as practicable.

All the drains including the Plinth protection drains will be of RCC within the battery limit of FGD package. All the buildings shall have plinth protection of 1000 mm wide towards the peripheral drains.

Auxiliary/Branch drains shall cover individual grades to terrains; collect storm water and other non-contaminated discharge from plant buildings and then to be connected to Main plant storm water drainage system.

The invert of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the drain under all condition. RCC box culverts will carry drainage under intercepting roads and railway tracks. Suitably designed underground storm water RCC box culverts on the basis of design loads

specified elsewhere in this specification shall be limited to required areas where surface drainage ways are not desirable or practicable from other functional point of view. The drains shall generally be of open type RCC rectangular construction. R.C.C. drains shall be covered with perforated R.C.C. pre-cast slab of minimum 50mm thickness with provision of openable galvanized steel grating covers at every 4.0 m intervals. Similarly, all drains along the periphery of buildings shall also have perforated R.C.C. pre-cast slab of minimum 50 mm thickness with provision of openable galvanized steel grating covers at every 4.0 m intervals. Design of such drain covers shall be done considering loading as specified elsewhere. In areas where vehicular loads would come, pre-cast RCC covers/box culverts of suitable thickness without perforations and designed for the vehicular loads shall be provided.

The drainage system shall be designed for precipitation intensity of 100 mm per hour (maximum hourly intensity of rainfall). Run-off coefficient for open ground area (unpaved) shall be minimum 0.90 and for paved area and other covered surface including roads the same shall be considered as 1.0.

Surface drains will normally have a slope of 1 IN 1000 along longitudinal direction and RCC pipes to have such slopes such as to have effective discharge. RCC structures will be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box culverts. Minimum self-cleansing velocity should be adopted as 0.7m/sec but the velocity of flow should not be more than 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec.

4.04.05 **Waste water Drainage system**

The FGD service water waste shall be collected and conveyed to waste water treatment plant which is also in the scope of the bidder.

4.04.06 **Construction Facilities for early works**

The Bidder shall develop and construct all necessary facilities like Batching plant, Construction store, Fabrication yard and Raw material storage area and Canteen for site personnel at no extra cost to the Owner. The associated roads and drains connecting these facilities shall also be constructed by the Bidder. The Bidder shall visit the site and locate suitable areas for these facilities.

5.00.00 DOCUMENT SUBMISSION

Design and Construction documents pertaining to all Civil, Structural and Architectural works that will be required to be submitted to Owner for their approval have been brought out under following clauses. Approval of these documents by the Owner/Consultant shall not relieve the successful bidder of his responsibility for any errors and fulfillment of Contract requirements.

5.01.00 **Design Document**

As it is not relevant to civil design document.

Design Document shall comprise ~~Mechanical/Electrical assignment Drawings~~,

design data, design assumptions & references, detailed structural analysis (including computer output, if any) & design calculations and design drawings.

Design calculations and drawings shall be submitted and reviewed only after approval of corresponding Mechanical/Electrical/System general arrangement drawings. The Bidder shall submit approved GA drawings along with design documents, design drawings for comments/approval of the Owner/Consultants. On final approval of the drawing and design, Bidder shall submit the drawing with soft copy in CD each to the Owner and consultant for distribution. For number of design documents, design drawings & GA drawing to be submitted, bidder shall refer to section VI of Vol.-IIA.

5.02.00 **Construction Document**

Based on approved design drawing, detailed drawings for construction will be prepared by the successful bidder. For reinforced concrete structures and foundations detailed bar bending schedules with approximate quantity involved (both reinforcement and concrete in grade-wise) in approved format shall accompany each detailed drawing. For structural steel work the detailed drawing shall have schedule of structural members with approximate quantity of steel involved. The successful bidder will prepare detailed fabrication drawing along with bill of materials.

All detailed drawings/ fabrication drawings as decided by Engineer for all structures along with bar bending schedule/bill of materials need be furnished to Owner/Consultants for their review and approval.

Upon approval, each drawing along with soft copy in CD shall be submitted to the Owner and Consultant for their distribution. Procedures for submission and approval of Construction Documents other than stated above have been mentioned elsewhere in this specification. For number of construction drawings/Fabrication drawings to be submitted, bidder shall refer to section VI of Vol.-IIA.

5.03.00 **As Built Drawings**

"As-built" drawings shall be prepared by the Bidder after completion of construction / erection incorporating all the changes, if any, done on Engineer's instruction/approval. In case of any discrepancy in the number of prints and CD to be submitted for Design, Construction documents and As-Built drawings mentioned elsewhere in the specification, stipulations made here shall prevail.

6.00.00 LAYOUT

Before starting the work, the successful bidder shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and benchmark. If the successful bidder uses the grid, benchmark and reference pillar made by other Bidders, he shall coordinate with the Bidder and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one

existing grid and benchmark, which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification / modification necessary. No complaint shall be entertained at a later stage. The successful bidder shall accurately set out the position for holding down bolts and inserts.

If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and benchmarks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The successful bidder shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderers shall take into account the cost of these in quoting their price.

7.00.00 WORKSMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those, which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge lining and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. . Necessary inserts/embedment's in buildings/structures shall be provided as per the technological requirements In addition to the requirement specified above, if the bye- laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the successful bidder shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the successful bidder shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the successful bidder at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such temporary work shall have the prior approval of the Engineer, but the successful bidder shall be responsible for proper strength and safety of the same. All temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re-erection, if required, shall be carried out by the successful bidder at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the successful bidder.

9.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other package bidder's scope. Necessary changes on this account will be made without any extra cost to Owner.

10.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the successful bidder. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The successful bidder shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all-important items of work.

ANNEXURE-I

LIST OF CIVIL FIELD QUALITY ASSURANCE LABORATORY APPARATUS (MINM REQMNNT)

SL NO.	DESCRIPTION	QTY
1	Cube moulds - 150 mm (ISI marked)	144
2	Cube moulds - 70.6 mm	18
3	Cube moulds - 50 mm	9
4	Cylindrical moulds - 300 long 150 dia	18
5	Beam mould – 700X150X150	18
6	Cube testing machine with two dial gauge and brick plate attachment	1
7	Digital thermometer - 200°C	6
8	Electrical oven	1
9	IS sieve set – 75 µ, 150 µ, 300 µ, 600 µ, 1.18 mm, 2.36 mm, 4.75 mm, 6.3 mm, 10 mm, 12.5 mm, 16 mm, 20 mm, 22.4 mm, 25 mm, 31.5 mm, 40 mm, 50 mm, 53 mm, 63 mm, 80 mm, 90 mm, 120 mm, 125 mm, pan (24 nos. / set)	1 Set
10	Measuring cylinder (glass) 50 ml, 200 ml, 500 ml	2 each
11	Physical balance Digital 10 kg capacity L.C. – 1 gm	1
12	Platform balance – Digital: 200 kg capacity	1
13	Pycnometer	2
14	Slump cone with tamping rod	8
15	Specific gravity bottle – 50 ml	2
16	Air entrainment meter capacity – 0.005 cum	2
17	Casegrande apparatus	1
18	Core cutter with collar and rammer	16
19	English type trowel	12
20	Hygrometer with thermometer	1
21	Impact testing machine	1
22	Le-Chatelier apparatus with water bath	1
23	Measuring cylinder (plastic) 50 ml, 100 ml, 200 ml, 500 ml	1
24	Modified Proctor test apparatus	1
25	Length gauge	1
26	Penetrometer for mortar test	1
27	Moisture meter	1
28	pH meter	1
29	Sand replacement method apparatus	2
30	Screw gauge	2
31	Spatula	8
32	Standard Proctor test apparatus	1
33	Standard sand grade 1, 2, 3	500 kg each
34	Stop watch - Digital	1
35	Thermometer ordinary 50°C	10
36	Thickness gauge apparatus	1
37	Vernier calipers - Digital	1
38	Vicat apparatus	2
39	Weigh Boxes	4
40	Cylindrical measures: - capacity 0.01 cum, Dia (I) – 250 mm, Height – 280 mm, (I) with tamping rod as per IS 1199.	1

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SECTION - II

SPECIFIC DESIGN REQUIREMENTS [CIVIL]

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SECTION-II

SPECIFIC DESIGN REQUIREMENTS [CIVIL]

1.00.00 INTRODUCTION

This section outlines the followings:

a) A brief description of Soil Characteristics.

b) Design considerations for Reinforced Concrete Structures.

c) Design considerations for Foundations.

d) Roads.

2.00.00 GEO-TECHNICAL SYSTEM

Detail soil investigation, as required, to be carried out for foundation design of various facilities.

Soil characteristics and parameters to be adopted in final design, the successful bidder is required to do detail geotechnical investigation work as part of the contract to verify/generate data so required.

It should be noted that nothing extra whatsoever on account of variation between soil data annexed in this specification and that found by detailed geotechnical investigation to be carried out by bidder shall be payable.

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456 (Latest) and on the basis of the soil investigation Report done by the Bidder. The type, size, depth of the foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.

3.00.00 LOADS

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements.

Any structure, which carries Indian Railway Loading or is situated in vicinity of Railway lines. The design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including

the clearance etc.

All structures shall be designed to sustain within the stress limitation as specified in the Code, all dead loads plus assigned live, equipment, wind, seismic or other design loads.

a) Dead Loads

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, Ash storage bins shall be measured at full capacity for this purpose. Hung loads and the contents of tanks and bins shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.

Materials		**Unit weight**
Plain cement concrete	:	24.0 kN /cum
Reinforced cement concrete	:	25.0 kN /cum
Structural steel	:	78.5 kN /cum
Brick work	:	19.0 kN /cum
Cement plaster	:	21.0 kN /cum
Floor Finish	:	24.0 kN /cum
Coal	:	12.0 kN /cum
Fly Ash	:	16.0 kN /cum
Bottom Ash	:	16.0 kN /cum

b) Live Loads

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part 2).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary.

Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

i) **General**

a)	Roofs :		
	Inaccessible roof (Flat)	:	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
	Accessible roof where equipments are placed	:	5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
	Accessible roof Without equipments	:	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
	Inclined roof	:	As per IS: 875 (Part 2)
b)	Stairs & Platforms	:	5.0 kN/Sq.m
c)	Corridors	:	5.0 kN/Sq.m
d)	Removable gratings, chequered plates, walkways etc.	:	5.0 kN/Sq.m
e)	Office, Laboratory, Conference rooms and other non-plant areas etc.	:	5.0 kN/Sq.m

ii) Plant Buildings

a)	Ground Floor	:	10 kN/Sq.m
b)	Cable Spreader Floor	:	7.5 kN/Sq.m
c)	Pump House Operating Floor	:	15 kN/Sq.m / As supplied by Pump manufacturer, whichever is higher
d)	Office Floor	:	5 kN/Sq.m
e)	Switchgear room	:	15 kN/Sq.m
f)	All other Floors	:	10 kN/Sq.m

iii) **Underground Structures/Trenches/pits**

Minimum surcharge shall be 20 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement surcharge shall be considered as applicable as per loading specified elsewhere in this specification. Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 15 kN/Sq.m whichever is greater.

iv) **Covers for Trenches / Channels**

~~Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall be considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards~~

Self-weight of top slab and a uniformly distributed load of **100 kN/Sqm** on each panel or one **100 kN** central point load, whichever is critical, shall be considered. At road crossings **and entrance of the buildings wherever vehicle/crane movement expected,** the covers shall be designed for vehicular movements as per IRC standards
(As per the design requirement.)

v) **Roads**

Design of roads shall be in accordance with Indian Road Congress standard IRC 15 & IRC-58.

vi) **Road Culverts and its allied structures including Road Crossing of Trenches.**

At all road crossings RCC box culverts along with manholes on both sides shall be used. Such road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class `AA' loading (wheeled and tracked both) and to be checked for Class `A' loading as per IRC standards.

vii) **Railway Supporting Structures, Rail Culverts**

Railway supporting structures and rail culverts shall be designed as per Railway Bridge Rules.

Reduction in Live load as per provision of IS: 875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to a uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater.
Foundations and fixing arrangements for items of equipment, which generates vibration, shall be designed to prevent transfer of such vibrations to the adjoining structures.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor, from floors below.

c) Equipment Loads

i) Loadings (both static and dynamic) of equipment obtained from the manufacturer's certified drawings of the specified equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings shall be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings shall include Hydraulic Testing loads.

iii) Air and gas duct loadings shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads.

Unless otherwise specified, the vertical and horizontal loadings shall conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which shall or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.

d) Wind Loading

Wind loading shall be in accordance with Indian Standard Code IS:875 (Part 3) (Latest Revision) for a basic wind speed of 39 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k1) shall be considered as 1.06 for all structures.

Notwithstanding the design wind forces calculated based on above parameters, the structures shall not be designed with a wind pressure less than 1.5 KN/sqm K4 factor shall be taken as 1.3 as per IS 875,part-3: 2015.

e) Seismic Loading

The lateral forces shall be established in accordance with the recommendations of IS: 1893 (Latest Revision). The site falls in Zone-II as identified in the map in IS: 1893 and hence seismic forces would be considered accordingly for the structures and buildings. Importance factor shall be taken as per latest versions of IS: 1893 parts.

f) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose shall be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Minimum ambient temperature = 20.8°C

Maximum ambient temperature = 36.5°C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

g) Steam Piping Load

Minimum intensity of steam piping load shall be 6.0 kN/Sqm for the areas at different levels through which steam piping is routed. However, the loading shall be checked as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any, shall also have to be considered in design.

h) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

However, for the design of sub-structure of pump house and underground liquid storage tanks earth pressure at rest shall be considered with coefficient of earth pressure at rest shall not be less than 0.50.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be considered as 2.0 t/sq.m in general unless mentioned otherwise.

i) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vendor's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter. For frame analysis, the lateral crane surge shall be applied on one side of the frame at a time and in either direction.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875/IS:807 (Latest Revision). The minimum impact factor to be used in design shall be as follows:

Crane loads

a) For vertical force, an impact factor of 25% of the maximum crane wheel load for crane girder 10% for column and foundation.

b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail.

c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.

Monorail loads

a) Impact factor of 10% of lifted load of hoist for monorail and support design

b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

j) Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing as far as possible.

However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

k) Other Loads

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

l) Thrust Load

Thrust blocks shall be designed against the thrust load from pipe lines considering the test pressure in the pipe lines and as per the relevant IS Code with adequate factor of safety.

3.01.00 **Stability of Structures**

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.20 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.

b) Factor of safety against sliding shall be 1.5 minimum.

c) Factor of safety against uplift due to hydrostatic forces shall be 1.20 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered at Plant Finished Grade Level for design of foundations and all underground structures.

3.02.00 **Load Combinations**

Buildings and structures shall be designed to resist the load stated in the previous section acting in the following combinations.

While designing consideration shall be given to the following load combinations:

i) DL + LL

ii) DL + LL + PL + Equip ± TL

iii) DL + LL + PL + Equip + Cb + CtLA± CS ± TL

iv) DL + LL + PL + Equip + Cb + CtLB± CS ± TL

v) 0.9DL ± EL (for DL only) ± TL

vi) 0.9DL ± WL1 ± TL

vii) 0.9DL ± WL2 ± TL

viii) DL + *LL + PL + Equip + Cb + Ct ± EL ± TL
(* Appropriate portion of LL which is considered for working out EL shall only be taken)

ix) DL + LL + PL + Equip + Cb + CtL1 ± (CS1+WL1) ± TL

x) DL + LL + PL + Equip + Cb + CtL1 ± (CS1+WL2) ± TL

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe Load

Equip = Equipment loads

Cb = CraneBridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction

WL2 = Wind load with internal pressure

EL = Earthquake load

TL = Temperature load

Appropriate impact factor shall be considered as per IS:875 (Part 2) (Latest Revision) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS:875 (Part 3) (Latest Revision). All possible load conditions considering external and internal pressures shall be considered in analysis and design for the combinations as stated above to assess worst effect on whole structure as well as its components.

Seismic Load shall be considered in all three directions for analysis and design of Structures.

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in permissible stresses shall be permitted.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under-ground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the

structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 (Latest Revision) against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

3.03.00 Design Concepts

Wind and seismic forces shall not be considered to act simultaneously.

`Lifted Load' of crane shall not be considered during seismic condition.

For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level.

If R.C.C. floors and roofs except those cast over metal decking are assumed to act as diaphragm transmitting lateral loads to braced bays then main beams/girders shall be provided with shear connectors. However, whenever large/more number of cutouts is provided in the floor slab, horizontal floor bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab. Shear connectors shall also be provided over beams having R.C.C. slab on one side and opening /chequered plate / grating on other side.

For R.C.C. roofs cast over metal decking, horizontal bracings must be provided below slab to transfer horizontal force to columns.

PTFE (Poly tetra Fluoro ethylene) bearing shall be provided where horizontal loads not to be transferred.

For calculation of seismic load, equipment load shall be considered as Dead Load.

Ultrasonic pulse velocity tests shall be carried out for the top decks of all machine foundations as applicable to ascertain the homogeneity & integrity of concrete.

Whenever any structure under this contract shall carry or receive additional load from the work of any other contract, the structures under this contract shall be provided with sufficient margin to carry the above load, details of which shall be finalized during detail engineering.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

4.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES BY BIDDER

a) Reinforced Concrete Structures shall be designed in accordance with the requirements of IS-456 (Latest Revision) & IS-875 (Latest Revision) or as specified in this specification for all possible combination of loads, e.g. dead load, live load, crane loads, wind or seismic loads, soil loads and surcharge loads, etc. The grade of concrete for RCC shall be M-35 for all structures.

The following grades of concrete as per IS-456 shall generally be used.

Sl. No.	Class	Grade of conc.	Min. cement content Kg/Cum	Max. free water cement ratio
1.	i) Plain cement concrete used for screeds and fill between two foundations one above other at different levels	M15	240	0.6
	ii) Lean concrete below all foundations, plinth beams, drains, pits, etc.	M10	-	-
2.	i) Plinth protection.	M35	400	0.55
	ii) Paving, Grade slab, RCC drains and trenches	M35	400	0.55
3.	i) Reinforced concrete for super structure and foundation	M35	400	0.45
	ii) Reinforced concrete for water retaining structure	M35	400	0.45
	iii) RCC roads	M35	400	0.5
4.	Pre-cast concrete	M35	400	0.5
5.	Reinforced concrete for foundation, columns and beams of Crusher	M35	400	0.45
6.	Piles	M35	400	0.5

Reinforcing bars shall be TMT bars of minimum grade Fe 500(CRS) conforming to IS-1786 (Latest Revision) and Mild Steel bars conforming to IS: 432 (Grade I (Latest Revision) of vendor approved by Owner. (As it is corrosive environment.)

b) ~~Reinforcing bars shall be TMT bars of minimum grade Fe 500 conforming to IS 1786 (Latest Revision) and Mild Steel bars conforming to IS: 432 (Grade I) (Latest Revision) of vendor approved by Owner.~~

c) ~~Higher grade of Ordinary Portland cement namely Grade 43 conforming to~~

c) Higher grade of Ordinary Portland cement namely Grade 43 conforming to IS : 811 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner. However the Ordinary Portland cement (Grade 53) be used wherever necessary and directed by Owner **Minimum cement content for RCC for aggressive environment like Tuticorin shall not be less than 400 kg/m3 for M-35 and above grade. Ordinary Portland cement conforming to IS with C3A content from 5% to 8% shall be used for all substructures and structures in contact with soil and for other structures OPC shall be used.**
(As per the site soil condition requirement)

~~IS : 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner. However the Ordinary Portland cement (Grade 53) may be used wherever necessary and directed by Owner.~~

~~Grade of cement shall be OPC and for underground structures, it shall be minimum 5% 8% C3A content.~~

The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456 (Latest Revision).

e) Concrete tanks/water retaining structures shall be designed in accordance with the recommendation of IS-3370 (Latest Revision) as un-cracked section.

f) Grouting material:

Grouting shall be done with Conbextra GP-2 or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips. Grouting thickness shall be 50mm minimum.

g) For reinforcement detailing IS: 5525 (Latest Revision) and SP:34 shall be followed.

h) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

i) Liquid Retaining Structures

RCC water retaining structure shall be leak proof and designed as un-cracked section in accordance with IS:3370 (Latest Revision) by working stress method.

Substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS:3370 (Latest Revision) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as un-cracked section in accordance with IS: 3370 (Latest Revision) by working stress method.

All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement.

In all liquid retaining structures leak-tightness shall be ensured and guaranteed. To achieve the same, methodology in design and construction in the way of providing PVC water bars at construction/expansion joints and/or injection grouting, usage of admixture in concrete or any such method should be adopted.

All RCC water retaining/conveying system structures shall have plasticizer cum waterproofing cement additives conforming to IS:9103 (Latest Revision) of any make approved by Owner. In addition, limits on permeability as given in IS: 2545 (Latest Revision) shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 (Latest Revision) @ 1.7 kg/sqm (min.) for water/damp proofing. Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.

5.00.00 ~~**FOUNDATION DESIGN**~~ FOUNDATION DESIGN **(All foundations shall be on Piling only)** (As per the existing plant soil condition)

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456 (Latest Revision) and on the basis of the soil investigation Report done by the Bidder.

Foundation shall be checked for safety against overturning, sliding and uplift. High ground water level up to final graded ground level shall be considered to take into account buoyancy effect.

Pile foundation shall be designed in accordance with IS: 2911(Part-I / Sec-I, II and III) (Latest Revision).
(As only pile foundation is to be adopted due to the existing soil condition.)

~~Pile foundation, if adopted, shall be designed in accordance with IS: 2911(Part I / Sec I, II and III) (Latest Revision).~~

The type, size, depth of the foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.

5.01.00 **Foundations**

Top of RCC foundation for the steel columns shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. Foundation levels of some columns shall have to be suitably lowered to accommodate underground services, pits, trenches, etc.

Common foundation should be provided for columns both side of the expansion joint and shall be designed for loading on both columns.

Foundations for Buildings and structures shall be designed to resist forces and moments, caused by vertical loads and by wind or seismic loads, based on static and dynamic analysis done for those structures. The foundation sections shall be sized and reinforced adequately for moments and shear stresses.

5.02.00 **Heavy and rotating Equipment Foundations**

Loadings (both static and dynamic) of major equipment shall be obtained from the manufacturer's certified drawings of the specified equipment. Where design of structures supporting minor equipment other than those included above must

Crusher shall be supported on vibration isolation system consisting of steel helical spring units and viscous dampers which in turn will be supported on RCC foundation system. For booster fans the supports as per OEM Proven practice. (Based on the equipment sizing and vibration intensity and proven practice followed in NLCIL projects.)

proceed but the exact load data is not available, the loadings shall be estimated from similar jobs or catalog data. Lime-stone ~~Crusher may preferably be supported on vibration isolation system consisting of steel helical spring units and viscous dampers (as per OEM proven practice) which in turn will be supported on RCC foundation system.~~

For static and dynamic analysis of machine foundation following data shall be furnished by the equipment manufacturer.

a) Loading diagram showing static and dynamic loads and points of application of loads.

b) Operating speed of m/c; Critical speed of m/c.

c) Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.

d) Location of C.G. of machines in all three axes.

e) Mass Moment of Inertia.

f) Allowable amplitude/velocity of vibration at machine bearing points.

g) Temperatures in various areas during operation.

Design of foundations for major equipment shall be done in accordance with relevant parts of IS-2974 (Latest Revision). Unbalanced loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. While designing following aspects shall also be taken care of.

i) Crusher foundation shall be isolated from adjacent structures for vibration control.

ii) Natural frequencies of structures and components shall be away from the running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. However, frequency separation criteria and amplitude criteria as laid down in IS:2974 (Latest Revision) and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall also be satisfied. A fatigue factor of 2.0 shall be considered for dynamic forces / due to normal unbalance. For design of foundation of large fans etc. provision shall be kept in the foundation for addition of mass/area for retuning of the foundations, if required at a later date.

This para is to be deleted
(As only pile foundation is to be adopted due to the existing soil condition)

~~All block foundations resting on soil shall be designed using the elastic half space theory or Barkan's theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%.~~

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably.

In case of machines supported on VIS with springs and viscous dampers it shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096.

For all equipment foundations supported on VIS system, the stiffness of the supporting substructure shall be at least ten (10) times that of spring elements as per DIN 4024.

While performing dynamic analysis of fan foundation, effect of soil contributing to dynamic properties shall be considered.

Tension in piles shall not be allowed for any combination of loads.

Wherever VIS is provided for equipment inside the Power Plant – The Civil Design document / drawings for the RCC Top deck above the VIS supporting the equipment shall be vetted / designed by the VIS spring manufacturer and the same shall be submitted to NLC / Consultant by the successful bidder for approval during detailed engineering. However the overall responsibility for the structural safety, rigidity & soundness of the entire structure lies with the successful bidder.

5.03.00 ~~**Open Foundations**~~

Open Foundations(Only Pile foundation is permitted. However open foundations may be allowed for the foundations having SBC requirement upto 5t/sqm)
(As open foundations could not be used for heavy foundations due to the existing soil condition)

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

a) Minimum width of foundation shall be 1.0 m.

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

c) It shall be ensured that all foundations of a particular structure/ buildings/facility shall rest on one bearing stratum, i.e. either overburden or rock.

d) Wherever the intended bearing structure is weathered rock but the actual stratum encountered during foundation excavation consists of both overburden soil and weathered rock at founding level, under such cases either the foundation shall be lowered completely into the weathered rock or the overburden soil up to the weathered rock level shall be removed and built up through PCC up to designed foundation level.

e) The net allowable bearing pressure values to be adopted for design upon Owner's approval shall correspond to total permissible settlement as mentioned under para "permissible settlement of foundations" or the permissible settlement from functional requirement, whichever is more stringent.

f) Permissible settlement of foundations: The total permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 13063 and from functional requirements, whichever is more stringent. However, total settlement shall be restricted to the following :

i)	All facilities in Main Plant area, ducts, Equipment foundation	- 25 mm
ii)	All foundations in miscellaneous building including, isolated/strip continuous/ Raft foundation	- 40 mm
iii)	Other footings of width up to 6m	- 40 mm
iv)	Other footings of width greater than 6.0 m (raft)	- 75 mm
v)	Footings on 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 / reviewed accordingly in consultation with Owner.

The total permissible settlement and differential settlement of the foundations shall be governed by IS: 1904 (Latest Revision), IS: 13063 (Latest Revision) and from functional requirements whichever is more stringent.

Maximum allowable total settlement should be restricted to 25 mm for foundations of all Main Structures.

Maximum allowable total settlement should be restricted to 40 mm for all other foundations.

5.04.00 **Pile Foundations**

a) The pile foundation shall be of RCC, Cast-in-situ bored, pile as per IS: 2911 (Latest Revision). Bored piles shall be installed by using rotary hydraulic rig. **Wherever the hydraulic rig could not be accessed, Tripod mounted piling rigs shall be used after consultation with the Engineer-in-charge.** Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.

In case piles are adopted, following shall be adhered to:

a) ~~The pile foundation shall be of RCC, Cast in situ bored, precast/cast in situ driven pile as per IS: 2911 (Latest Revision). Bored piles shall be installed by using rotary hydraulic rig. Three stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.~~

b) ~~The minimum diameter of pile shall be 450mm for cast in situ and 300mm for precast piles. The uplift and lateral load capacity shall be~~

b)The minimum diameter of pile shall be 450mm for castin-situ . The uplift and lateral load capacity shall be established by field test.

~~established by field test.~~

c) Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.

d) The bidder 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 like (SPT &SCPT value, set criteria etc.), reinforcement for job as well as test piles, etc.) for Owner's approval.

e) The piling work shall be carried out in accordance with IS: 2911 (Relevant part) (Latest Revision) and accepted construction methodology. The construction methodology shall be submitted by the Bidder for Owner's approval.

f) ~~Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:~~

f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as stipulated in IS 2911(part 4) (As per the standard practice adopted to avoid the time delay)

~~Vertical~~
~~Lateral~~
~~Uplift~~ } ~~Minimum of 3 Nos. in each mode.~~

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

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

g) Routine pile load tests shall be performed for each diameter/allowable capacity of pile as per IS: 2911 (Part-4) (Latest Revision).
(As per the standard practice adopted to avoid the time delay)

~~i) Vertical 1.0 % of the total number of piles provided.~~
~~ii) Lateral 1.0 % of the total number of piles provided.~~

~~The routine tests on piles shall be conducted up to test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part 4) (Latest Revision).~~

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 Bidder shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required, without additional cost to the Owner.

h) Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4) (Latest Revision). Bidder shall ensure that all the measuring equipment and instruments are properly

calibrated at a reputed laboratory/ institute prior to their use. Additional measurement for pile movement shall also be done.

i) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test and not intended to replace the use of static load testing.

5.05.00 **Other Requirements**

i) In case of high ground water table, for excavations comprehensive dewatering arrangement shall be required. Scheme for dewatering and design with all computations and back-up data of dewatering and sheet pilling shall be submitted for Owner's information.

ii) The 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.

iii) Excavation for open foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil at founding level during excavation, the same shall be removed and compensated by PCC of Grade M10. The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.

iv) Backfilling, around foundations and bottom of pipes, thrust blocks, etc. shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.

Excess/surplus excavated material, **debris and other unusable materials as decided by owner** shall be disposed of by the Bidder as per the instructions of the Owner up to a lead of about **10 km**
(Correction made based on the site condition.)

~~v) Excess/surplus excavated material shall be disposed of by the Bidder as per the instructions of the Owner up to a lead of about 5 km.~~

vi) CBR tests for rigid / concrete pavement design shall be carried out by Bidder after earth filling has been completed, if applicable.

vii) The storage tanks shall rest on flexible tank pad resting on an open/shallow foundation or pile foundation. The tank pad shall be made of two layers. The first layer shall be thoroughly compacted fill of gravel, coarse sand or other suitable material topped with minimum 75mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (80 / 100 bitumen or equivalent 8 to 10% by volume), rolled and compacted. The second layer shall be with minimum 25 thick premix carpet with 12 mm and down broken stone chips and 80/100 grade hot bitumen. The tank pad shall be laid by an expert agency having wide experience in execution of similar works. The tank pad shall be made up from founding level to the required level by controlled compaction in layers of 200 mm to achieve a relative density of 85% using suitable compaction equipment approved by the Owner. In addition to the above, in case of an

open/shallow foundation, a ring wall shall be provided adjacent to the tank wall for retaining the fill below tank. The foundation system shall be designed as per the provisions of IS: 803. The tank shall have a flexible bottom plate, which shall establish complete bearing with the foundation fill.

After the tanks have been erected, hydro testing shall be done.

6.00.00 GENERAL REQUIREMENTS

6.01.00 Minimum Thickness of Structural Elements

The following minimum thickness shall be followed :

Pile caps	900 mm
~~Suspended floor / slab / walkways / canopy slabs, etc.~~	~~150 mm~~
Ground floor slab/Grade slab (non-suspended)	200 mm
Water Retaining slabs / walls	200 mm
Walls of Cable / pipe trenches / underground pits / Launder walls and base slab	150 mm
Drain walls and base slab	125mm
All footings (including raft foundations)	300 mm
Parapets	125 mm
Sunshades at edge	75 mm
Pre-cast louvers / fins	50 mm
Pre-cast trench cover slabs / floor slabs / louvers	100 mm
Paving	200 mm
Basement walls and base slab	250 mm
Silo / bin walls	200 mm
Underground reservoir	
Below ground (Walls and base)	250 mm
Above ground (Walls)	200 mm

Suspended floor / slab / walkways / canopy slabs, etc.**(thickness of roof slab and intermediate floors shall be measured excluding the depth of deck sheet trough)** 150 mm
(For clarity in design.)

The above are minimum requirement only unless otherwise mentioned

elsewhere in the specification.

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per Fig 1 or Table 16a of IS 456 (Latest Revision) or specified above, whichever is higher.

6.02.00 **Minimum Heights for Pedestals/Encasements of Steel Columns**

Pedestals to Steel Columns for building structures:

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following.

a)	Open area	:	300 mm above paved level
b)	Covered area	:	300 mm above FFL

Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

Pedestals to Steel Columns for Equipment structure:

a)	Equipment in open area	:	as required (300mm min)
b)	Equipment in covered area	:	as required (150 mm min)
c)	Structures and equipment supplied by vendor	:	as per vendor's data subject to minimum as specified above

6.03.00 **Ground floor slab-on-grade**

Ground floor slab-on-grade shall be minimum M-35 grade RCC construction laid over minimum 75mm thick lean concrete. Minimum consolidated 230mm thick graded stone or laterite (63mm down size) soling with interstices filled with sand/gravel and compacted mechanically, shall be provided as sub-base below lean concrete. The sub-base shall be laid over rammed and well-compacted earth fill or hydraulically compacted sand fill as specified elsewhere in this specification unless the thickness required from design consideration is more.

The ground floor slab shall be of minimum 200 mm thick with double layer reinforcement of 8mm (minimum) dia at the rate of 200 (maximum) c/c both ways.

6.04.00 **Stairs, Platforms, Handrails**

~~All internal stairs, platforms and walkways shall either be of RCC or Structural Steel with minimum 6mm thick chequered plate construction. All outdoor stairs, platforms and walkways shall either be of RCC or Structural Steel with minimum 40mm thick GI grating (40x6 mm flats).~~

All internal stairs, platforms and walkways shall either be of RCC or Structural Steel with **minimum 8mm thick chequered plate** construction. All outdoor stairs, platforms and walkways shall either be of RCC or Structural Steel with minimum 40mm thick GI grating (40x6 mm flats).

All handrails made of MS Galvanized hand railings with 40 mm NB (medium) main posts and 32 mm NB (medium) as horizontal rails as per IS:1161(Latest Revision) with toe guard of 150x6mm shall be provided.

7.00.00 ROADS

Geometric design of road shall be done in accordance with Indian Road Congress Standard. The ruling gradient for roads in longitudinal direction shall be 1 in 25. Normally roads shall have much flatter gradient. Transverse camber of 1 in 40 shall be provided.

A detailed CBR test, shall be carried out as per the procedure outlined in IS-2720 (Part-XVI)(Latest Revision). CBR test shall be carried out in remoulded soil samples under soaked condition.

All roads shall have hard shoulder on either side of carriageway. Shoulders shall have sufficient load bearing capacity to support loaded trucks. A flatter slope of 1 in 30 shall be provided on shoulders.

Slab culverts, or RCC box culverts, as suitable, shall be provided at road crossings for drainage, LP pipes, Ash pipes, cable trenches etc. Water line pipes at road crossings shall run through encasings. Level crossings shall be provided where a Railway siding line crosses the road. All culverts shall be designed for IRC class "AA" loading and checked for class A loading.

At all road crossings RCC box culverts along with manholes on both sides shall be used. Such road culverts and its allied structures including R.C.C. Road Crossing of Trenches shall be designed for Class `AA' loading (wheeled and tracked both) and to be checked for Class `A' loading as per IRC standards.

8.00.00 DRAINAGE

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 125 mm or as per design considerations whichever is higher. Drains shall have minimum 600mm base-width. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads.

Inside surface of the drain will have smooth neat cement finish over with screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec.

9.00.00 MISCELLANEOUS DESIGN / CONSTRUCTION CRITERIA

1) All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab. The grade beam shall be partially above FGL and partially below FGL. Minimum embedment of the grade beam below grade level shall be 300 mm.

2) The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.

3) For exposed areas, the columns shall have a minimum encasing of 300 mm above paved level.

4) Ramps for building entrance shall be cast in situ RCC slab and the slope of ramps shall not be more than 1 (vertical) to 8 (horizontal).

5) Minimum 75 mm thick lean concrete M-10 shall be provided below all underground structure, trenches etc., to provide a base for construction.

6) All buildings shall have RCC/steel framed super structure. All walls shall be non-load bearing infilled panel walls.

7) Duct banks consisting of PVC/GI conduits for cables shall be provided with reinforced concrete encasing of M35 grade. The minimum depth of top of duct bank from grade level shall be 500mm.

8) Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains supporting grating covers, edges of RCC cable/pipe trenches, manholes supporting covers, supporting edges of pre-cast covers and any other places where breakage of corners of concrete is expected.

9) ~~Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum M-35 grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers. The minimum drainage slope along line shall be 1 in 500.~~

Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum M35 grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers.
(Correction as the work is to be carried out within the existing plant)

10) All underground concrete structure such as basement, sumps water-retaining structure shall be designed for water tightness.

11) All underground concrete structure like basements, sumps, water retaining structure etc., shall have plasticizer cum water-proofing cement additive conforming to IS-9103 (Latest Revision). In addition limit on permeability as given in IS-2645 (Latest Revision) shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing. In case of water leakage in the above structures, injection method shall be applied for repairing the leakage.

12) All joints, including construction and expansion joints for the water retaining structure and others below subsoil water level shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 230mm.

13) All mild steel parts used in the water retaining structures shall have anticorrosive epoxy based paint or equivalent.

14) Anti-termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors, switchyard area etc., as per IS-6313 (Latest Revision) and other relevant standards.

15) Concrete hume pipes for underground service shall of class NP3 as per IS-458 (Latest Revision).

16) For all buildings suitable arrangements for draining out of water collected from equipments, blowdowns, leakages, floor washing, fire-fighting etc., shall be provided for each floor.

17) All walls and slabs shall have two layers of reinforcement for section having thickness 150 mm and above.

18) All gratings shall be made of 40x6 thick GI flat unless noted elsewhere in the specification. Stairs treads made of grating shall be provided with non-skid abrasive nosing.

19) Unless stated specifically elsewhere in this specification, the clear height of roof/beam from finished floor shall not be less than 4.5 M for plant building.

20) Unless stated elsewhere specifically in this specification, the finished floor level of any building shall be at least 500 MM above the finished grade level.

21) For RCC buildings of more than 15M span steel roof truss/girders will be provided to support the concrete roof on permanently colour coated (on exposed face) galvanized M.S. troughed metal decking over concrete columns. Gable and side cladding will be constructed with brick masonry.

22) Sealing of joints shall be done by two part polysulphide sealant and shall be from approved manufacturer conforming to IS: 12118 (Latest Revision). Material shall consist of polysulphide polymer and a curing agent. If any similar design criteria mentioned elsewhere in this specification contradict the above, the stringent of the criteria shall be adopted for design.

23) Specific corrosion resistant painting system with protective coatings shall be adopted as per CSIR – CERI recommendations for marine

26) All manholes and chambers for drainage and sewage system shall be of RCC with grade M35

environment with required material, proper application procedure and approved number of coating. Stipulations mentioned in ISO 12944 shall be followed.

ANNEXURE – I

VIBRATION ISOLATION SPRING FOUNDATIONS

1.0 General Requirement

Steel helical springs and viscous dampers shall be provided for equipments requiring foundations with vibration isolation system by the supplier with requisite experience and proven track record of similar installation in power plants of Unit capacity not less than 500 MW.

Complete Vibration Isolation System with Steel Helical Springs and Viscous Dampers may be provided for the foundations of Crusher foundations (if recommended) and any other vibrating/rotating equipment resting on intermediate floors.

2.0 Material (Design & Supply)

2.1 Steel helical springs and viscous dampers shall consist of

i) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

ii) Frames for pre-stressing of spring elements.

iii) Suitable hydraulic jack system including electric pumps, high-pressure tubes etc. required for the erection, alignment etc. of the spring units. One set of extra hydraulic jacks and hand operated pumps shall also be provided.

iv) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment and commissioning of the steel helical springs.

2.2. The objective of designing the supporting arrangement for any rotating equipment shall be so that the vibration level is maintained as minimum as possible under all operating conditions. Accordingly, respective rotating equipment shall be supported on RCC deck slab which in turn shall rest on vibration isolation unit consisting of steel helical springs and viscous dampers, which in turn shall be supported on RCC supporting structure. The above design shall form part of this specification.

2.3. The spring units shall have definite stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 30% of vertical stiffness. The stiffness shall be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 to 5 Hz.

2.4. The damper units or spring-cum-damper units shall be of viscous type offering velocity proportional damping. The damper units shall be suitable for temperatures ranging from 0 to 50˚C. The damping resistance of individual damper units shall be such that the designed damping is provided using reasonable number of units. Damper shall have damping resistance ranging from 40 kN sec/m to 750 kN sec/m.

2.5. The sizes of the spring units, damper units and spring-cum-damper units shall be such that groups of such units can be accommodated on column heads in case of elevated foundations and on pedestals/walls in case of foundations at ground level.

2.6. The steel helical springs and viscous dampers shall be designed for ensuring “fit and forget” guarantee.

3.0. Manufacturing & Testing

3.1. Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub-vendor/supplier. For this purpose, the successful bidder/sub vendor shall submit the detail program for approval of engineer and take up the manufacturing/testing after approval of such program. The program shall include :

i) Manufacturing schedule and quality check exercised during manufacturing.

ii) Detail of test to be carried out at the manufacturing shop with their schedule.

iii) Special requirements, if any, regarding concreting of top deck.

iv) Complete step-by-step procedure covering the installation and commissioning of the spring system.

v) Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.

vi) A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.

vii) Checklist for equipment required at each stage of erection.

viii) Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

ix) Bill of materials (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc. with their rating and numbers.

x) Any other details which may be necessary to facilitate design and construction of the foundations/structures.

3.2 The springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedures shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

4.0 Erection, Commissioning and Supervision

4.1 Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre stress in spring elements, making final adjustments and alignments etc. all shall be done a specialist supervisor of supplier/sub vendor trained for this purpose.

4.2 The scope of work shall be deemed to include all activities, which may not have been explicitly mentioned but are reasonably implied for the successful commissioning of steel helical springs and viscous dampers.

4.3. The successful bidder shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as “Guarantee Period”.

5.0. Realignment of Spring System

If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of Commercial Operation of the machine, the same shall be done by the successful bidder as and when asked for at no extra cost of the Owner.

6.0. Acceptance Criteria

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed :

i) General workmanship is being good and as recommended by the manufacturer are approved by the Engineer.

ii) Tolerances are within the specified limit

iii) Material test certificate (MTC) is in compliance with the applicable codes/standards.

iv) Bought out material is from the approved manufacturer/vendor

v) Bought out material is matching with the approved sample

7.0. Codes and Standards

Latest revision of following codes shall be used for the design of the spring supported foundations :

IS: 456	Code of practice for plain and reinforced concrete.
IS: 2974	Code of practice for design and construction of machine foundations.
IS: 1893	Criteria for earthquake resistant design of structures
DIN: 4024	Machine foundations; Flexible supporting structures for machine with rotating masses
DIN: 2089	Helical compression springs out of round wire and rod : calculation & design
DIN: 2096	Helical compression springs out of round wire and rod : quality requirements for hot formed compression springs.
VDI: 2056	Criteria for assessing mechanical vibrations of machine.
VDI: 2060	Criteria for assessing the state of balance of rotating rigid bodies.

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SECTION- III

SPECIFIC DESIGN REQUIREMENT [STRUCTURAL]

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SECTION-III

SPECIFIC DESIGN REQUIREMENT [STRUCTURAL]

1.00.00 STRUCTURAL STEEL DESIGN

a) Structural steel design shall be carried out as per the National Building Code with specific consultation to IS-800 (Latest Revision) unless noted otherwise. Cl 3.00.00/sec III/Vol-II G- 1/page 6 of 14 shall be followed.

b) Lateral forces along the length of the building shall be resisted by bracings in horizontal and vertical frames. The transverse lateral load shall be resisted by stiff jointed frame action. Additional bracing or moment connection shall be used to assure stability of the structures.

c) Structural steel will conform to Grade E350 / E250 of quality (A/BR/B0), semi killed / killed as per IS: 2062 (latest) for rolled steel members or plates. All structural steel plates and sections shall be procured from any make approved by Owner.

For Crane Girder Steel will confirm to Grade E350 / E250 of quality C (Killed).

d) Shop connections shall be all welded and field connections shall generally be bolted unless specified otherwise. Field bolts, wherever provided, shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 as per IS-1367 (Latest Revision) for all major connections. The bolted joints shall be designed for friction type connection and the H.T. bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams etc. shall be done by 16 mm dia. M.S. black bolts (minimum 4.6 grade) conforming to IS-1363 (Latest Revision) unless specified otherwise.

e) Welding shall be in accordance with the recommendations of IS-816 - Code of Practice (Latest Revision) for use of metal arc welding for general construction in mild steel and IS-9595 (Latest Revision) - Recommendation for Metal Arc Welding of Carbon and Carbon Manganese Steels. Built-up members shall be fabricated using submerged arc welding procedure unless manual arc welding is specifically required. All butt welds in plate girders and columns shall be full penetration.

All butt welds shall be radiographically or ultrasonically tested as per relevant IS codes and standard practice. The bare wire electrodes for submerged arc welding shall be as follows:

Filler wire : AWS-A-5.17-EH14

Flux shall be agglomerated type of classification AWS-A-5.17-F7A2EH14

f) Galvanizing of steel structures (wherever specified for transformer yard structures, handrails, gratings, etc.) shall be done after all fabrication work is completed. Zinc coating over galvanized surface of structural members and threaded fasteners shall not be less than 610 gm/sqm and 375 gm/sq. m. of surface area respectively. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts and nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS-1573 (Latest Revision). All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS-2633 (Latest Revision). All galvanizing work shall be done at shop.

PAINTING
Structural painting shall be done as per CECRI recommendations: For all internal and external steel structures under civil scope : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake (High Build) of 100-110 micron + Top coat of Aliphatic Polyurethen (TiO2) rutile of 50-60 micron shall be applied.
(As recommended by CECRI for the existing plant civil structures.)

g) ~~Specific corrosion resistant painting system with protective coatings shall be adopted as per CSIR – CERI recommendations for marine environment with required material, proper application procedure and approved number of coating. Stipulations mentioned in ISO 12944 shall be followed.~~

h) All welding electrodes shall be of Low Hydrogen type conforming to IS: 814 (Latest Revision) and shall be EB5426H3JX type. All electrodes, flux, wire etc. shall be of ADOR Welding Ltd., ESAB India Ltd., D & H Secheron Electrodes Pvt. Ltd. Or any other equivalent manufacturer accepted by Owner.

Alternatively, flux coated arc welding (FCAW) conforming to AWS-E70T-5 which is a modified procedure of MIG/CO2 (solid wire) can be used.

If submerged arc welding is used, the bare wire electrodes shall be as follows :

Filler wire	:	AWS-A-5.17-EH14
Flux	:	agglomerated type of classification AWS-A-5.17-F7A2EH14

i) Minimum preheat & inter pass temperatures for welding over 40mm to 63mm (thickness of the thicker part at the point of welding) shall be 66°C and for over 63mm, it shall be 110°C. However, higher preheat & inter pass temperatures may be required due to joint restraint etc. and shall be followed as per approved welding procedure.

j) Minimum tests to be carried out during fabrication and erection of structural steel shall be as follows :

Steel

Ultrasonic Test : Plates above 25mm thick shall be subjected to ultrasonic test as per ASTM-A435 or equivalent to check the presence of lamination.

Fillet weld

Dye Penetration Test : 5% of the total length, Dye penetration shall be carried out to the root run.

Butt weld :

Dye Penetration Test : 10% of the total length, Dye penetration shall be carried out to the root run after back gouging

Radiographic Test : Generally splicing should not be provided in tension flange of Bunker Girders and crane girders. Spot radiography shall be carried out on 100% joints in tension zone and 10% joints in compression zone. Minimum 300mm length shall be spot radiographed. When radiograph is not possible ultrasonic test shall be carried out after grinding the surface.

Ultrasonic Test : 10% of all other Butt welds except crane girder and bunker girder shall be subject to spot radiographic test and the entire balance butt weld for ultrasonic test.

k) Connections

Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section shall be as follows:

- Full shear capacity for box section.
- 80% of full shear capacity or actual shear (if indicated in Sellers drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.
- All welds will be continuous. The minimum size of fillet weld shall be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force should be more than actual shear.

Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns shall be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.

Following connections shall be provided during erection:

Welded Connection

Connection of secondary beam to main beam
Connection of bracing to column
Connection of bracing to longitudinal tie beam
Connection of longitudinal tie beam to column
Connection of spandrel beam to column
Connection of other secondary structures

HSFG Connection (Grade 8.8 bolts)

Splicing of column/transverse frame beam/ longitudinal tie beam
Connection of frame beam to column
Connection of Crane Girder to column
Connection between crane girders
Other major connections

Bearing Type Connection (HT bolts Grade 8.8)

All removable type connections

M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc.

2.00.00 LOADS

Loads as defined under Clause 3.00.00 Section-II shall be applicable.

3.00.00 LOAD COMBINATIONS

While designing consideration shall be given to the following load combinations:

i) DL + LL

ii) DL + LL + PL + Equip ± TL

iii) DL + LL + PL + Equip + Cb + CtLA± CS ± TL

iv) DL + LL + PL + Equip + Cb + CtLB± CS ± TL

v) 0.9DL ± EL (for DL only) ± TL

vi) 0.9DL ± WL1 ± TL

vii) 0.9DL ± WL2 ± TL

viii) (DL + *LL + PL + Equip + Cb + Ct ± EL ± TL)
(* Appropriate portion of LL which is considered for working out EL shall only be taken)

ix) [DL+LL+ PL + Equip + Cb + CtL1 ± (CS1+WL1) ± TL]

x) [DL+LL+ PL + Equip + Cb + CtL1 ± (CS1+WL2) ± TL]

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe load

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction

WL2 = Wind load with internal pressure

EL = Earthquake load

TL = Temperature load

Limit state method to be followed for design of steel structures as per latest version of IS 800. Applicable load factors to be used for Design of Steel Structures by Limit State Method of strength & serviceability as per IS 800 (Latest).

Appropriate impact factor shall be considered as per IS: 875 (Part 2) (Latest Revision) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS: 875 (Part 3) (Latest Revision). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination numbers (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components. Analysis shall be done in all three directions X, Y and Z.

In absence of any suitable provision for design loads, any other recognized code of practice may be followed subject to prior approval of the purchaser.

Seismic Load shall be considered in all three directions for analysis and design of Structures.

4.00.00PIPE AND CABLE RACK STRUCTURES

The pipe and cable rack structures shall accommodate the pipes/cables with proper access and adequate working space for erection and maintenance. These shall be designed to carry safely all the loads acting on them (DL, LL, WL, EQL, forces from pipe lines etc.). The structures shall be adequately rigid to carry the forces from the pipelines at anchor points without undue deflection so that the pipelines are really anchored at the anchor points. Bridges shall be provided to support pipelines of smaller diameters for which maximum permissible span are less than the distance between supporting trestles.

It is envisaged that pipe/cable rack under this Package shall have to accommodate some additional pipes and cables, which are not in the scope of the Bidder. The Bidder shall keep reasonable margin for accommodating such additional pipes/cables in the rack structure, details of which shall be furnished to him during the detailed engineering stage.

5.00.00OTHER SPECIFIC REQUIREMENTS

All steel framed structures shall be either “rigid frame” or “simple space frames” or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings shall be designed as simple space frame structures.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However wherever large cut outs (area more than 1.0 sq. m.) are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support in the form of shear connector and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimize vibration, avoid resonance and maintain alignment and level. However heavy vibrating/rotating equipments shall rest on VIS if provided in intermediate floors. Resonance in structures: Structures supporting vibratory/reciprocating equipments shall be designed so as to obviate occurrence of resonance. The ratio of applied frequency to natural frequency shall not lie within the range as per codal stipulation.

Chequered plates shall conform to IS: 3502 (Latest Revision).

All indoor gratings shall be electro-forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm x 6mm for indoor installation and outdoor installation. The opening size shall not be more than 30mm x 100mm. All gratings shall be hot dip galvanized @ 610 gm/sq.m.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

Crane Girders

For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange shall not be permitted. Bearing edges of crane girders shall be machined. Crane stoppers shall be designed in accordance with IS 875(part-5).

The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

Crane girders shall generally be of simply supported design, unless continuous crane girders are specifically required.

Each flange of crane girder shall have uniform thickness throughout its length. However width of flanges can be varied as per design requirement.

All intermediate stiffeners shall be fitted against top flange and welded to it by fillet welds/partial penetration butt welds. These stiffeners shall terminate short of bottom flange with at least 50 mm clear gap. The stiffeners shall be fillet welded to web plate and corners shall be cut suitably to clear thermally affected area of web to top flange connection.

End bearing stiffener plates of crane girder shall be capable of transmitting the maximum reactions to the columns. The bearing surface of the bearing plate shall be planed/ machined to ensure full contact. Thickness of End Bearing stiffeners shall not be less than top flange thickness and their width shall not be less than width of bottom flange.

Tension flange of crane girders shall be stabilized by horizontal latticed bracings, where required in order to limit the slenderness ratio of the flange to 150.

Generally for girders having span 12m and above, vertical auxiliary girder and horizontal girder at crane girder bottom flange level shall be provided.

At crane girder level, walkway shall be provided on both sides. Walkway at column location s shall have minimum clear width of 750mm.

All crane girders and their supporting structures shall be designed for loading from loaded crane in worst position of crab and crane to create most unfavourable loading condition of the girders. For increase of load due to impact and crane load combination including lateral surge & longitudinal surge shall be taken as per provision of IS 875 (Part – 2).

Suitable approach to be provided for tightening of bolts of Crane Rail. Approach for Crane Rail fixing shall be properly planned for all types of sections of Crane Girders.

Surge Girder walkways and auxiliary beams

Continuous maintenance walkways with safety hand-railing shall be provided along each column row adjacent to each crane gantry girder. These walkways shall be of non-slip plate construction connected to crane girder top flange by continuous fillet welds. Access at every 120m shall be provided from floor for access to these walkways so that accesses are available within 60m from any location.

Connections between surge girder and the main columns shall be designed to resist load due to lateral braking of crane trolley.

On the periphery of the building, full length handrails shall be provided along the edge of the maintenance walkway at crane girder level.

Handrail and its clearance from crane end carriage shall conform to provisions of relevant safety regulations.

Crane stops shall be provided at the ends of each crane girder system, or as required to limit the movement of crane as per technological requirements.

Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

Vertical Deflection

a)	For beams supporting dynamic equipment	:	Span / 500
b)	For beams supporting floors / masonry	:	Span / 325
c)	For beams supporting pipes (pipe racks)	:	Span / 400
d)	For roofing and cladding components	:	Span / 250
e)	For gratings and chequered plates	:	Span / 200 subject to a maximum of 6 mm

For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

a)	For manually operated cranes & monorails		:	Span / 500
b)	For electric overhead cranes			
	i)	Up to 50 t capacity	:	Span / 750
	ii)	Over 50 t capacity	:	Span / 1000

Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

a)	Single storey building (without crane load)	:	Height / 300

The permissible deflection limit of H/500 along the conveyor and H/1000 across the conveyor shall be followed.

b)	Multistoried building (without crane load)	:	Height / 500
c)	Pipe rack columns	:	Height / 200
d)	Open Structures	:	Height / 200
e)	Crane gantry girder due to surge	:	Span / 2000 limited to maximum of 15 mm
f)	Building main columns at crane rail level due to action of crane surge load only	:	Height / 2500 limited to maximum of 10 mm
g)	Open gantry columns at crane rail level due to action of crane surge load only	:	Height / 4000 limited to maximum of 10 mm

Provisions of IS: 800 (Latest Revision) and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

Minimum Thickness of steel elements

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment (Exposed to open air i.eto Rain, Contact with soil, Coal, Ash, Contact with drained liquid or contaminated water, alkali/acid etc.) shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

a)	Trusses, purlins, girts and bracing	:	6 mm
b)	Columns and beams	:	8 mm
c)	Gussets	:	8 mm
d)	Stiffeners	:	8 mm
e)	Base plates	:	10 mm & above
~~f)~~	~~Chequered plates~~	~~:~~	~~6 mm o/p & above (6mm for walkways & stairs and 8mm for maintenance platforms)~~
g)	Grating flats	:	6 mm

f) Chequered plates : **8 mm o/p & above (8mm for walkways & stairs maintenance platforms)**

h) Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

Minimum Sizes of steel elements

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

Slenderness and Depth Ratio

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800 (Latest Revision).

The following limiting ratios of depth to span shall be considered as a general guide.

a)	Truss	1 / 10
b)	Rolled beams and girders for Ordinary floors and rafters	1 / 24
c)	Supporting floor beams for vibrating Machinery / equipment	1 / 15
d)	Roof purlins and girts	1 / 45
e)	Gable columns	1 / 30

Expansion joints

Longitudinal and transverse expansion joints shall be provided in buildings and structures in accordance with IS: 800 (Latest).

Expansion joints shall be formed by providing double rows of columns, with overhanging gantry girders, secondary roof and wall framing being detailed to allow the maximum calculated movement for the specified temperature variation.

Miscellaneous Criteria

Natural ventilation shall be provided ensuring that it does not permit rain water entry into the building. Scope of natural lighting shall be used to the maximum possible extent. For this purpose, minimum 15% of side sheeting area and 10% of roof sheeting area, unless otherwise specified, shall be provided with polycarbonate sheets. Protective grating shall be provided below such sheets to prevent accidents due to damaged sheets.

DI gutters and DI down-pipes with gutter outlets having grating cover shall be provided to carry rain water from roofs of buildings to the drainage system at

ground level. All gutters shall be designed as walkable (with provisions of handrails) with 600 mm sole width.

Adequate facilities in the form of monorails, hoists, platforms etc. shall be provided to facilitate repair and maintenance of overhead cranes, equipment, etc. Access to these platforms shall be provided by stairs / ladders from the nearest accessible floor or platform. Wherever the monorail projecting from the building, sliding steel flush doors shall be provided (side hung doors may also be provided depending upon the location).

Edges of floors, gangways, stairs and landings shall be provided with safety hand railings. All hand railings shall be of tubular hand railings with vertical post, top rail and mid rail made up with tubes.

At gable ends of buildings, platforms shall be provided connecting the walkways at crane gantry level.

Connection by permanent bolts to structural elements subject to vibration shall be provided with lock nuts.

Monorails shall be designed for local bending both in transverse and longitudinal direction. The projection of the monorail outside the building shall be 3m minimum.

Chequered plates, Purlins, Side runners, sheeting etc shall not be considered as structural members for transferring horizontal loads. Except where purlins form part of bracing system and designed for axial loads also.

Design drawings shall contain Section-wise Bill of Quantity etc .Necessary number of prints of drawings and documents; as per contract shall be submitted for approval.]

The slopes of bracings, lacings for columns, diagonal members of trusses, bridges, girders etc shall be kept preferably in the range of 35 to 50 degrees.

Purlins and side runners shall be considered as part of cladding unit and shall be subjected to local wind coefficients as specified in IS 875.

Structural schematic general arrangement with plans at various levels, elevations along each row and axes, sections, considered loads and load diagrams with location etc. and Structural design drawings with BOQ and Table of members containing design forces along with design calculations shall be submitted for Purchaser's/Consultant's approval. STAAD Pro file along with Editable excel sheets with active formulae to be submitted. However the approval shall be limited to checking of overall dimensions, general stability of system, effective load transfer and deflection limits etc. The approval shall not relieve the contractor of his responsibility of correctness in design, adequacy of connections, accuracy etc.

Shear force at the column base shall be resisted either by shear keys shop-welded to the underside of column base plates or by welding base plate to inserts provided in foundation.

The level of underside of column base shall be so chosen such that the complete anchor table lies below the finished floor level, thus keeping the shop floor free from projections of anchor tables.

Minimum thickness of base plate for columns at ground level shall be 25 mm (at other levels 16 mm) and minimum thickness of washer plate at any level shall be 0.8 times of Base Plate thickness.

All Built-up columns shall be provided with nominal stiffeners to maintain orthogonal & torsional rigidity, at a spacing not exceeding 1500 mm centre to centre

Roof Structures

a) The main supporting element for roof shall preferably be roof rafters, made of rolled sections or built-up sections, provided at uniform spacing to suit shop layout. Roof shall be provided with adequately sized roof monitor for natural ventilation, wherever required.

b) For all main technological units / buildings, rafters / roof girders shall be made of I sections either rolled or built up. Trusses shall not be used.

c) Roof shall have suitable slope (1:5, i.e. 1 Vertical: 5 Horizontal, unless otherwise specified) to meet technological as well as rainwater drainage requirements. Hand railings at eaves level and gable ends of the roof of the building shall be provided.

d) System of bracings shall be provided in the roof top chord and bottom chord levels along with longitudinal ties to ensure stability and rigidity of the roof structures.

e) Galvanized wind tie (40x6 mm flat) shall be provided at the free edge of roof sheeting. Suitable arrangement of anchors shall be provided at the ridge of roof sheeting for holding lanyards of safety belts.

f) For design of roof and side wall frame work, purlins / side runners shall be treated as part of cladding unit and shall be subjected to local wind coefficients as given in codes.

g) Roof drainage system shall be designed for maximum precipitation for 5 minutes based on local meteorological data. In the absence of meteorological data, precipitation of 2 mm per minute may be considered for designing drainage system. A factor of safety of 1.3 shall be kept in the design.

h) All valley and eaves gutters shall be of pressed plate construction with a minimum sole width of 600 mm so as to function as walkways.

i) Eaves gutter shall be provided for eaves height ranging between 10 m to 25 m above apron/ground level.

j) The gutters shall be laid to slope towards down-pipes with welded outlets and having grills fitted flush with gutter sole. Slope of gutters and collector pipes shall not be flatter than the following limits:

i) Longitudinal slope of gutter 1: 500
ii) Longitudinal slope of collector pipe 1: 300

Velocity of discharge may be considered as 1 to 2.5m/s. Corrosion factor may be taken as 1.5 mm for designing the gutter plate.

k) Poking holes with cover shall be provided in the down-pipes at suitable intervals as well as at accessible levels, to clean the down-pipes.

l) Eaves gutter shall be provided with safety handrails.

m) When rain water falls from higher to lower roof, double layer of sheets shall be provided for the portion of roof sheeting on which rain water falls, provided the drop of roof is in the range of 3 m to 6 m. In case the drop is more than 6 m, independent gutter shall be provided.

Wall Structures

a) Wall runners with necessary sag rod arrangements shall be provided to support wall and gable sheeting, including internal partition wall, wherever required.

b) Walls shall be provided with louvers and polycarbonate sheeting at appropriate levels, to provide natural ventilation and lighting.

c) Adequate framing arrangement shall be provided both in roof and side wall framing, for fixing of ventilator fans / exhaust fans as per requirement.

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SECTION- IV

SPECIFIC DESIGN REQUIREMENTS [ARCHITECTURE]

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SECTION - IV

SPECIFIC DESIGN REQUIREMENTS [ARCHITECTURE]

1.00.00 SCOPE OF ARCHITECTURAL WORKS INCLUDING SANITARY AND PLUMBING

1.01.00 Scope

The architectural services shall cover finishing work of plant buildings, starting from brick work, partition walls, roof protection, finishing of walls, floors and false ceiling, cladding, as required potable water system, service water, Plumbing and sanitation etc. as required for functional requirement.

The bidder offer shall cover the complete requirements as per the best prevailing practices keeping in view the statutory and functional requirements of plants & facilities and providing enough space & access for operation, use & maintenance and to complete satisfaction of the owner.

Buildings under scope of work:

- Absorber pump house and oxidation blower house – 2 Nos.
- FGD control Building - 1 No
- Limestone Slurry Preparation building – 1 No
- Limestone storage shed - 1 No
- Crusher house annex to Lime stone slurry preparation Building - 1 No
- Gypsum Dewatering Building with Elevator – 1 No
- Gypsum storage shed – 1 No
- Waste Water Treatment Plant Building for FGD - 1 No

Above list of Plant is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work.

Building Descriptions

Sl. No.	List of Structures / Buildings	No. Reqd.	No. of Storey	Types of Building structure				
				Frame / Structure	Floors	Roof	Side Cladding	Remarks
1.	Absorber pump house and oxidation blower house	2	G	Steel	R.C.C.	R.C.C. on metal deck sheet.	Fly Ash Brick wall cladding	
2.	FGD control Building	1	~~G+1~~ G+2	R.C.C.	R.C.C.	R.C.C.	Fly Ash Brick wall cladding	
3.	Limestone Slurry Preparation building	1	~~G~~ Multi storeyed	Steel	R.C.C.	R.C.C. on metal deck sheet.	Fly Ash Brick wall cladding up to 3.0m and Colour coated Zincalume sheet metal cladding above brick wall.	
4.	Limestone storage shed	1	G	Steel	R.C.C.	Colour coated Zincalume sheet metal slopped roofing	Fly Ash Brick wall cladding up to 3.0m and Colour coated Zincalume sheet metal cladding above brick wall.	The grade slab is required. It shall be RCC and cl.6.03.00/ Vol-IIG1/ sec-II shall be followed.
5.	Crusher house annex to Lime stone slurry preparation Building	1	G	Steel	R.C.C.	Colour coated Zincalume sheet metal slopped roofing	Colour coated Zincalume sheet metal cladding above 3.0m high fly ash brick wall.	

6.	Gypsum Dewatering Building with Elevator	**1**	G+2(part plan	Steel	**R.C.C (R.C.C intermediate floor over metal deck)**	Colour coated Zincalume sheet metal slopped roofing	Fly Ash Brick wall cladding up to 3.0m and Colour coated Zincalume sheet metal cladding above brick wall.	
7.	Gypsum storage shed	1	~~G~~ **Multi storeyed**	Steel	R.C.C.	Colour coated Zincalume sheet metal slopped roofing	Fly Ash Brick wall cladding up to 3.0m and Colour coated Zincalume sheet metal cladding above brick wall.	The grade slab is required. It shall be RCC and cl.6.03.00/ Vol-IIG1/ sec-II shall be followed.
8.	Waste Water Treatment Plant Building for FGD	1	G	Steel	R.C.C.	R.C.C. on metal deck sheet.	Fly Ash Brick wall cladding	

2.00.00DESIGN REQUIREMENTS

2.01.00 Codes and Standards

The latest revision of Indian codes and standards are applicable. Unless otherwise stated the latest editions / revision of all related and applicable Indian codes and standards (including IRCs as applicable) along with addendums / amendments, if any, shall be followed. In case the specific Indian Codes and standards are not available, accepted International Codes / standards shall be used.

- National Building Code-2016
- TAC/LPA norms
- Local Fire regulations

2.02.00 Architectural Concepts

a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.

b) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.

c) Overall colour scheme of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements.

d) Overall emphasis shall be on developing an eco- friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipment so that the proper co-ordination with other agencies can be taken up at appropriate time.

2.03.00 **Architectural Design**

a) Natural light shall be used to the maximum extent especially in the form of north light/skylight. For adequate light and ventilation, National Building Code recommendation shall be followed. However all windows of plant building shall have minimum 1.0m sill height and bottom of lintel height shall be minimum 2.5 m from finished floor level and minimum door height shall be 2.5m.

For all windows of non-plant building shall have minimum 1.0m sill height and bottom of lintel height shall be minimum 2.1 from finished floor level. Minimum door height shall be 2.1.

b) Entrance canopies, sunshade (projections, recesses) over openable windows and door openings on exterior facades shall be provided.

c) All the buildings shall be architecturally designed to meet the National Building Code.

d) All architectural drawings shall be prepared under responsibility of an Architect. The Architect should be registered under Council of Architecture.

e) A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to

inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology and architectural & civil engineering for a smooth control hierarchy and man machine interface.

f) At the inception of the detail engineering the bidder should submit the architectural concept of the area under scope of work with 3D views & colour scheme of Plant & Non-plant buildings for selection of the owner. The selected concept shall the vernacular of the project to bring harmony all over the plant site.

g) Rain-water pipes or sanitary pipes shall not be visible from outside. Provision of pipe ducts shall be made to ensure pipe routing.

h) All cable spreader floors shall have proper slopes and provision of fire emulsifying system for drainage.

i) Steel columns within fire hazardous areas like electrical room, Main control room and switch gear room shall be encased with brick wall. All steel columns shall have 150 mm high concrete base above FFL to ensure proper floor finishing work and to protect the column base.

j) Minimum 2.1m high headroom clearance has to be maintained at every part of the building including staircases. Vertical Head room clearance shall be maintained as per industry factories Act. Sufficient headroom shall be provided in cable galleries.

k) Where false ceiling is to be provided, provision of human access has to be made to maintain the HVAC, Electrical and other service lines above false ceiling. The access shall be of steel grid system (1.2M X 1.2M span) with catwalk to support the false ceiling system and human access respectively.

l) Minimum 1.5M wide passage is to be marked on the floor as safety exit route. Such passages shall lead to Fire-escape staircases or fire-safe zones. Doors of fire-hazardous rooms or areas shall open towards safety exit passage. All external doors shall open towards outside. Fire escape staircases shall be located as per fire-code and TAC.

2.04.00 Plant Buildings

2.04.01 FGD Control Building

This will be RCC framed structure with fly ash brick clad wall. This will be G+2 storied building having cable spreader room at Ground and switchgear room and control room at first floor respectively. This building shall have toilet facility.

Windows shall be coloured powder coated aluminium partially fixed and partially sliding type openable window, escape doors shall be fire check doors. Fire doors shall also be provided for switchgear room and cable spreader rooms. Control room shall have glazed aluminium door. Elastomeric waterproofing treatment shall be applied on RCC roof. For finishing schedule please refer Annexure-I.

2.04.02 **Other Plant Buildings**

Structures of Other plant buildings shall be as per description stated elsewhere in this Civil/Structural Specification. Architectural concepts of structures shall offer its own identity and will be aesthetically blended to give pleasing appearance maintaining harmony of the plant complex. Functional needs of each building shall be maintained.

3.00.00 ARCHITECTURAL REQUIREMENTS

3.01.00 **Roof Insulation and Ventilation**

The roof of buildings which are recommended by HVAC department for insulation shall be under deck insulated as per specification given elsewhere in this document. The roofs/floors housing manpower and precious equipments/instruments and AC rooms exposed to heat environment shall be provided with underdeck insulation with false ceiling.

Extractor fans will be provided for ventilation. For ventilation requirements relevant section of the specification shall be referred.

3.02.00 **Roof Waterproofing**

Roof water proofing treatment shall be as follows:

After curing of the concrete, all roofs of buildings shall be provided with 3 layers, first being minimum 1.5mm thick elastomeric membrane waterproofing treatment coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in two coats, secondly screed concrete shall be laid over 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating and finally the wearing course.1.5mm thick Elastomeric membrane shall be laid as per manufacturer's specification. Run off gradient shall be given a minimum of 1 in 100. Gradient shall comprise screed concrete M15 using 12.5 mm or below coarse aggregate and waterproofing treatment as per IS:2645, mixed with polypropylene fibres. Over the screed concrete wearing course treatment shall be provided as below:

A wearing course shall consist of pressed clay tiles of size 230x230x18 mm laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints

using sealing compound.

Where technically necessary from HVAC requirement, under deck insulation of required material and thickness shall be provided as per technical specification.

3.03.00 **Partition Wall**

All intermediate walls shall be full brick thick wall in 1:6 cement sand mortar. Half brick thick wall in 1:4 cement : sand mortar with 2 nos. 6 mm dia rod in every fourth layer shall be provided. For long walls intermediate RCC pillars and RCC horizontal tie shall be provided or shall be provided with structural steel member at minimum 2.5 m clear height with MS inserts/lugs for anchoring in brick work shall be provided. Similarly MS lugs shall be provided on the structural member at spacing 500/600 mm on vertical face for proper anchorage for brickwork, lugs embedded in concrete and suitable vertical structural member at maximum 0.5m c/c. Full glazed partition in powder coated aluminium frame shall be provided for operator's cubicles for clear view of the operating equipment and in Control room area.

3.04.00 **Plastering**

Exterior & rough side of interior brick wall	20mm thick minimum sand faced plaster with 1:4 cement-sand mortar in two layers.
Interior wall	12 mm thick with 1:4 cement-sand mortar
Ceiling	10 mm thick with 1:3 cement- sand mortar shall be provided to all exposed ceilings.

3.05.00 **False Ceiling**

Stove-enamelled Aluminium false ceiling, similar or equal to LUXALON with either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Areas like office space or where specified, Mineral Fibre Based Acoustic Ceiling Board, in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative, Moisture & Fire Resistant Gypsum Board false ceiling system may be used.

Under deck insulation is to be provided in areas of as per HVAC requirement.

The false ceiling work shall take care of all illumination, fire detection & fighting,

HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183 over the false ceiling panels. Wherever under-deck insulation is required, the insulation shall be as per specification mentioned elsewhere in the specification, and shall be glued to the roof/floor slab.

3.06.00 **Special Finish**

a) The main entrance of FGD control room building shall be finished with granite stone slab and RCC stairs shall be finished with granite slab with SS hand-railing. For other finishes refer Annexure-I.

3.07.00 **Doors**

a) Generally factory made hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.

b) Factory made Solid core wooden flush doors in teak wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.

c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings-9.0 Sqm and above- are required. Rolling shutters shall be electrically operated. Wherever truck entry is envisaged, minimum size of rolling shutter size shall not be less than 3.5m (W) x 4.0m (H).

d) Special areas like control rooms and other special area shall be provided with minimum 15 micron pre-coated i.e. colour powder coated aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems.

e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside.

g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core FRP.

h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

3.08.00 **Windows & Ventilators**

Full glazed windows and ventilators shall be powder coated and UV protected aluminium window frame with 4 to 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired glass where required from safety point of view. All windows and ventilators shall meet the requirement of industrial windows and Ventilators. Glazing between AC and Non AC areas shall be double insulated glass. Aluminium sections shall be of heavy duty and from reputed and approved manufacturer. Windows and ventilators shall be fabricated and painted by the reputed fabricators at their own fabrication shop.

The window area shall be so decided as to allow adequate natural ventilation and light.

***Note**: member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.* (As glass thickness is specified in this volume)

~~***Note**: Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.*~~

3.09.00 **Landscaping**

Not applicable under this package.

3.10.00 **Facilities in Buildings**

Adequate toilet and drinking water facilities shall be provided for personnel working in each building. Each building shall have toilet facilities both for Gents and Ladies and physically challenged persons. Number of toilet fixtures shall be adequate for the occupancy as per National Building Code.

However minimum 1 EWC and 1 IWC with cistern, 1 washbasin with mirror, towel rail, soap case, 2 urinal shall be provided in each toilet.

Each floor shall have drinking water facility connected through potable water with water cooler.

Provisions should be kept for barrier free environment for physically challenged persons like ramps in 1 in 12 slope, lifts, toilets, etc. The main entrances of all the plant buildings shall be provided with ramp.

Pantry provision should be kept for the areas which have office space, control room or the spaces which will be 24 hours manned.

3.11.00 **Potable Water System and Service water Plumbing**

This system for various buildings shall be connected to the drinking water and service water systems, the scheme for which is indicated elsewhere in this

specification.

Water outlets shall be provided for an instantaneous flow rate of approximately 7 Cu.M/Hr. (25 GPM).

System will satisfy state and local plumbing codes. Following I.S. Codes for the system shall be followed:

a) IS-2065: Code of Practice for water supply in buildings.

b) IS-1172: Code of basic requirements for water supply, drainage and sanitation.

c) IS-1200: (Pt. XVI) Laying of water and sewer lines including appurtenant items.

d) IS-1239 Specification for mild steel tubes and mild steel tubular and other wrought steel pipe fittings. (10 mm to 15 mm nominal diameter).

e) IS-3589: Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).

Potable water shall be supplied to basins, water coolers, showers and other plumbing fixtures. Soil and waste piping shall drain through traps to the yard sanitary sewer system.

Service water shall be supplied to water closets, urinals, sinks, and other plumbing fixtures.

3.12.00 **Roof Drainage Systems**

The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

a) Roof Drain Heads

b) Rain Water Down comers

c) Gully pits

IS-1742 code of practice for building drainage shall be followed for this purpose.

Adequate numbers of rainwater drains heads shall be provided for all roof areas as per standard norms for roof area.

System will be designed to handle rainfall at a rate as specified elsewhere in this specification and in accordance with stipulations of IS-1742.

Any roof more than 8.0 metres above grade shall have access from within the building for cleaning of roof drains.

Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view.

All the drains including plinth protection drains are RCC under this package.

3.13.00 **Glazing & Glazed Partition**

a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.

~~b) 4 mm thick ground glass shall be provided for toilets.~~

b) **6** mm thick ground glass shall be provided for toilets. (As per the requirement.)

c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.

d) All glazing shall be in aluminium frame having 15-micron colour powder coated.

e) **5.5mm** thick. Wired glass shall be used for windows / ventilators **for all buildings except AC rooms Office rooms and control rooms.** (As per the availability.)

~~e) 6mm thick. Wired glass shall be used for windows / ventilators at higher level for safety.~~

f) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured powder coated aluminium frame suitable for structural glazing system.

g) For glazed aluminium door, 8.0mm thick clear float glass with or without etching is to be provided

3.14.00 **Sealant**

Silicon sealant around external doors and windows / Polysulphide sealant with polystyrene filler board shall be used in all expansion joints exposed to weather. All joints around exterior doors, windows, and expansion joints, etc. shall be sealed for proper water- lightness.

For expansion joints more than 50mm width special type expansion joint control system with extruded aluminium sections and EPDM membrane shall be used. On exposed vertical faces of the expansion joints after sealing, extruded aluminium special type of flashing shall be provided.

3.15.00 **Damp Proof Course**

40 mm thick M 20(1:1.5:3) concrete with 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

3.16.00 **Plinth Protection**

Minimum 1000 mm wide and minimum 100 mm thick P.C.C. M 20 plinth protection along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be provided. The plinth protection shall be laid over prepared sub-grade and base formed with two layers of locally available broken ~~laterite~~ stone. Each layer shall have a pre-compacted thickness of 150 mm and consolidated to 115mm. Thus the total thickness becomes 230mm.

(As broken stone is easily available)

3.17.00 **Miscellaneous Metal Railing**

Hand railings of Plant building shall be MS Galvanised (as per IS 4736) and finished with suitable paint hand railing with 40 mm NB (medium) main post and 32 mm NB (medium) as horizontal rails, as per IS-1161, with toe guard shall be provided.

3.18.00 **Painting**

Exterior Masonry Surface	:	Buildings shall be finished with waterproof External Quality Acrylic Emulsion Paint over plaster (two finishing coats over one coat of primer). Granular textured paint may also be combined along with External Quality Acrylic Emulsion Paint to form suitable pattern on building façade. Aluminium composite panels (ACP) may be used to accentuate certain portion of the façade or certain element of the façade as the case may be.
Exterior Steel Work	:	~~Two primer coats steel work Zinc silicate 50 microns each. Two finish coats High built epoxy finish of 90 microns each coat.~~
All Woodwork	:	Synthetic paint two coats over a coat of primer.

A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake (High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO2) rutile of 50-60 micron shall be applied (as recommended by CECRI for the existing plant civil structures.)

A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO2) rutile of 50-60 micron shall be applied (as recommended by CECRI for the existing plant civil structures.)

All Internal Steel Work	:	~~Epoxy Paint two coats over approved primer~~
Steel in contact with acid /alkali	:	Chemical resistant paint two coats over one coat of primer.
Interior Office Spaces Control Rooms, All A.C. Areas and as mentioned in the annexure	:	Acrylic emulsion paint two coats over one coat of primer over 3 mm thick white cement putty punning.
Other Areas	:	Acrylic distemper over plastered surface as indicated in annexure for finish schedule in this document.
Fire Door	:	Post Office red shade shall be provided.

3.19.00 **Miscellaneous Work**

a) Window grill shall be generally powder coated aluminium grill shall be provided. But in specific cases, M.S. grills shall be used as per approved design for security purpose made of 25 mm X 6mm M.S. Flats / 12mm – 20mm M.S. square bar of approved design shall be provided to suit security requirements.

b) R.C.C. stair railing shall be with Stainless Steel handrails and balusters shall be provided.

c) RCC stair of plant buildings shall be of Kota stone and white marble strip combination with all edges and moulded nosing.

d) Anti-termite treatment shall be given to columns pits, foundations, and trenches, below floor as per IS: 6313.

e) Suitable arrangement of floor drain with trap shall be provided in floor where spillage of water or floor washing will occur.

f) RCC staircase shall be provided in main entrance of Facility building and other important buildings. Other staircase shall be provided with Structural steel work.

g) Doors, windows and rolling shutter in all buildings shall have sun- shade either recessed in the wall or projected out. Projection of sunshade shall be 750 mm for door and 600 mm for windows. Projections for Rolling shutter shall be 1000mm. Where doors and windows are side by side, 750 wide continuous sunshades shall be provided.

h) North Light provisions on the plant buildings shall be made of Polycarbonate sheet fixed to structural framework as per approved design. Arrangement shall have to be provided to prevent ingress of rainwater if any.

i)-Roof access: All roofs shall be accessible through proper staircase. Where staircase cannot be provided at least cage ladder shall be provided. **(buildings more than one floor ie. G+1 and above shall necessarily be provided with staircase).** Roof access stairs may be open outdoor type. Cage ladder height shall not be more than 6.0m at a stretch. One rest platform shall be given at every 6.0M height of the cage ladder if the ladder height is more than 6.0 m.

i) ~~Roof access: All roofs shall be accessible through proper staircase. Where staircase cannot be provided at least cage ladder shall be provided. Roof access stairs may be open outdoor type. Cage ladder height shall not be more than 6.0m at a stretch. One rest platform shall be given at every 6.0M height of the cage ladder if the ladder height is more than 6.0 m.~~

j) Window sill: All window sill height shall be measured from finished floor level.

k) Lintel height: All lintel height shall be measured from finished floor level.

l) Parapet height: All roofs shall have minimum 1000mm high parapet wall. Parapet wall shall be of RCC and shall be of 125mm thickness.

m) Internal wall height: Wall height between AC and Non AC areas as well as between two AC areas, shall be full height up to bottom of roof slab or bottom of beam.

n) False ceiling height: Unless specifically mentioned the false ceiling height shall be 3.m within rooms and 2.7m-3.0m at corridors outside the rooms.

o) Floor opening: Any uncovered floor opening more than 0.3sqm in area shall have 150mm high RCC kerb all round and shall be protected with minimum 1000mm high railing.

p) Dado/Skirting height: Unless specifically mentioned the skirting height shall be 150mm from finished floor level and dado height shall be 100mm higher than the door opening height for toilets and kitchen / pantry.

q) Walkways shall be of heavy duty 75 mm (minimum) thick anti-skid interlocking concrete paver blocks of approved design and top colour.

r) Scheme to be made and executed rainwater harvesting system for the entire plant within the battery limits of this package.. From individual building roof, rainwater shall be collected through down comers and charged to the ground locally.

s) All roofs shall have adequate provision for erecting Solar Panels as per manufacturer's erection and anchoring specification and also as per civil design(it may be considered in design, the panels will be erected over the entire area of roof).

3.20.00 **Chain Link Fencing**

Minimum 2.4 meter high fencing above toe wall shall be provided around building transformer area & other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 metre high galvanized chain link fencing of minimum 3.15 mm diameter G.I. wire of mesh size 75 mm. The diameter of steel line wire for chain link fencing shall not be less than 4.0 mm. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level. Chain-link fencing shall be as per IS: 2721. Galvanisation on chain link shall be as per IS: 12753, hard coated finish. Vertical posts shall be 80NB G.I. pipe at 2.5m interval and with strainer posts wherever necessary.

3.21.00 **Temporary Fencing**

The construction of Temporary Fencing shall be done as mentioned below:

a) 50NB G.I. post and its foundation shall be at 3.0m interval.

b) Fence shall be installed along lines shown on approved drawings.

c) Total height of the posts shall be 2400mm from grade level.

d) Strainer posts shall be provided at sharp changes in grade, at comers at change of direction and where directed, and at every 30.0m interval.

e) All comer post will have two stay posts and every tenth post will have a transverse stay post.

f) Barbed wires shall run post to post and to be fixed to the posts by tightening hooks.

g) Diagonals and vertical per span with barbed wire shall be provided. In general CPWD specification is to be followed.

3.22.00 **Watch Towers**

Not applicable under this scope of work.

3.23.00 **Sanitary Drainage System**

a) Diameter of Soil Pipe and Wastewater Pipe outside the building and

vertical / horizontal stack connected with 8 fixtures shall not be less than 150 mm.

b) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995).

Pipes shall be as follows:
DI Pipes --- Plant Buildings
UPVC Pipes ---- Non-plant Buildings
DI Pipes --- Underground Pipes
For sewage line, UPVC pipes above ground and CI pipes below Ground shall be used.

c) IS: 1742 - Code of Practice for building drainage & IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings should be followed.

d) If not specified the minimum gradients of soil and drainage pipe line shall be as follows:

I. 100 mm nominal dia : 1 in 35
II. 150 mm nominal dia : 1 in 65
III. 230 mm nominal dia : 1 in 120
IV. 300 mm nominal dia : 1 in 200

e) Each floor drain should have 'P' or 'S' trap connection as required.

f) Pipe to pipe should be connected in 45^0 or 135^0 both vertically and horizontally.

g) For cleaning purpose during maintenance, Floor Cleanout and Wall Cleanout should be provided for horizontal run and vertical run of the pipes.

h) In no case soil pipe shall be connected to waste pipe.

i) In vertical stack proper venting system with anti-siphonage vent pipes should be provided for all Water Closets.

j) Drop slab of minimum 450mm depth shall be provided for the toilets where technically and aesthetically required.

k)All plumbing and water supply fittings & fixtures, rain water drainage of plants of any building/premises/open area within the **FGD Area** Battery limits are in the scope of this contract. All the sewerage shall be collected from **FGD Area** battery limit and the same shall be interconnected to the Main Plant Sewer System

k) ~~All plumbing and water supply fittings & fixtures, rain water drainage of plants of any building/premises/open area within the SE 1 Battery limits are in the scope of this contract.~~
~~All the sewerage shall be collected from SE1 battery limit and the same shall be interconnected to the Main Plant Sewer System (SE3 scope) at~~

~~the RCC manhole located at an approximate distance of 50M away from the SE1 battery limit, as per detailed layout requirement.~~

4.00.00 DESIGN DATA FOR ARCHITECTURAL WORKS

1. Brick works – internal and external : 230 mm thick fly ash brick wall with 1:6 Cement- Sand mortar. All non-load bearing Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise.
Fly ash bricks (cement bonded) shall be locally made. Bricks shall have smooth rectangular faces with sharp and square corners. Bricks shall be machine moulded and shall be made from the admixture of suitable good quality of fly ash, sand and cement as per the composition mentioned below:

FLY ASH	:	50-60%
SAND	:	32-40%
CEMENT	:	8-12%

The fly ash bricks will be as per latest relevant IS code. The bricks will be of dimension as per standard clay brick, suitable for making 230mm thick full brick wall, 115mm thick half brick wall and 75mm thick minor partition walls, as applicable, as per drawing/specification/BOQ. A maximum tolerance of (+/-) 2mm shall be allowed as the manufacturing tolerance. The bricks shall have frog of 100 mm in length 40 mm in width and 10 to 20 mm deep of one of its flat sides.

			The bricks when tested in accordance with the procedure laid down in IS 3495 (part 2): 1992 after immersion in cold water for 24 hrs., water absorption shall be within 13-15% by weight. Similarly, the porosity of the fly ash bricks shall be within 12-20%. The bricks shall have a minimum crushing strength of 75 Kg/ CmSq. Chamber burnt clay bricks shall be used for any load bearing brickwork and in case of non-availability of Fly ash bricks, subject to the approval of NTPL.
2.	Half brick thick wall	:	1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.
3.	One third brick wall	:	1:3 cement: sand mortar with 2 nos. 6 mm dia M.S. rod at every alternate layer.
4.	Damp proof course	:	40mm thick 1:1.5:3 Concrete with a 2% admixture of water proofing compound or as per manufacturer's recommendation.
5.	Plaster:		
	Exterior & rough side	:	20 mm thick with 1:4 cement-sand of interior brick wall mortar in two layers except where special finish provided.
	Interior	:	12 mm thick with 1:4 cement-sand mortar
	Ceiling	:	10 mm thick with 1:3 cement-sand mortar (chicken wire mesh shall be provided at the jounctions between RCC-BW Steel-BW, etc before applying

Plastering. Also refer Cl 2.02.03/Sec Iv/Part B/G2 of Vol II)

6. White Cement Putty Punning : 3 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.

7. Metal Cladding :

The **Zincalume** wall cladding **and roof sheeting wherever specified for steel buildings under this package** shall be of **Single skin** panels comprising of metal colour coated profile steel sheet of minimum depth 34.5 mm at 333 mm pitch permanently colour coated steel sheet made out of 0.8 mm TCT high tensile zincalume steel (150 gsm. Zinc - aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength, having colour coating with silicon modified polyester finish of thickness 20 microns over 5 microns (DFT) back coat. The permanently colour coated sheet shall meet the general requirements of IS:513, IS:277 & IS:14246. The panels shall be directly bolted on to the horizontal runners.
Note: For single skin wall cladding/ roofing, the flashings shall be of same thickness and material that of sheeting.

~~The wall cladding for buildings shall be of double skin sandwiched prefabricated factory made Rockwool/PUF TR panels comprising of outer metal colour coated profile steel sheet of minimum depth 34.5 mm at 333 mm pitch & inner slightly ribbed or plain permanently colour coated steel sheet made out of 0.6 mm TCT high tensile zincalume steel (150 gsm. Zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for top sheet and 0.5 mm TCT zincalume steel (150 gsm zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for inner sheet, having colour coating with silicon modified polyester finish of thickness 20 microns over 5 microns (DFT) back coat. The permanently colour coated sheet shall meet the general requirements of IS:513, IS:277 & IS:14246. In between the metal sheet, there will be lamellar mineral wool insulation having density 100 kg/m3 and average thickness 50 mm conforming to IS:8183 having a thermal conductivity value of 0.040 W/m2K at 50oC mean temp. Alternatively insulation shall be PUF having density of 40- 42Kg/m3 and a thermal conductivity value shall be as per IS:12436. The prefabricated Rockwool/PUF panels shall be supplied up to max. length of 12 m and finished with profile sheet overlap jointing arrangement. The panels shall be directly bolted on to the horizontal runners. The double skin cladding with single skin on either side of the horizontal runners without insulation wool in the middle shall also be used as per the requirement and as specified.~~

~~For single skin wall cladding/ roofing, specification for outer sheet as mentioned above is to be followed and the thickness of the sheet shall be 0.8mm minimum. Flashings shall be of same material that of sheeting.~~

The work is to be executed by the in-house/authorised applicator of the manufacturer, under the supervision of the authorised representative of the manufacturer

8. False Ceiling :

Aluminium pre-painted stove enamelled finish false ceiling, either lineal

panel system or aluminium tile/plank system.

a) PANELS

Panels to be manufactured from pre-painted, stove enamelled, alloy EN-AW-5050 or equivalent (according to EN 1396 and ECCA).

Panels are to be coupled in longitudinal direction by means of panel splices.

Optionally the flange with 3 x 7 ventilation holes can be used to achieve a ventilated ceiling.

b) SUSPENSION

Rows of 0.5 Fe/0.95 Aluminium roll formed carriers shall be installed about 1200mm centre on centre by means of adjustable suspensions about a distance of 1200mm, centre on centre. Carriers will be joined by means of carrier splices. Carriers provided with prongs to hold panels in a standard module of 100mm.

c) PERIMETER PROFILES

- Clip-on U-profile, 28.6x12.5 x20 mm, made of 0.35 thick aluminium
- Wall L-profile, 29.2x19.4 mm, made of 0.5 mm thick aluminium
- Wall L-profile, 45x18.5 mm, made of 0,8 mm thick aluminium
- Wall W-profile, 45x21x21x18.5 mm, made of 0.8 mm thick aluminium

d) PERFORATIONS

Manufacturer shall supply panels with following perforation specifications:

- ∅ 1.0 mm, Δ 2 mm with 23% open area
- ∅ 2.0 mm, Δ 5 mm with 16%open area

Perforated panels to have a nominal plain border along the longitudinal panel direction to assure a maximum flatness and product stability:

- 84C panel, 1 mm perforated to have a plain border of 7 mm
- 84C panel, 2 mm perforated to have a plain border of 6 mm

e) ACOUSTICS

Manufacturer shall supply acoustic non-woven tissue, thickness 0.2 mm factory applied inside the panels. Alternatively the installer can place individual PE wrapped mineral wool pads.

f) COATING

The coating will consist of a tough and durable polyester finish in nominal thickness of 20 microns, applied in a continuous coil-coating process ensuring uniform coating and absolute adhesion.

g) INSTALLATION

All materials shall be installed by the approved applicator/erector of the manufacturer under supervision of the authorized representative of the manufacturer.

9. Floor finish:

a. Generally finish to utility areas shall be 50 mm thick heavy-duty granolithic flooring with metallic hardener on concrete slab.

The heavy-duty overlay shall be ready-to-use, metallic aggregates based powder after application of epoxy based bonding agent of two components, solvent less epoxy resin based. It shall be formulated to meet the requirement of ASTM C881 Type 2, Grade 2, and Class B &C. The Bonding agent shall exhibit minimum open time of 6 hours and shall exceed the tensile strength of concrete in terms of its adhesive bond strength. The Floor topping product shall be high strength with compressive strength of 80 MPa at 28 days; flexural strength exceeding 8 MPa at 28 days. The product shall be capable of resisting metal crawler chassis and shall have abrasive wear less than 0.15 mg/cycle on H22 wheel, ASTM C501 test method. The product shall have adhesive bond strength in excess of 1.5 MPa when tested as per ASTM D4541. Curing of

the layer to be done with non-degrading membrane forming curing & sealing compound shall be acrylic resin based formulation. The product shall comply with ASTM C 309 Class B. The product shall exhibit water loss not more than 0.55 kg/m2 in 72 hours when tested as per ASTM C156. The product shall form non-degrading abrasion resistance film which shall also exhibit capability as primer for subsequent protective coatings or bituminous overlays.

b) Acid Alkali resistant floor

For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

c) Wet area flooring

All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

d) Access flooring

Access Floor (if required) panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non-combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate - PVC/ Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the

laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment
Sub-structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of levelling and accurately align panels for a maximum ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement. The Pedestal head assembly shall consist of a 90 x 90 mm x 4.00 mm embossed head mechanically riveted to a 100mm long 20mm dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-vibrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 25.00 mm OD pipe of thickness 2.00 mm mechanically locked on a press for perpendicularity and then welded to a base plate of 125 x 125 x 2.50 mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, and rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x570 mm length.

e) Floor/staircase and the areas prone to slippage due to oil spillage etc. shall be provided with non-skid floor finish.

f) For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 shall be applied in front of equipment.

10. Doors and Windows:

a. Hollow metal door at all levels shall be installed from ISO 9001-2000 certified Manufacturer. All hollow metal general doors with or without vision panel. Pressed Galvanised steel Single /Double

leaf to required sizes which consist of frame, shutter, infill and finish as detailed below and conforming to IS 277.
Door frame shall be Single rebate profile of size 100 x 57 mm made out of 1.20 mm thick galvanised steel sheet (18 gauge). Frames should be Mitered and field assembled with self tabs. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonry opening.

Door leaf should be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 0.8mm (22 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be as per joinery details with a screw on glass beading on the inside. The glass should be 5 mm clear toughened glass. Louvers when recommended should be site proof and shall be flush fixed on the external surface.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

b. Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel confirming to IS 277 with the following specification shall be used. Recommended fire door shall have doors tested at CBRI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision litters /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory.

Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2 mm (18 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

c. Special areas like control rooms and other special area shall be provided with minimum 15 micron pre-coated i.e. colour powder coated aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems.

d. Doors of W.C. and shower shall be hard core FRP door.

e. Full glazed windows and ventilators shall be powder coated and UV protected aluminium window frame with 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. All windows and ventilators shall meet the requirement of industrial windows and Ventilators. Glazing between AC and Non AC areas shall be Double insulated glass. Aluminium sections

shall be of heavy duty and from reputed and approved manufacturer. Windows and ventilators shall be fabricated and painted by the reputed fabricators at their own fabrication shop. Windows shall be glazed aluminium windows conforming to IS: 1949 & IS: 1948.

11. Rolling Shutters:

Rolling shutters as per IS: 6248 with electrically operating arrangement according to size shall be provided in buildings to facilitate handling and transportation of equipment for large openings from 9.0 sqm and above. Wherever truck entry is envisaged, minimum size of rolling shutter size shall not be less than 3.5m (W) x 4.0m (H).

The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanised steel lath section of 18swg tested mild steel strips at 75mm rolling centres, locked with galvanised malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3mm thick galvanised steel plate and security riveted with stiffening angles.

12. Glazing:

a. Glazing for windows in general **for offices,control rooms and A/C rooms** shall be minimum **6 mm** clear float glass and as mentioned elsewhere in this document. **Wired glass of 5.5mm shall be provided except offices, control rooms and A/C rooms.** **(**As per the requirement for 6mm and As per the availability for 5.5mm.)

a. ~~Glazing for windows in general shall be minimum 4~6 mm clear float glass and as mentioned elsewhere in this document.~~

b. Glazing in Control room between A/C & non-A/C area shall be with double glazed insulating glass consisting of 2 nos. 6 mm clear toughened float glass with 12 mm air gap in between, hermetically sealed.

c. Minimum 8.0 mm thick toughened float glass as specified below shall be provided in doors, partitions.

d. 24mm thick insulated double glazing having 6mm thick tinted heat- reflecting type outer float glass and 6mm thick plain inner float glass with 12mm air gap & hermetically sealed shall be mounted on powder coated aluminium frame suitable for structural glazing system. Quality of glass is given below.

- 6mm thick Glass quality shall be toughened hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 82%, Visible light Reflectance- 10% & inside – 11%, Total Solar Energy Transmittance – 66% Reflectance–10% UV transmission – 49%, Solar Heat Gain Coefficient – 0.70

Shading Coefficient – 0.81 ,U – Factor Air 2.77 W/m2k , Sound Insulation – 31db outer lite.

- 6 mm thick toughened Blue low E hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 35%, Reflectance 13%outside & inside – 30 %, Total Solar Energy Transmittance – 19%, Reflection – 9%, UV – 9 %, Solar Heat Gain Coefficient – 0.29 Shading Coefficient – 0.33,U –Factor Air – 1.9 W/m2k, Sound Insulation – 33db outer lite (# 2 surface) Glass with a combination of 6 mm thick toughen Optifloat clear 6mm glass inner lite (# 3 Surface) Now the two sheets of glass will be separated by an aluminium spacer leaving an air gap of 12.7 mm thick and sealed with the weather proof sealant.

13. Roof waterproofing :

a) Roof water proofing treatment shall be as follows:

For roofs with structural slope:

Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Top of thoroughly cleaned roof surface shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with pressed clay tiles of size 230x230x18 mm laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing compound.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand

mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

For roofs having no structural slope:

Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Top of thoroughly cleaned roof surface shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with pressed clay tiles of size 230x230x18 mm laid in waterproofing compound mixed cement mortar (1:3) and sealing of joints using sealing compound.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

For vertical surfaces (Parapet)

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc. and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls (2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating,

composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person.

b) For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100. The top surface of finished roof shall be such as to allow quick drainage of rainwater.

c) Heavy duty UPVC pipes of 150mm dia minimum conforming to relevant BIS Code shall be provided to drain off rainwater from the roof for Non plant buildings. The numbers and size of down comers shall be governed by IS: 1742 and IS: 2527. For plant buildings DI pipes of 150mm dia shall be provided.

14. Painting:

a) External masonry surfaces of all buildings shall be finished with External Quality Acrylic Emulsion paint over plaster. Granular textured paint may also be combined along with External Quality Emulsion paint to form suitable pattern on building façade.

b) Acrylic plastic emulsion paint of shall be provided in control room, control equipment room, computer room, UPS room, all office areas and all air-conditioned areas including entrance lobby.

c) All other areas shall be provided with Acrylic Distemper paint.

d) Internal surface of walls in rooms for pumps, machineries and maintenance shall be painted with washable synthetic enamel paint of dark shade up to a height of 1.5 m above floor level.

e) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid shall be painted with chemical resistant paint. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado as specified elsewhere in this section. Ceiling shall also be painted with Chemical resistant paint.

f) ~~All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed~~

14. Painting: f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall **be As per cl 3.18.00 above.** (As recommended by CECRI for the existing plant civil structures given in the clause.)

~~steel work shall have two or more coats anti corrosive paint and shall have minimum 110 micron DFT. Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Co polymer coating.~~

g) All woodwork shall be painted with two coats of synthetic enamel paint over a coat of approved primer. DFT shall conform to IS specification.

h) All fire exits shall be painted in Post Office red.

i) Epoxy paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.

j) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided for fire sealing. In general all the paints shall be applied in two coats over one coat of primer.

15. Aluminium Composite Panels (If applicable)

1. Material:

Total thickness of the panel – 4mmThickness of the aluminium skin – 0.5mm, Tensile strength of aluminium skin –120N/mm2 minimum, Density of PE core – 920 – 980 Kg/m3 (Non toxic grade Polyethylene) Coating – PVDF Adhesive film – DUPONT, USA Coating thickness (front foil) – 24µ - 30µ in PVDF including primer.15µ - 18µ in polyester coating. Coating thickness (back foil) – 4µ - 7µ polyester coating.

2. Colour – as indicated in the drawing.

3. Fixing arrangement – aluminium composite sheets shall be folded inwardly on four edges (without cutting the outer skin) to from Aluminium Composite Panels (ACP) and shall be riveted to the aluminium extruded section like angel or channel. There shall be at least one rivet at the both ends of the folded edge and other rivets shall be 200mm c/c per panel edge/fold. Aluminium angles shall form a frame around the panel and shall be fixed to the steel sub-frame by self tapping screws with EPDM shim to prevent by-metallic reaction. The gap/groove between two adjacent panels shall be filled with Silicon sealant of approved make (GE or similar make) to prevent water seepage.

4. The supply fabrication and erection of ACP is inclusive of steel sub-base frame work if necessary as per site condition. The Bidder shall take site measurement and produce working drawings for approval of engineer before erection of ACP.

16. **Poly Carbonate Sheet**

a) 4 mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or MAKROLON Polycarbonate sheet or similar approved.

b) Framing shall be specially designed aluminium sections, colour powder coated, with EPDM Gasket as per system provider's details. Framing shall be fixed to the steel structure as per site measurement, drawings and – Engineer in Charge.

c) Sealing of joints shall be done with Silicon sealant.

d) Minimum Density required for Multiwall Polycarbonate and Compact sheets:-

- 6 mm Multiwall Sheets: - 1.3 kg/m^2
- 8 mm Multiwall Sheets: - 1.5 kg/m^2
- 10 mm Multiwall Sheets: - 1.7 kg/m^2
- 16 mm Multiwall Sheets:- 2.8 kg/ m^2
- Compact Sheets: - 1.2 kg/m^2/mm

e) The sheets should have the minimum co-extruded UV coating of min 45 Micron

f) The fixing should be done Aluminium Clamping profile (top and bottom) min 60mm wide profile with EPDM gasket by using self-driving and self-tapping screws.

g) The sheet should be produced and supplied Preferably by local manufacturer

h) The sheet should pass the ISI 14443 specification for Multiwall system.

17. Stairs:

a) All stairs shall have not more than 12 risers in one flight. All staircases shall comply with all staircase related norms of National Building Code 2016, Part-4.

Height of risers and width of treads shall be 166 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 150mm (maximum) & 300 mm (minimum) for general staircases(for RCC stair cases in both plant and non plant buildings). For steel staircases the riser shall be 166 mm maximum and tread shall be 250mm minimum. Minimum width of stairs shall be1200mm for indoor and 1000mm for outdoor stairs.

b) Aluminium angle nosing shall be provided for edge protection of RCC stairs.

c) 40ø NB medium class G.I pipe Handrail & 32ø NB medium class G.I pipe rails for stairs shall be, minimum1.0 metre high, shall be provided around all floor/roof openings, projections/balconies, walkways platforms, concrete and steel stairs.1200mm high railing may be provided for external fire escape stairs. Handrail shall be two rail systems with the top rail 1000mm / 1200mm above the walkway/ platform/ floor surface and the intermediate rail 500mm below the top rail. Guardrail post spacing will be proportional to the length of the protected horizontal opening but will not exceed 1500mm c/c to posts. 150mm Toe guard should be provided for all railings.

18. Draining out water from floors:

In all buildings, suitable floor drainage system to drain out water collected from equipment, blow downs, leakages, floor washings, firefighting etc., shall be provided in each floor.

19. Fencing :

Minimum 2.4 meter high fencing above toe wall shall be provided around building transformer area & other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 metre high galvanized chain link fencing of minimum 3.15 mm diameter G.I. wire of mesh size 75 mm. The diameter of steel line wire for chain link fencing shall not be less than 4.0 mm. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level. Chain-link fencing shall be as per IS: 2721. Galvanisation on chain link shall be as per IS: 12753, hard coated finish. Vertical posts shall be 80NB G.I. pipe at 2.5m interval and with strainer posts wherever necessary.

20. Water Supply and Sanitation :

~~a)~~ ~~HDPE roof water tank of adequate capacity depending on the~~

a)- HDPE roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building. **The minimum capacity for HDPE tank should be 1000 litres. (**for more clarity)

~~number of users for 8 hours storage shall be provided for each building.~~

b) **CPVC** Pipe of class I as per IS 15778 upto 50mm DN shall be used for all piping works including concealed type for potable water supply. All water supply pipes inside the Non plant buildings are to be laid as concealed type **wherever possible.**
(due to corrosive environment CPVC pipe is recommended).

b) ~~Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply. All water supply pipes inside the Non plant buildings are to be laid as concealed type.~~

c) Extra heavy cast iron pipes with lead joints or UPVC pipes with thermoplastic joints shall be used for sanitary work below ground.

d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.

e) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995)

Pipes shall be as follows:

DI Pipes --- Plant Buildings
UPVC Pipes ---- Non-plant Buildings
DI Pipes --- Underground Pipes

f) Each toilet shall contain following best quality fittings/porcelain fixtures in adequate numbers as per National Building Code. In toilets primarily meant for workers an additional squatting type WC shall be provided. Minimum one exclusive toilet facilities for handicapped shall be provided in each floor.

- Water closet – Indian & European type.
- Large flat back urinal with marble slab divider.
- Shower set.
- Wash basin – Oval shaped Counter-top (Granite) wash basin.
- Sink – Stainless steel sink with integrated drain-board to be provided in janitor's closets, kitchen, pantry areas.
- Metal storage cabinets, under- counter as well as overhead, shall be provided in janitor's room, kitchen, pantry and similar areas as per requirement of Owner.
- Minimum 600 mm long Chromium plated tray.
- Minimum 500 mm long Chromium plated towel rail.

- Chromium plated liquid soap holder.
- Recessed Chromium plated soap tray in shower area.
- Chromium plated toilet paper roll holder.
- Robe hooks
- Minimum 750 mm high square edge 6 mm thick float glass mirror of adequate width to match toilet layout and interior décor, shall be mounted on PVC sheet.
- Drinking fountains in adequate numbers.

The exact number of fittings and fixtures, brand, colour etc. shall, however be finalized during detail engineering stage and same shall be of Owner's choice and Approval. However minimum 1 EWC and 1 IWC with cistern, 1 washbasin with mirror, towel rail, soap case, 2 urinal shall be provided in each toilet.

Note Toilets for physically-challenged persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures.

21. Under-Deck Insulation

a. Insulation material shall be Closed Cell Elastomeric Nitrile Rubber

b. Density of Material shall be between 40 to 60 Kg/m^3

c. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C

d. The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category. Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

e. Under-deck insulation shall be provided for all AC areas having roof exposed to sun/floor exposed to heat atmosphere.

f. Thickness:

- o For Concrete Slab: 25 mm thick sheet is used
- o For Corrugated or metal ceiling: 32 mm thick sheet

22. Sealant:

1. Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation having weathering resistance to ultraviolet ray property. The product shall exhibit **shore 'A' hardness of 25** and have **movement accommodation factor of 25%**. The sealant must comply with the performance specifications as laid in **BS: 4254 and ASTM C 920**. All the joints must be primed using compatible primer for the substrate from the equal or similar to MASTERFLEX PRIMER range of BASF. Sealant application shall be carried out, strictly in accordance with Manufacturer's recommendations.

2. Polyurethane based single component joint sealant materials based upon polyurethane resins. They have been formulated with different modulus of elasticity 0.25-0.45 N/mm2 and Shore 'A' hardness of 15-30 which makes them suitable for slightly different applications. The product shall exhibit elongation at break 600 % and recovery of 80%.

23. **Expansion joints may be as per following locations:**

a) Floor to Floor Joints at all internal locations
b) Roof to Roof Joints
c) Floor to Wall joints at internal locations
d) Roof to Wall Joints
e) Wall to Wall joints in exterior locations

During construction of RCC slab, beam, column the expansion gap shall be maintained by using polystyrene filler board.

During finishing stage expansion gaps shall be finished with the either elastomeric EPDM profile or elastomeric extruded poly vinyl chloride fitted in extruded aluminium sections with aluminium joint cover to form an integral system.

Expansion gap between metal cladding shall be finished with metal saddle of same material having 'U' or 'W' shape and shall be covered with metal cladding –fixed at one end and fixed with slotted hole on other end or as per manufacturer's detail.

Externally the expansion joint sealing system shall form a continuum vertical and horizontal sealing system to make the building envelop water tight.

24. Statutory rules:

a) Design shall be complied with all applicable statutory rules pertaining to Factories Act as applicable for the State, Rules of Tariff Advisory Committee (TAC) / Loss Prevention Association (LPA), and Water Act for pollution control etc.

b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 500 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

c) Provision for fireproof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. Shall be made according to the recommendation of Loss Prevention Association of India / Tariff Advisory Committee.

d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

ANNEXURE -I

INTERIOR FINISH SCHEDULE

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Limestone Slurry Preparation building							
		50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.00mts height wall and single skin metal cladding on both side of steel side runner for balance height.	Exposed painted structure.	Hollow metal flush door / fire door	Aluminium glazed window / ventilator	Polycarbonate sheet shall be combined with metal cladding to form pattern.
Limestone storage shed							
		-DO-	-DO-	-DO-	-DO-	-DO-	-DO-
Crusher house annex to Lime stone slurry preparation Building							
		-DO-	-DO-	-DO-	-DO-	-DO-	-DO-
Gypsum Dewatering Building with Elevator							
		-DO-	-DO-	-DO-	-DO-	-DO-	-DO-
Gypsum storage shed							

ANNEXURE -I

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		-DO-	-DO-	-DO-	-DO-	-DO-	-DO-
FGD Control Building							
	Control room, Control panel room, Control equipment room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in pattern for Control room.	Acrylic emulsion paint over white cement putty for control room	Pre-coated aluminium panelled (600mmx600mm size) ceiling similar to 'Luxalon" in Control room and air-conditioned areas.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	
	Switchgear room, Cable spreader room, other electrical rooms	50mm thick heavy duty granolithic flooring with metallic hardener.1.0m wide Flexible electric insulated PVC synthetic sheet in front of electrical equipment.	Synthetic enamel paint up to 1.50mts height and Acrylic distemper paint over white cement putty for balance height.	Acrylic Distemper paint	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	
	MCC Room	10 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm (overall 50 mm thick) laid in	Acrylic distemper paint over white cement putty.	Pre-coated aluminium panelled (600mmx600mm size) ceiling.	Hollow metal flush fire door/ Aluminium glazed door	Aluminium window / ventilator	

ANNEXURE -I

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		pattern. MCC rooms shall have 1.0m wide flexible electric insulated PVC synthetic sheet in front of MCC Panels.					
	Toilet & other wet areas	10 mm thick non-skid fully vitrified tiles of make of minimum size 400 mm x 400 mm (overall 50 mm thick) laid in pattern with 5 mm thick glazed ceramic tile dado of same make topped with 50 mm wide matching ceramic trims. Height of dado shall be 100mm higher than the lintel level starting from floor finish level.	1st quality coloured glazed ceramic tiles of minimum 5 mm thickness up to 100 mm higher than lintel level starting from finish floor level. And balance portion with Acrylic distemper paint over white cement putty.	Acrylic Distemper paint	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be FRP door frame & shutter.	Aluminium glazed window / ventilator	
	Staircase & Lobby	Overall 50mm thick granite slab flooring with 20mm thick granite slab and matching skirting.	Acrylic distemper Paint	Acrylic distemper Paint	Fire check doors -2hr rated.	Aluminium glazed window / ventilator	SS railing for stairs.

ANNEXURE -I

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Absorber pump house and oxidation blower house							
		50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Synthetic enamel paint up to 1.00mts height wall and single skin metal cladding on both side of steel side runner for balance height.	Exposed painted structure.	Hollow metal flush door / fire door	Aluminium glazed window / ventilator	Polycarbonate sheet shall be combined with metal cladding to form pattern.
Waste Water Treatment Plant Building for FGD							
		-DO-	-DO-	-DO-	-DO-	-DO-	

VOLUME: II-G/2

PART-A

SECTION: I

GUIDELINE
FOR
GEOTECHNICAL INVESTIGATION

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SECTION: I

GUIDELINE
FOR
GEOTECHNICAL INVESTIGATION

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The successful bidder shall perform all work under the purview of this specification along with all incidental and related work including setting out, staging, approach to test locations, successful bidder's office, stores and protection of adjacent buildings, structures or services / facilities. No separate payments shall be made on such accounts. The tenderer should therefore take into account all such relevant items while quoting his bid. The boreholes shall be selected such that all the founding structures including RCC roads and Concrete pavements are represented.

2.01.00 **Work to be provided for the successful bidder**

The work to be provided by the successful bidder, unless specified otherwise shall include but not be limited to the following.

a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervisions by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per tender terms, drawings, specifications and instruction of the owner / engineer.

b) Locate in the field and in layout drawing all boreholes and other field investigation items.

c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.

d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification and instructions of the owner / his engineer.

2.02.00 **Work to be provided by others**

No work under this specification will be provided by any agency other than the successful bidder unless specifically mentioned elsewhere in the contract.

2.03.00 **Location and Levels**

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the successful bidder at his own cost from two reference grids and one bench mark given by the owner/ his engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets / tables to be incorporated in the report by the successful bidder.

Making bench mark pillar (s) and reference line pillars (whatever are required for the work) and maintaining them upto the completion of the work shall be the responsibility of the successful bidder at no extra cost by the owner.

2.04.00 **Codes and Standards**

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

IS:1498 - Classification and identification of soils for General Engineering purposes.

IS:1888 - Method of load tests on soils

IS:1892 - Subsurface investigation for foundation

IS:1904 - Structural safety of buildings : shallow foundations

IS:2131 - Method for standard penetration test for soils

IS:2132 - Code of Practice for thin walled tube sampling of soils

IS:2720 - Methods of tests for soils

IS:2809 - Glossary of terms and symbols relating to Soil Engineering.

IS:2810 - Glossary of terms relating to soil dynamics

IS:3025 - Methods of sampling and testing for water used in industry

IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores
IS:4434	-	Code of Practice for insitu vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation
IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
IS:4968 (Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
IS:5529 (Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009	-	Calculation of settlement of foundations -
(Part-I)		Shallow foundations subjected to symmetrical static vertical loads
(Part-II)		Deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands
IS:8764	-	Method for determination of point load strength index of rocks
IS:9143	-	Method for the determination of unconfined

		compressive strength of rock materials
IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils
IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge.

Various methods of boring as described in IS:1892 may be adopted. The tenderer shall furnish in his tender the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.
During the boring operations if rock strata is not encountered, the boring shall be continued upto 30 m depth for two bore holes and upto 20m depth for the remaining boreholes unless stated otherwise. Incase rock strata is encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The successful bidder shall describe in detail the equipment and method of

boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the successful bidder shall have no claim whatsoever on this score. If the successful bidder can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it should be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it should be chopped using suitable chopping bits and the debris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The successful bidder shall use his own materials for this and the scope shall be inclusive of the same. These bore holes after completion of observation shall be handed over to the owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall be backfilled by the successful bidder using sand fill as and when directed by the Engineer.

3.02.00 **Stabilization of Boreholes**

Boreholes shall be stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as bentonite), grouting (in rack) or other suitable methods.

3.03.00 **Open Trial Pits**

The open trial pits shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The successful bidder shall provide a suitable access to the bottom of the

pits. Sampling in trial pits shall be done as directed by the engineer.
The successful bidder shall include the scope of trial pit with earthwork in excavation, necessary side slope, backfilling and shoring/ sheeting for side protection, if required.

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

3.04.00 **NOT USED**

3.05.00 **Rock Drilling**

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation will be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The tenderer shall furnish the type of coring bit he proposes to use. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock then by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole will be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each bore-hole the successful bidder shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the successful bidder shall determine nature of fractures and degree of weathering of rock for each bore hole. The successful bidder shall also note

and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The successful bidder shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stages of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The successful bidder shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer. (All the field works shall be verified and signed by the Engineer (owner's) at site)

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is weathered, drilling must be continued upto 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the successful bidder shall also take into consideration the provisions of the latest revisions of the following Codes of Practice :

a) IS:6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).

b) IS:4078 - Code of Practice for indexing and storage of drill cores.

c) IS:4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.06.00 **Adits and Test shafts**

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for insitu tests to determine the modulus of deformation of rock.

3.07.00 **Sampling**

Bored soil shall be collected continuously during boring to note any change of strata. Samples of undisturbed soil shall be obtained preferably at every 1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring , since it is intended to ascertain the characteristics of the soil at various depths. If, however , there is fair uniformity in the characteristics of the soil for certain depths the engineer may limit the number of samples stipulated above.

3.07.01 **Tube Sampling**

For obtaining undisturbed samples in its simplest from , an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used should have area ratio less than 13 percent and preferably less than 10 percent. The head should have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling will be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately on inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge of cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high , but not less than 50 mm dia. x 150 mm high.

Representative / disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.07.02 **Chunk Samples**

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An

arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.07.03 **Sampling in rock**

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed should be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.08.00 **Record of Boring**

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and should be submitted to the owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing should be submitted with the soil report.

The field log should contain at least the following information :

a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.

b) Personnel information - name of drilling Bidder, driller and inspecting engineer.

c) Equipment data - manufacturer's name and model designation.

d) Sampling and coring information :

   i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.

   ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.

   iii) Push samplers : hydraulic pressure and rate of penetration.

   iv) Soil or rock coring : average rotational speed, down-ward hydraulic pressure and rate of penetration.

   v) Rock coring : Rock quality designation (R Q D)

e) Description of material penetrated but not sampled.

f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate

of penetration for drilled casing.

g) Seepage pressure test information-depth and duration of test.

h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.

I) Artesian pressure information - depth at which encountered, measured head and lime at which each measurement is made.

j) Elevation of top and bottom of hole and top of rock

k) Date and time of all operations and delays with reasons.

l) Miscellaneous information to aid interpretation of sub-surface conditions.

m) Additional pertinent information.
The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log should present a clear, concise and accurate picture of subsurface conditions to be utilized by the engineer.

4.00.00 PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00 Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS:2131 at every change in strata or at 1.5 m intervals or as directed by the engineer. The successful bidder shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Hammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetrating shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for last 300 mm of penetration) at appropriate depths.

4.02.00 Static Cone Penetration Test

The test shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge.. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance

is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec approximately so as to advance the cone only to a depth which is possible with the cone assembly available.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The successful bidder shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00 Dynamic Cone Penetration Test

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentoite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure, field observations and reporting or results shall conform to IS:4968 Part – II, the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5 mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300 mm penetration vs. depth.

5.00.00 GROUND WATER INVESTIGATION

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 **Ground water level observation**

The successful bidder shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes should be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations will be taken by the successful bidder during the period of investigation. At the end of the site investigation work , these boreholes shall be handed over to the owner in such a condition that further observations can be taken by the owner for a period of at least a year.

Piezometers will have to be installed in boreholes as directed by the owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station will be used.

5.02.00 **In-Situ Permeability Test**

In-situ permeability test shall be performed in the boreholes specified and/or at such other locations at specified depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The successful bidder shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01 **Pump - in Test**

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) **Constant Head Method (in borehole)**

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall

be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) **Falling Head Method (in borehole)**

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of pre-bored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS : 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) **Percolation test (in trial pit)**

Percolation test shall be conducted in the trial pit in areas where effluent is stored / discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS : 2470-Part-I, Appendix-A.

5.02.02 **Pump - Out Test**

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00 FIELD TESTS

In situ tests shall be performed as desired by the engineer to measure properties of soil during the field investigation work.

6.01.00 **Menard Pressure meter test**

This test shall be carried out as per clause 3.7 of IS:1892 in the bore holes specified and/or at such other locations as directed by the Engineer to the full

depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The successful bidder will submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The successful bidder shall also check and confirm whether the equipment he proposes to use will be suitable for carrying out this test in bore holes of size specified under clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00 **Direct Load Tests on Soils**

The direct load tests on soil shall be carried out in the trial pits specified and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm square plate will be used in clayey soil and in sandy soils , three plates of size varying between 30 cm to 75 cm will be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of sub-grade reaction and deformation modulus of soil.

The excavation and side protection during the test and back- filling after the test shall be carried out by the successful bidder. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of dewatering shall be borne by the successful bidder.

The successful bidder will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The successful bidder must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The successful bidder shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level and staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the successful bidder shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

Each test shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m shall also be considered by the bidder if the site condition warrants. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement will have to be provided by the successful bidder himself.

6.03.00 **Vane Shear Tests**

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be omitted with the permission of the engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00 **Determination of Dry-Density of Soils**

In place dry density of soil is required for assessment of bearing capacity of soils analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the engineer for determination of in-place dry density of soils.

6.04.01 **Sand Replacement Method**

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder should be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder should be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS:2720 (Part XXVIII)

6.04.02 **Core-cutter Method**

The specification for this test shall be as per IS:2720 (Part XXIX). The method should be applied for fine grained soil, free from aggregates. Fine grained soils for the purpose of application of this method is defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03 **Ring and Water Replacement Method**

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic film inserted in the hole to retain the water. The method should be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04 **Rubber balloon Method**

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV). This method should be applied for firmly bonded soils, it is unsuitable for very soft soils which will deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00 **In-situ Block Shear / Wedge Shear Test**

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The test in the trial pits shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The interpretation of test data and report shall be as per the provisions of IS:7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

6.06.00 **Test for Measurement of soil Resistivity**

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing S = 5, 10, 15, 20 metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V, between the two inner electrodes is measured. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity will be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes , then the soil resistivity.

= 2 X 3.14 X S.V / I

Where , Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

= Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement , above formula becomes

= 2 X 3.14 X S.R.

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than 1/20 or the spacing between the electrodes.

Correction of the test results should be done, if necessary, using the method outlined in IS:3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.

The locations at which such tests are to be carried out as indicated and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.

The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The successful bidder will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The scope shall include earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 Block Vibration Test

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator

assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

a) Vertical Vibration Test

b) Longitudinal Horizontal Vibration Test

c) Free Vertical Vibration Test

d) Horizontal Free Vibration Test.

7.02.00 **Wave Propagation Test**

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 **Cyclic Plate Load Test**

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS: 1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.
The successful bidder must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The successful bidder shall bring not less than two dial gauges and one pressure gauge as standby.

The successful bidder shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the successful bidder shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the successful bidder shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00 FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

The test shall be carried out by successful bidder at the locations which will be marked by the successful bidder based on the approved plot plan and/or at such other locations as directed by the Engineer-in-charge. The test shall be carried out at a depth of 500 mm below the finished ground level.

The successful bidder shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down is IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00 LABORATORY TESTS ON SOIL SAMPLES / ROCK CORES

The successful bidder shall carry out the tests as listed out as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

The owner shall have the right of access to successful bidder's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labelled and transported carefully to the approved laboratory for carrying out the tests. The method and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory- in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

10.01.00 General

a) On completion of all the field (all the field works shall be certified by the owner) and laboratory work, the successful bidder shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc. Initially, the successful bidder shall submit ----- copies of the report in draft form for the owner's review.

b) The successful bidder's qualified geotechnical engineer shall visit the owner's corporate office for a detailed discussion on the owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft report. Thereafter the successful bidder shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted along with one set of reproducibles of the graphs, tables, etc.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The successful bidder shall acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 Data to be furnished

The report shall include the enlisted items but not be limited to them.

a) Purpose and scope of investigation
b) Authorization enabling the successful bidder to carry out the work at the site.

c) Project description including proposed facilities and construction materials required for the works.

d) Description of the site which shall include :

i) Location of the site and existing facilities.

ii) Topography of the site

iii) Drainage Characteristics

e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.

f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.

g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.

h) Geological information

i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.

ii) Description of overburden and bedrock at the site (if applicable for the site)

iii) Comments on texture and structure of rock, joints, bedding planes, fissures, weathering condition etc (of applicable for the site)

iv) Effect of geologic features on design.

i) Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.

j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.

k) Plot of SPT (N) value (both uncorrected and corrected) with depth.

l) Procedure of investigations employed - field tests and laboratory

investigation.

m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.

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

o) For all consolidation tests, the following curves shall be furnished :
e vs. log p
e vs. p and
compression vs. log t or
Compression vs. square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.

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

q) For pressure meter tests, the following curves shall be furnished :

Field pressure meter, creep and air calibration curves indicating Po, Pf and P1.

Corrected pressure meter and creep curves indicating P'o, P'f & P'1.

r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00 **Recommendations**

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following:

a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements

permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.

b) If required for shallow foundations, the following shall be indicated with comprehensive supporting calculations:

i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.

ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.

iii) Rate and magnitude of settlement expected of the structure.

iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results along with time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The recommended values shall include the effect of size, shape and depth of foundation.

c) As piling is envisaged, the following shall be indicated with comprehensive supporting calculations:

i) Type of pile and reasons for recommending the same considering soil characteristics.

ii) Suitable founding strata for pile.

iii) Estimated length and diameter of pile for various values of pile capacities. End bearing and frictional resistance shall be indicated separately.

iv) Magnitude of negative skin friction, if any, to be considered in pile design.

d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.

e) Recommendations regarding bases of roads and pavements.

10.04.00 **Additional Recommendations**

a) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.

c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.

d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.

e) Co-efficient of earth pressure at rest and stress strain modulus of soil from Menard pressure meter test.

f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.

g) Recommendations regarding method and slope of deep excavations.

h) Recommendations regarding stability of slopes, during excavations, etc.

i) Potential of rock slides and methods of stabilisation of sides for very steep cut.

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

k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.

l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.

m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub- structures and also recommended protective measures, if required.

n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.

o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated

pits / trenches.

p) Recommendation on the use of rock available as construction material.

q) Recommendation on the availability of material for use as aggregates at the site.

r) Recommendation for additional investigation beyond the scope of the present work if the successful bidder considers it necessary.

s) **Plates**

i) General plan showing location of site, and areal geology.
ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
iii) Geologic sections and soil profiles.

t) **Appendices**

i) Logs of subsurface explorations
ii) Field test results
iii) Laboratory test results

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PART-A

SECTION-II

GUIDELINE FOR AREA GRADING

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SECTION-II

GUIDELINE
FOR
AREA GRADING

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, , hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for sub-grade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof.

Since the work is to be carried out within the existing plant premises, dismantling of any existing structures as instructed by the owner, clearing and disposal of debris outside the plant premises and stacking the useful materials within the plant boundary in locations as directed by the owner included in this scope.

One workshop building has to be dismantled and the area shall be cleared of debris, etc and to be graded to the required level. The Useful materials shall be stacked within the plant premises as directed by the owner. Bidder may visit the site to access the quantum of work before bidding.

2.00.00 GENERAL

2.01.00 **Work to be provided for by the Successful bidder**

Necessary site leveling & Area Grading works of the FGD package area including final micro leveling is to be done by the successful Bidder.

The work to be provided for by the Successful bidder, unless specified otherwise, shall include but not be limited to the followings:

a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing etc. and all other details as may be required by the Engineer.

c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

2.02.00 **Work to be provided for by others**

No work under this specification will be provided by any agency other than the Successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place,
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils,

IS : 3764	:	Safety Code for Excavation Work
IS : 4081	:	Blasting and related drilling operations
IRC : SP-11	:	Hand book of quality control for construction of roads and runways
IRC : 36	:	Construction of Earth Embankments for Road Work

2.04.00 **Conformity with Designs**

The Successful bidder shall carry out the work as per the drawings issued to him and/or Successful bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be used**

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Owner.

2.05.02 Borrow Material (If required)

Borrow material if required for area filling shall be excavated from approved locations and levels **within a lead of 25KM**, and shall consist of selected material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail Engineering stage

~~Borrow material if required for area filling shall be excavated from approved locations and levels, and shall consist of selected material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail Engineering stage.~~

Necessary arrangement shall be done by the Successful Bidder for locating and using the borrow areas after approval as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 Quality Control

The Successful Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades: i) Periodic Surveys

ii) Establishment of markers, Boards etc.

iii) Checking levels and slopes of the graded surface.

b) Area filling : i) Checking the quality of fill material

ii) Checking moisture content of the fill.

iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications shall be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection shall be reviewed in accordance with the site Quality Plan.

3.00.00 EXECUTION

3.01.00 General

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks (if applicable), cable, pipelines, drains, trenches, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the Successful Bidder. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Owner. Adequate area lighting shall be provided by the Successful Bidder, if night work is undertaken.

The Successful Bidder shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Owner. The proposal shall include but not be limited to the following.

a) Mobilization and demobilization of plant

b) Proposed plant and equipment, labour resources & supervision.

c) Details of proposed method of clearing and grubbing for each area of cut and fill.

d) Drawings showing the areas for placement of material.

e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.

f) Temporary works proposals

g) Excavation, filling and compaction by mechanical plant

h) Dealing with surface water

i) Dewatering

j) Disposal of materials

k) Safety precautions, fencing and lighting

l) Calculations as appropriate to support work proposal

3.02.00 Setting Out

The Successful Bidder shall prepare and submit to the Owner/Consultant, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Owner/Consultant with modifications and corrections if necessary, the Successful Bidder shall set out the work from the control points furnished by the Owner and fix permanent points and markers for future checking. These permanent points and markers shall be checked by the Owner and certified by him after which the Successful Bidder shall proceed with the work. It should be noted that this checking by the Owner prior to start of the work shall in no way absolve the Successful Bidder of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Successful Bidder's work at any stage, the same shall be remedied by the Successful Bidder.

3.03.00 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Owner shall be taken by the Successful Bidder jointly with the Owner over the original ground prior to starting actual grading work and after setting out these initial levels and cross-sections shall be jointly signed by the Successful Bidder and the Owner before commencement of work.

3.04.00 Clearing and Grubbing etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. If existing, trees up to 300 mm girth shall be uprooted. Trees above 300mm girth which are required to be cut, shall be got identified by the Owner and then marked.

Felling of trees shall include taking out roots up to 600 mm below ground level. After the tree is cut and roots taken out, the pot- holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Owner otherwise. The trees shall be cut in suitable pieces as instructed by the Owner and then shall be transported to the Owner's store or any other space as directed by the Owner.

Before grading is started, all the spoils and unserviceable materials and rubbish shall be removed from the site to approved disposal areas as may be specified. Useful materials, saleable timber, firewood, steel scrap, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Owner.

3.05.00 **Classification**

Materials involved in grading shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Successful bidder:

a) **Ordinary and hard soil**

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) **Soft and Decomposed Rock**

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction. The mere fact that the Successful bidder resorts to blasting for his own convenience shall not

mean that the rock will be classified as hard rock.

3.06.00 **Earthwork in Excavation**

3.06.01 General

Before commencement of excavation/filling the existing ground surface shall be cleared in accordance with Clause no. 3.4.0.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Owner shall be obtained by the Successful Bidder, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Owner responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Owner.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Owner, soft and undesirable spots shall be removed even below the final level and the same shall be filled with lean PCC (M10) upto the founding level.

3.06.02 **Excavation in Ordinary Soil, Hard Soil & Soft and Decomposed Rock**

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Owner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines, drains, trenches, etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Owner thoroughly and the balance work shall be carried out carefully to avoid any over-excavation.

On completion, the work shall be finally checked and approved by the Owner. Further work shall be resumed after getting clearance from the Owner.

3.06.03 **Excavation in Hard Rock**

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed

after clearance from the Owner.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

3.06.04 **Blasting is not permitted since work is to be carried out within the existing running plant.**

3.06.05 **Disposal**

The excavated spoils shall be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Owner:

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

c) i) by either spreading, or

ii) Spreading and compacting at designated filling areas and/or disposal areas.

3.06.06 **Dewatering**

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Successful Bidder shall remove by pumping or other means approved by the Owner, any water inclusive of rain water and subsoil water accumulated in the area. Method of dewatering shall be got approved by the Owner.

Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure / super structure in a water free condition is in the scope of contractor. Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of purchaser to the nearby sump/drain i.e. Korappallum back water channel located at western side of plant boundary. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

3.06.07 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Successful Bidder may need to construct temporary drainage systems to drain surface water from working areas.

3.07.00 **Treatment of Slips**

The Successful Bidder shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Successful Bidder, the same shall be removed by him.

3.08.00 **Earthwork in Filling**

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Owner, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated soils or from borrow pits in selected areas designated/approved by the Owner. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murmur or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Owner, Successful Bidder shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed of as directed by the Owner within a lead of 5 KM after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have

been properly intercepted or otherwise dealt with as directed by the Owner. Before commencement of area filling the existing top soil shall be removed up to a minimum depth of 150 mm, or more, as directed by the Owner in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 300mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Owner.

a) Each layer of earth of cohesive in nature shall be compacted to 90% of proctor's dry density unless otherwise permitted/directed by the Owner.

b) Each layer of earth of non-cohesive in nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Owner. Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Owner.

The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six possess of 8/10 tons roller.

i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.

ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimize the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Owner and shall conform to the stipulations laid down in IS:4701.

The cohesion-less soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the Successful Bidder's cost as directed by

the Owner/Consultant. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the Successful Bidder's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill shall be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonnes roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 **Filling in Disposal Areas**

Excavated materials if not used in area filling, shall be disposed of in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Owner.

All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Owner.

3.09.00 **Compaction Control**

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Successful Bidder in accordance with these specifications and as directed by the Owner.

The Successful Bidder shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Successful Bidder is to obtain the Owner's/Consultant's approval for the firm to be used. The Successful Bidder

may undertake this work with the Owner's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Owner/Consultant based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The Successful Bidder shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Owner.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

Tests shall be undertaken by the Successful Bidder as per IS 2720 and as required by the owner. The results and reports shall be submitted to the Owner/Consultant for approval. Test failures if any are to be immediately notified to the Owner/Consultant, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction.

Each layer is to be tested in a manner that is representative of its full depth. The Owner/Consultant may at his discretion instruct the Successful Bidder to increase or decrease the frequency of testing.

4.02.00 **Acceptance Criteria**

4.02.01 Excavation

On completion of excavation, the dimensions of the area shall be checked as per the drawings after the area is completely dewatered. The work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by lean mix PCC M10. Over excavation of the sides shall be made good by the Successful Bidder. The excavation work shall be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.02 Area-filling

The degree of compaction required shall be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved shall be as decided by the Owner. The work of area filling shall be accepted after the Owner is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 After Award

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted before starting the work.

i) Equipment, machinery & earthmoving vehicles, available with the Successful bidder and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1.0 (i) above.

iii) Method of transportation.

5.02.00 After Award of Contract

After award of contract the Successful Bidder shall submit the following for approval and adoption:

a) The Successful Bidder shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area-filling quantities shall be balanced, minimizing temporary stacking of soils.

It is to be noted that the Owner even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Successful Bidder. The initial programme being submitted by the Successful Bidder should have sufficient flexibility to take care of such reasonable variations.

b) The Successful Bidder shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Owner/Consultant for adoption.

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PART-A

SECTION-III

GUIDELINE
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING

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SECTION-III

GUIDELINE
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 **Work to be provided for by the Successful Bidder by FGD Package**

The work to be provided for by the Successful Bidder of FGD Package, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of soils, disposal area, fencing, etc. and all other details as may be required by the Owner.

c) To carry out sampling and testing and submit to the Owner/Consultant, results of soil compaction tests whenever required by the Owner/Consultant to assess the degree of compaction.

2.02.00 **Work to be provided for by others**

No work under this specification shall be provided by any agency other than the Successful Bidder of FGD Package unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Consultant shall be followed :-

IS:2720 (Part-II)	Determination of Moisture Content
IS:2720 (Part-VII)	Determination of Moisture content / Dry Relation using Light Compaction.
IS:2720 (Part-xiv)	Determination of Density Index (Relative Density) of cohesionless soils.
IS:2720 (Part-xxix)	Determination of Dry Density , in place, by core cutter method.
IS:2720 (Part- xxviii)	Determination of Dry Density of soils, in place, by sand replacement methods.
IS:3764	Safety code for Excavation work.
IS:4081	Blasting and Successful Drilling Operations
IS:4701	Earthwork on canals

2.04.00 **Conformity with Designs**

Successful Bidder of FGD Package is to carry out the work as per the drawings which are approved by the Consultant and/or the Owner's instructions.

2.05.00 **Materials to be used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and approved by the Owner.

2.05.02 **Borrow Material**

Borrow material if required for back-filling shall be excavated from approved locations and levels, and shall consist of material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material without any additional cost to owner.

2.06.00 **Quality Control**

The Successful Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades : i) Periodic surveys

ii) Establishment of markers, boards etc.

b) Back-filling : i) Checking the quality of fill material

ii) Checking moisture content of the backfill

iii) Checking the degree of compaction

2.07.00 **Information regarding site conditions**

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Successful bidder must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.00.00 EXECUTION

3.01.00 **Setting Out**

Successful Bidder of FGD Package shall prepare and submit to the Owner /Consultant, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Owner /Consultant with modifications and corrections, if necessary, the Successful Bidder shall set out the work from the control points furnished by the Owner and fix permanent points and markers for ease of future checking. Adjacent structures/foundations shall be protected while executing the FGD construction work.

These permanent points and markers shall be fixed at intervals prescribed and checked by the Owner and certified by him after which the Successful Bidder shall proceed with the work. It should be noted that this checking by the Owner prior to start of the work shall in no way absolve the Successful

Bidder of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the Successful Bidder's work at any stage.

3.02.00 **Initial Levels**

Initial levels either in a definite grid pattern or as directed by the Owner will be taken by the Successful Bidder jointly with the Owner over the original ground prior to starting actual excavation work and after setting out. These initial levels and cross-sections shall be jointly signed by the Successful Bidder and the Owner before commencement of work

3.03.00 **Clearing and Grubbing, etc.**

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Owner and then marked. Felling of trees shall include taking out roots upto 600 mm below ground level or 150 mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Owner otherwise. The trees shall be cut in suitable pieces as instructed by the Owner.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Owner.

3.04.00 **Classification**

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include:

i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;

ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;

iii) soling of roads, paths, etc., and hard core ;

iv) macadam surfaces such as water bound, and bitumen/tar bound;

v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;

vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and

vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include:

i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;

ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;

iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include:

i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required;

ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

e) **Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (d) above excavation has to be carried out by chiselling, wedging or any other agreed method since blasting is prohibited within the plant premises.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.05.00 Excavation for Foundations and Trenches

3.05.01 General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Owner shall be obtained by the Successful Bidder, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Owner responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Owner. The vertical faces of excavation shall not be undercut for extended footings / foundations. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Owner they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Owner /Consultant and the Successful Bidder shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Successful Bidder shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Successful Bidder shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Owner, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring

removal as contemplated in the work, but which, in the opinion of the Owner, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Owner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Owner.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Owner, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Owner (with lean PCC M10).

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Owner, due to the Successful Bidder's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than M10 concrete or richer) as directed by the Owner in each individual case.

Should the bottom of any excavation at design depth appear to be soft, unsound or unstable, the Successful Bidder shall report the matter to the Owner and if the Owner so directs, shall excavate the same to indicated depths. The extra depth shall be filled up with concrete M10 or such other material as the Owner shall direct.

In formation of rock requiring blasting, those overcuts which are unavoidable shall be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Owner and shall be the property of the Owner.

3.05.02 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Owner. The work shall be carried out in a workman like manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work shall be checked by the Owner thoroughly and the balance work shall be carried out carefully to avoid any over-excavation. On completion, the work shall be finally checked and approved by the Owner. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Owner may order to suspend the work at any stage and instruct the Successful Bidder to carry out the balance work just before the foundation work of the structure can be started.

3.05.03 **Excavation in Hard Rock**

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Owner.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

As blasting is prohibited, the excavation shall be carried out by chiselling, wedging or any other approved method.

3.05.04 **NOT USED**

3.05.05 **Disposal**

The excavated spoils shall be disposed of in any or all the following manners:

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading or

ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Owner for use in backfilling by some other agency.

3.05.06 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Owner.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

3.05.07 **Protection**

The Owner shall be notified by the Successful Bidder as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Owner, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval by the Owner. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Owner.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Successful Bidder shall protect all under-ground services exposed by excavation. The Successful Bidder shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean. The use of mechanical equipment shall not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. The existing facilities shall be retained either by modifying or relocating as the case may be without any additional cost to owner.

3.05.08 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Successful Bidder may need to construct temporary drainage systems to drain surface water from working areas.

3.05.09 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Successful Bidder shall remove by pumping or other means approved by the Owner any water inclusive of rain water and subsoil water accumulated in excavation and keeps the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Owner but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

Any special dewatering system like well point dewatering required for lowering the ground water table to facilitate construction work of sub-structure / super structure in a water free condition is in the scope of contractor. Dewatering will be planned and continued till backfilling is completed. For discharge of sub-soil water / rain water, a suitable piping system with pumping arrangement will be provided by the contractor with prior approval of purchaser to the nearby sump/drain i.e. Korappallum back water channel located at western side of plant boundary. Contractor has to deploy dewatering diesel driven pumps/ DG sets of suitable capacity to take care of any exigencies in case of power disruption to the electrical driven dewatering pumps.

3.05.10 **Timber Shoring**

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Owner. It shall be the responsibility of the Successful Bidder to take all necessary steps to prevent the sides of trenches and pits from collapsing. Since the work is to be executed in the existing plant, the safety of the adjacent structures including foundation shall be protected.

3.05.10.1 **Close Timbering**

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Owner. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacings, cross strutted with ballies or as directed by the Owner. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 **Open Timbering**

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Owner. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 **Treatment of Slips**

The Successful Bidder shall take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Successful Bidder, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Successful Bidder shall be cleared and back-filled later by him.

3.07.00 **Back-filling**

3.07.01 **General**

The material used for backfilling shall consist of material, approved by the Owner obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Owner. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Owner may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete. No extra cost shall be claimed by the bidder on account of this.

3.07.02 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less that 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Owner. Compaction of the structure backfill by inundation with water

shall not be permitted.The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Owner.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.07.03 **Plinth Filling**

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Owner. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 **Filling in Trenches for Water Pipes and Drains**

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or laterite or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings or as specified elsewhere in the specification.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling up to a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock ,laterite or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 **Filling in Disposal Area**

Surplus material from excavation which is not required for backfilling shall be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers shall be employed and compaction done to the satisfaction of the Owner at the optimum moisture content which shall be checked and controlled by the Successful Bidder.

In certain cases the Owner may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00 **Approaches and Fencing**

The Successful Bidder should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.09.00 **Lighting**

Full scale area lighting is to be provided by the bidder if night work is permitted or directed by the Owner. If no night work is in progress, red warning lights should be provided by the bidder at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 **Excavation**

On completion of excavation, the dimensions of the pits shall be checked as per the drawings after the pits are completely dewatered the work shall be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of M10 proportion and/or richer and/or by compacted earth, as directed by the Owner / Consultant. The choice of grade of concrete shall be a matter of unfettered discretion of the Owner / Consultants.

Over excavation of the sides shall be made good by the Successful Bidder while carrying out the back-filling.

The excavation work shall be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 **Back-filling**

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part - VII) or a relative density of 75% as per IS-2720 (Part-XIV) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling shall be accepted after the Owner is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 **After Award**

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted before commencing the work.

5.02.00 **After Award of Contract**

After award of the Contract the Successful Bidder shall submit the following for approval and adoption:

a) Successful Bidder shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

The programme should show how the excavation and back-filling quantities shall be balanced, minimising temporary stacking of soils. It is to be noted that the Owner even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Successful Bidder. The initial programme being submitted by the Successful Bidder should have sufficient flexibility to take care of such reasonable variations.

b) The Successful Bidder shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Owner/Consultant for adoption.

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SECTION-IV

GUIDELINE
FOR
ELECTRICAL GROUNDING

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PART-A

SECTION-IV

GUIDELINE
FOR
ELECTRICAL GROUNDING

1.00.00 SCOPE

This Specification covers erection of Electrical Grounding mat / grid system along with risers upto various elevations for the buildings under the scope as defined in General Specification and other ancillary buildings as may be required as per details broadly indicated below and as per Grounding Notes and Details by Successful Bidders. Necessary steel shall be supplied by the FGD Package Bidder.

1.01.00 **Main Grounding Mat/ Grid**

Laying underground conductor each of one (1) 40 mm dia. M.S. Rod in the above areas and arc welding of conductor at each crossing and splicing (lap joint). Suitable pigtails shall be provided (minimum two) for each interconnection between individual mats and also for connections with future / existing grounding mat. Interconnection of ground conductors between mats and risers (rods) are within the scope of this specification and are the responsibility of the Successful Bidder.

1.02.00 **Grounding Electrode**

Fabrication and driving into ground 40 mm dia., 3000 mm long M.S. Rod grounding electrodes as required and connecting them to the grounding mat by arc welding shall be within the scope of this specification.

1.03.00 **Column Grounding**

All steel columns of FGD Package Area building& Structure shall be grounded using one (1) no. 50 x 6 mm galvanized steel flat arc welded to the columns at one end and riser at the other.

The necessary risers (40 mm dia. M.S. Rod) shall be provided for columns grounding. One end of these risers shall be arc welded to grounding mat and other end shall be brought 300 mm over grade level / concrete floor properly aligned with column foundation and arc welded to 50 x 6 mm G.S. flat.

1.04.00 **Risers & Sub-grids**

All risers shall be of 40 mm dia M.S. rod and arc welded to the grounding mat and brought 300 mm over grade level / concrete floor properly aligned with foundation.

1.05.00 **Cable Trench Grounding**

All electrical cable trenches shall be grounded by using one (1) no. 40 mm dia M.S. Rod at an interval of ten (10) meters. The end of this rod which is projected outside the wall of the trench shall be arc welded to the riser (40 mm dia M.S. Rod) which in turn connected to main grounding mat.

1.06.00 **Ancillary Works**

All ancillary works in connection with the items of work described above which though not specifically mentioned but are necessary to complete the work, shall be under the scope of this specification.

No additional excavation and backfilling are envisaged for mats in the other areas. However, if any such work is required, this shall be done at the agreed item rates but before undertaking such additional work of excavation or backfilling, specific prior approval of the Owner/Consultant in writing shall be obtained.

2.00.00 MATERIALS

All mild steel ground conductors and risers required for the work covered by this specification will be supplied by the Successful Bidder of FGD Package in standard lengths.

Supply of all materials required to complete the installation shall be the responsibility of the Successful Bidder. These materials shall include but not be limited to welding rods, bitumen compound, supports, clamps, connectors, consumables and sundry materials etc.

Any item of work or erection materials not specifically mentioned but essential to complete the installation shall be deemed to be included in the scope of this specification and shall be furnished by the Successful Bidder.

3.00.00 WORKMANSHIP

3.01.00 **Main Grounding Mat / Grid**

3.01.01 The underground mat / grid of mild steel rods shall be laid at a depth of minimum 1000 mm below grade level along the length and breadth of the

area. Mat conductors will comprise one (1) no. 40 mm dia. M.S. Rod. All crossings and lap-splicing shall be arc welded for good electrical continuity.

3.01.02 A minimum earth coverage of 300 mm shall be provided between the ground grid conductor and the bottom of trench, underground pipes foundation etc. at the crossing.

3.01.03 The related Successful Bidder shall plan and organize work to lay ground mat in the same sequence in which the building and equipment foundations are scheduled. Any additional excavation and backfilling, if required and authorized, shall also be carried out in time meeting the construction schedule.

3.01.04 In some cases it may happen that the construction work of cable trench, equipment foundation, laying of underground pipes are being taken up after the grounding mat has been laid. It may be required to cut a portion of grounding conductors to avoid fouling with cable trenches, equipment foundations, pipes etc. In this case, the ground conductors shall be properly rerouted and reconnected with the main ground mat during the construction of cable trench, equipment foundations, laying of underground pipes etc. and good electrical continuity of grounding conductor shall be ensured.

3.02.00 **Grounding Electrodes**

Grounding electrodes shall be 40 mm dia., 3000 mm long M.S. Rods. These are to be fabricated and driven into the ground by the side of mat conductors and electric arc welded to the grounding mat conductors.

3.03.00 **Risers & Sub-grids**

Risers are needed for connecting equipment or structures to the ground mat. These shall be 40 mm dia. M.S. Rod upto 300 mm level above ground. The risers shall be laid along the outer edge of concrete foundations properly aligned.

3.04.00 **Cable Trench Grounding**

The cable trenches shall be grounded through one (1) no. 40 mm dia. M.S. Rod as indicated under Clause No. 1.05.00. The projected end of this rod from the cable trench outer wall shall be electric arc welded with 40 mm dia. M.S. Rod from grounding mat. The other end of the rod shall be connected (arc welded) with one (1) no. 50x6 mm galvanized steel flat inside the cable trench.

3.05.00 **Column Grounding**

All steel columns of buildings shall be grounded as explained under clause no. 1.03.00. This laying, aligning along column foundation and connection to column and main grounding mat of 40mm dia.

Mild steel rod(riser) for column grounding are within the scope of this specification.

3.06.00 **Completeness of Work**

The installations shall be complete in all respects for efficient and trouble free service.

All work shall be done in a first class, neat workmanlike manner by persons skilled in the trade. All details of the installations shall be electrically and mechanically correct.

Any scaffolding or temporary structures made by the Successful Bidder for facility of work shall be removed to leave the place clean, failing which the work shall not be considered as complete.

4.00.00 TEST

On completion of installations, wholly or in individually units, it shall be tested in compliance with I.E. Rules/Indian codes of practice/Indian standard by the Successful Bidder in presence of the Owner.

5.00.00 SPECIFIC REQUIREMENT

5.01.00 **Handing over of the installation**

After satisfactory tests, the Successful Bidder shall write to the Owner for taking over the installation submitting results of all tests carried out. The Owner shall arrange for inspection and on receipt of satisfactory report, shall take over the installation in whole or in part, as the case may be. Till such time, the responsibility of the installation, not yet taken over, against theft, damage etc. shall fully be with the Successful Bidder.

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SECTION-V

GUIDELINE
FOR
CEMENT CONCRETE (PLAIN & REINFORCED)

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SECTION-V

GUIDELINE FOR CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or pre-cast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in IS: 456.

1.03.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Consultant shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder.

The work to be provided for by the Successful Bidder, unless otherwise specified shall include but not be limited to the following :-

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

c) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

d) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

e) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

f) Design and submit for approval concrete mix designsrequired to be adopted on the job.

g) Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

h) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

i) For supply of certain materials normally manufactured by specialist firms, the Successful Bidder shall produce, if directed by the Owner/Consultant, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Successful Bidder, jointly and severally.

2.02.00 **Work by Others**

No work under this specification shall be provided by any agency other than the Successful Bidder unless specifically mentioned elsewhere in the contract.

2.03.00 **Information to be submitted by the Tenderer**

2.03.01 After award

The following technical information shall be furnished after award:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 **After Award of Contract**

The following information and data including samples where necessary shall be submitted by the Successful Bidder progressively during the execution of the contract.

a) Programme of Execution and Requirement of Materials

This Master Programme may have to be reviewed and updated by the Successful Bidder, quarterly or at more frequent intervals as may be directed by the Owner's Consultant depending on the exigencies of the work.

Detailed day to day programme of every month shall be submitted by the Successful Bidder before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Owner/Consultant, in sufficient quantities for approval. Approved samples shall be preserved by the Consultant for future reference. The approval of the Owner/Consultant shall not, in any way, relieve the Successful Bidder of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates

ii) Admixtures

iii) Plywood for Formwork

iv) Embedded and anchorage materials as may be desired by the Owner/Consultant.

v) Joint sealing strips and other waterproofing materials.

vi) Joint filling compounds

vii) Foundation quality Rubber Pads

c) Design Mix

Design mix as per Clauses 2.01 (f) & 3.04 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., shall be submitted to the Owner/Consultant for his approval before it can be used on the works. After approval of design mix if the bidder changes the source of the aggregates of brand/type of the cement for any reason, fresh design mix shall be carried out and get approved by the owner.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.01(b).

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01 (b).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.01 (d).

g) Mill Test Reports for Cement & Reinforcing Steel

h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Owner/Consultant in accordance with Clause 2.04 of this specification.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 Conformity with Design

The Successful Bidder shall prepare check lists in approved proforma which shall be called 'Pour Cards'. These Pour Cards shall list out all items of work involved. The Successful Bidder shall inform the Owner/Consultant, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Owner/Consultant for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and

specifications, the Owner/Consultant shall give written permission on the same 'Pour Card' allowing the Successful Bidder to commence placement of concrete. Details of all instructions issued by the Owner/Consultant and the records of compliance by the Successful Bidder, deviations allowed by the Consultant and any other relevant information shall be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', shall be prepared by the Successful Bidder on approved proforma. The Pour Cards along with accompaniments shall be handed over to the Owner before starting placement of concrete.

One of the mix designs developed by the Successful Bidder as per the I.S. Specifications and established to the satisfaction of the Owner by trial mixes shall be permitted to be used by the Owner, the choice being dictated by the requirements of designs and workability.

The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete shall be as approved or directed by the Owner.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Code unless stated otherwise and be of best approved quality.

2.05.02 Cement

Generally cement shall be 43 grade ordinary Portland Cement conforming to IS-8112. In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Owner/Consultant:

a) 53 Grade ordinary Portland Cement conforming to IS-12269

b) Rapid hardening Portland Cement conforming to IS-8041

c) Portland slag cement conforming to IS-455

d) Hydrophobic Cement conforming to IS-8043

e) Low heat Portland Cement conforming to IS : 12600

f) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 Aggregates

Aggregates shall be natural or crushed stone or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine

and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Owner/Consultant.

a) Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm shall be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS: 383 shall be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS: 383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Owner/Consultant may ask the Successful Bidder to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 (latest revision) is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification shall be allowed to be used on works. Normally river sand shall be used as fine aggregates.

In case of unavailability of normal specified river sand, the M sand or Crushed stone sand shall be used with the approval of the Owner /Consultant as per given criteria/specifications below.

i) As per Cl. 3.1.4 , of IS-383 (latest revision) the terminology of M-sand (manufactured sand) as defined as fine aggregate manufactured from other than natural sources, by processing materials using thermal or other processes such as separation, washing, crushing and scrubbing. Generally the M-sand or Crushed stone sand for the fine aggregate is produced by crushing the hard stone.

The Crushed stone sand or M-sand conforming to the following shall only be used as fine aggregate in making concrete for sub and superstructures.

The Crushed stone sand is to be manufactured using VSI crushers only and not with HSI crushers. In order to remove the fines, Crushed stone sand manufacturer should have mechanized washing facility unit. Crushed sand stone conforming to Grading zone –II as per IS-383 (latest rev.) shall

only be used. The M-sand shall comply all the parameters and recommendations of IS: 383 (latest rev.)

ii) The M-sand shall be used only after the following tests are to be conducted by the bidders at the NABL accredited laboratories with proven track records of performing such type of tests by sending sealed samples of the materials –

a) Gradation Test.
b) Petrography.
c) Silt content.
d) Permeability test.
e) Adulteration test.
f) Design Mix Report.
g) Chemical Analysis Report

Using of M-Sand/Crushed Stone Sand based on the Test reports shall only be done after written approval of Engineer–In-Charge.

iii) The Crushed stone sand in general shall not be used for the following structures/facilities :-

a) Structures constructed using slip form technology
b) All internal & external plastering works.

The structures where the slip form construction is envisaged the M-sand or Crushed stone sand may be used for casting its foundations only as they are not constructed using slip form Technology.

iv) Special care for design mix, cement content and necessary curing in the initial stage shall be taken care of while using M-sand / Crushed stone sand. However if the results are not satisfactory, the use of crushed stone sand shall not be allowed for all RCC floor slab up to and including 150 mm thickness, which are directly exposed to the atmosphere immediately after casting. In such cases the ordinary river sand shall be used.

v) The M-sand/Crushed stone sand manufacturing locations shall be inspected by the Owner before giving approval for supply. The bidder shall ensure that the manufacturing process is done using only VSI crushers & shall have mechanized water washing unit for removal of fines in the Crushed stone sand manufactured.

Aggregates smaller than 4.75 mm and within the grading limits and other requirements set in IS-383 (latest rev.) as termed as fine aggregate. Only fine aggregate from approved sources

and conforming to IS: 383 (latest rev.) shall be used for execution. The bidder shall have well developed site laboratory and quality control team to take extra care while manufacturing and casting concrete using M-sand/ Crushed stone sand.

Normally, any particular structure shall be constructed by using any one type of sand (fine aggregate) only as per the direction / approval of engineer-in-charge. In general, it is not permitted to use different types of sand in any particular structure.

2.05.04 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 shall be followed for routine tests. Acceptance test for water shall be as per IS: 3025, and Table-1 of IS: 456.

In case of doubt regarding development of strength , the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 Admixture

Only admixture of approved quality shall be used when directed or permitted by the Owner/Consultant. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

IS : 2645 - Integral cement water proofing compound

IS : 9103 - Indian standard specification for Admixtures for Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075 , Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

- Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or equivalent.

b) Retarding admixtures :

- Modified lignosulphonate based set retarding concrete admixture like , "Plastiment R" or equivalent.

c) Water reducing admixtures :

- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" or equivalent.

d) Air entraining admixtures :

- Modified lignosulphonate based air entraining concrete admixture like "FLOMO AEP " or surface - active agents like "Sika AER" or equivalent.

e) Water proofing admixtures

All water retaining structures shall be provided with water proofing admixtures.

- Modified ligno-sulphonate based waterproofing admixture like "Plastocrete Super" or equivalent.

However, the Successful Bidder shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Owner/Consultant:

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride &sulphate content , PH value infra-red analysis & solid content.)

2.05.06 Reinforcement

Reinforcement shall be of Fe 500 grade Corrosion Resistant Steel and as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Owner/Consultant, shall not be used for concrete and shall be removed from site immediately, failing which, the

Owner shall be at liberty to get the materials removed and Storage of materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Successful Bidder to the satisfaction of the Owner/Consultant.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Owner/Consultant, as soon as it is detected.

Different types of cement shall be clearly marked with the Type and different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Owner/Consultant.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Owner/Consultant. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Successful Bidder shall establish and maintain quality control for different items of work and materials as may be directed by the Owner/Consultant to assure compliance with contract requirements and maintain and submit to the Owner/Consultant records of the same.
The quality control operation shall include but not be limited to the following items of work :

a)	Admixture	:	Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete. For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
b)	Aggregate	:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c)	Water	:	Impurities tests.
d)	Cement	:	Tests to satisfy relevant IS Specifications
e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f)	Reinforcement	:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Specification
g)	Grades of concrete	:	Usage and mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.
i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of

mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction : Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Beaming plates : Lines, elevations and bedding mortar.

n) Concrete Finishes : Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing : Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Owner/Consultant for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Owner/Consultant.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Owner/Consultant reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Owner/Consultant.

3.03.00 Grades of Concrete

Structural concrete grade shall be as per clause 4.00.00 Design of Reinforced Concrete Structures of volume: II-G/1 section-II and for other part of the work if not covered in the above clause, shall be as shown on the drawing as per grade classification of IS-456 and in case of liquid retaining structures, IS: 3370 shall be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Owner/Consultant.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS: 456 may be used if shown on drawings or approved by the Owner/Consultant. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Owner/Consultant is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes shall be designed by the Successful Bidder to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design shall keep in view the following considerations:

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Owner/Consultant. The Successful Bidder shall strictly abide by the same in his design of concrete mix installation. Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, values given in the tables in IS:456, shall be followed.

Various trials shall be given by the Successful Bidder with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE - I

STRENGTH REQUIREMENT OF CONCRETE

Grade of concrete	Specified Characteristic Compressive strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)
M - 15	15
M - 20	20
M - 25	25
M - 30	30
M - 35	35
M - 40	40

NOTE: 1 - Concrete Grade M-15 shall be used as lean concrete for simple foundations for masonry walls , below the reinforced concrete foundations and mass filling .Grades of concrete lower than M-35 shall not be used in reinforced concrete. These mixes need not be designed.

TABLE - II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO

(FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER / CEMENT RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
	0.7	01:08.0	01:08.5	01:07.4	01:08.0
Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE : 1 - Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Owner/Consultant.

NOTE : 2 - It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

NOTE : 3 - The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per cl 4.00.00 of Vol G1/sec II.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on -

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS: 456, shall be selected by trial and error. The values of water-cement ratios for different grade and mix designs shall have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Owner/Consultant. Frequent checks on test shall have to be carried out and the water-cement ratios shall be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Successful Bidder's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, proportions for different grades of concrete is specified in Table-9 of IS: 456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Table-5 of IS:456 gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 shall be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete.

The Successful Bidder may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super-plasticizer. However the Successful Bidder has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It shall be preferable to use Melamine based plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE - III

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts.
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

(**NOTE**: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Owner/Consultant)

With the permission of the Owner/Consultant, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as

adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Owner/Consultant, the compacting factor test in accordance with IS: 1199.

3.09.00 Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Owner/Consultant:-

Very narrow space	- 12 mm
Reinforced concrete including foundation	- 20 mm
Ordinary Plain concrete M10 and below	- 40 mm
Mass concrete	- 40 mm
Mass concrete in very large structure	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that shall work readily into position without segregation.

Coarse aggregate shall normally be separated into the following sizes and stacked separately in properly designed stockpiles :

40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions. Coarse aggregates more than 40mm size shall not be used in concrete.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 Mixing of Concrete

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Owner/Consultant for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum.

When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Owner/Consultant. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Owner/Consultant as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 shall be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS: 2722 may be used.

Batching plant conforming to IS: 4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of Cement, water or total aggregates being measured and within + 5% of the quantity of any admixture being used . The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Owner/Consultant. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Owner/Consultant, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and

compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as shall prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design shall be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Owner/Consultant, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code shall be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Owner/Consultant, shall be adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Owner/Consultant and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Owner/Consultant before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Owner/Consultant and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Owner/Consultant.

Rock foundation or construction joint shall be kept moist for at least 72 hours prior to placement. Concrete shall be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Owner/Consultant shall have to be adopted.

Formwork shall be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry shall be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar shall be deemed to be included.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Owner/Consultant, doubtful, in addition to immersion vibrators the Successful Bidder may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the Successful Bidder shall additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Owner/Consultant. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Owner/Consultant. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the

Owner/Consultant. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Owner/Consultant. Any deviation therefrom shall be set right by the Successful Bidder as instructed by the Owner/Consultant.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Owner/Consultant may direct to remove the portion and reconstruct or repair the same.

The Owner/Consultant shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints shall be formed in a manner specified in the drawings/ Instruction. Vertical construction joints shall be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint. For water retaining structures and leak-proof buildings suitable approved water bars shall be installed at the construction joints.

Where the location of the joints is not specified, it shall be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Successful Bidder proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Owner/Consultant for study and approval without which no construction joint shall be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Successful Bidder should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness (not leaner than the grade of concrete under consideration), shall be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint shall be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, the joint shall be left to harden for at least 12 - 24 hrs. It shall then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under Clause 3.12.

3.14.00 Repairs, Finishes and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection shall not be accepted and at successful bidder's own risk and cost, shall have to be dismantled, removed and replaced by sound concrete. The Owner/Consultant may, at his sole discretion, allow to retain concrete with minor defects provided the Successful Bidder is able to repair it by approved methods. All concrete work shall be inspected by the Successful Bidder immediately after the forms are removed and he shall promptly report occurrence of any defects to the Owner/Consultant. All repair works shall be carried out as per the instructions and in the presence of the Owner/Consultant or his representative. Generally, repair work shall consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the inforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left bycutting out defective concrete.

i) Grouting with a cement-sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 Finishing Unformed Surface

A few typical and common cases of treatment of concrete surface are cited below:

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance.

No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Owner/Consultant, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Owner/Consultant may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Successful Bidder shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Owner/Consultant, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing.

Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Owner/Consultant. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding.

Steps, as approved by the Owner/Consultant, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration,

abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water shall be allowed if the Owner is satisfied with the adequacy of the arrangements made by the Successful Bidder.

If permitted by the Owner, curing compound like "ANTISOLE (WP)" may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface.

It is important not to apply the curing compound when standing water is still present on concrete.

The Successful Bidder shall arrange for the manufacturer's supervision.

The Successful Bidder shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Owner's decision regarding the adequacy of curing is final.

In case any lapse on the part of the Successful Bidder is noticed by the Owner, he shall inform the Successful Bidder or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Successful Bidder within 3 (three) hours of issuance of such instruction, the Owner shall be at liberty either to employ sufficient means through any agency to make good the deficiency and entirely at the discretion of the Owner and at bidder's cost.

3.16.00 Reinforcement

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., shall be used as reinforcement as per drawings and directions. The reinforcing bars shall be TMT CRS of grade Fe500 as per IS 1786 (latest revision). If required, in an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Owner/Consultant.

3.16.01 Bar Bending Schedules

The Successful bidder shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the

arrangements proposed by the Successful bidder to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Successful bidder shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Successful bidder of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Cutting & Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Owner/Consultant. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Successful Bidder before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Owner/Consultant, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that shall injure the material. Rebending can be done only if approved by the Owner/Consultant. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat(not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Owner/Consultant at exceptional cases.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by three strands of No. 20 G/two strands of 18G/one strand of 16G annealed soft iron wire. Tack welding of bars should not be done unless permitted by

the Owner/Consultant. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held.

The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Successful Bidder shall study the drawings thoroughly and inform the Owner/Consultant in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Owner/Consultant.

3.16.05 Welding

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Owner/Consultant, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Owner/Consultant for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out.

Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Owner/Consultant. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Owner/Consultant. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Owner/Consultant.

3.17.00 Cold Weather Concreting

When conditions are such that any operation of concreting may be expected to be done at 5ºC atmospheric temperature or below the work

shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Successful Bidder shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40ºC while placing. Positive temperature control by precooling, postcooling or any other method, if required, shall be specified.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 Form Work

3.20.01 General

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The Successful Bidder shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Owner/Consultant prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Owner/Consultant.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rekers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Successful Bidder wishes to adopt any other design criteria, he has to convince the Owner/Consultant about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Owner/Consultant shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being

embedded, only mild steel or concrete of adequate strength shall be used.

Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits shall be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Owner immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Owner. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings , saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork.

The oiling of the formwork shall be inspected just prior to placement of concrete and redone wherever necessary.

3.20.02.01 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Owner/Consultant. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms shall carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The Successful Bidder shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.03 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Owner/Consultant. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Owner/Consultant shall be obtained.

3.20.04 Removal of Forms

Before removing any formwork, the Successful Bidder must notify the Consultant well in advance to enable him to inspect the concrete if he so desires. The Successful Bidder shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Owner/Consultant regularly.

The Successful Bidder shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. The Owner/Consultant may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Owner/Consultant in each case.

TABLE - IV

SCHEDULE OF REMOVAL OF FORM

	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
Part of Structure	Temperature °C				Temperature °C			
	Above 40°C	40°C.- 20°C	20°C -5°C	Below 5°C.	Above 40°C	40°C.- 20°C	20°C.- 5°C	Below 5°C
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove forms until site cured test speci- men develop at least 50% of the specified 28 days strength	1	1	1	Do not remove forms until site cured test specim- en dev- elop at least 50% of the specif- ied 28 days strength
b) Beam sides	3	2	3		2	1	1	
c) Slabs, 125 mm	10	7	8		7	4	5	
d) Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40ºC can be reduced to those of the temperature range of 20ºC to 40ºC subject to approval of the Owner/Consultant.

Construction joints in beams, if required to be provided, shall be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to

be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Owner/Consultant.

If any type of cement other than ordinary portland cement and Rapid hardening portland cement is used the time of removal or forms shall be revised as approved by the Owner/Consultant such that the strength of this cement at the time of removal of forms match with strength of portland cement at the time of removal of form as mentioned above . This has to be supported by regular tests.

3.20.05 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Owner/Consultant :

For

a) Sectional dimension - ± 5 mm

b) Plumb - 1 in 1000 of height

c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Owner/Consultant. Any error, within the above tolerance limits or any other as may be specially set up by the Owner/Consultant, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.06 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Owner/Consultant.

3.20.07 Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Owner/Consultant :

a) Ordinary : These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) Plywood : These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Owner/Consultant. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.

c) Ornamental: These shall be used where ornamental and curved surface are required and shall be made of selected best quality well-seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Successful Bidder shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Owner/Consultant.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures. The Successful Bidder shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Successful Bidder, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Owner/Consultant. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Owner/Consultant. Items to be embedded.

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any miscellaneous embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Successful Bidder.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter.

In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids by using water proofing admixtures and water stoppers as specified on the drawings/specifications or as directed by the Owner/Consultant. All materials are to be procured from reliable manufacturers and must have the approval of the Owner/Consultant. Where it is the responsibility of the Successful Bidder to supply the material, the Owner/Consultant may demand test certificates for the materials and/or instruct the Successful Bidder to get them tested in an approved laboratory. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Owner/Consultant before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. On already concreted surface a coat of hot bitumen shall be applied and the board shall be pasted over it. After placing the board a coat of Bitumen paint may have to be applied on the board against which concrete shall be placed.

At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality\of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material shall have to be procured from reliable manufacturers as approved by the Owner/Consultant. The method of installations shall be similar to that recommended by the manufacturers for fixing on cold storage walls. . On already concreted surface a coat of hot bitumen shall be applied and the board shall be pasted over it. After placing the board a coat of Bitumen paint may have to be applied on the board against which concrete shall be placed. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.

The sealing strips shall be non-metallic like rubber or P.V.C.

Sealing strips shall not have any longitudinal joint and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs.

The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Owner/Consultant. The Successful Bidder is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Owner/Consultant, joints in rubber seals may have to be vulcanised.

Non-metallic sealing strips shall be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features :

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints shall be allowed only under unavoidable circumstances and with the specific approval of the Owner/Consultant.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Owner/Consultant taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm unless otherwise specified. The actual size and shape shall be as shown in drawings of items and/or as directed by the Owner/Consultant. The material shall be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties shall be generally as follows. The actual requirements may be slightly different as decided by the Owner/Consultant:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75ºC
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C. sealing strips shall be 3 mm and the minimum width 100 mm unless otherwise specified. The actual size and shape shall be as shown in drawings/schedule of items and/or as directed by the Owner/Consultant. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties shall generally be as follows. The actual requirements, which shall be directed by the Owner/Consultant, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70ºC
Ultimate Elongation	:	Not less than 275%

3.23.04 Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed , the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 Isolation Joints

Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Owner/Consultant shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Owner/Consultant. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Successful Bidder. In general unless otherwise specified, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Owner/Consultant, 6 mm down stone chips may have to be

used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Owner/Consultant, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Owner/Consultant. Admixture, if directed to be added.

Alternatively non-shink , free flow, cementious grout like "Sikagrout 214/ Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Owner/Consultant.

3.25.00 Precast Concrete

The Specification for precast concrete shall be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Owner/Consultant, casting shall have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Owner/Consultant, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.
All members shall be indelibly marked with a unique identification mark on a surface which shall not be permanently exposed to show on which production line they were manufactured , their type , the class of concrete, the data of casting and if they are of a symmetrical section the face which shall be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Owner/Consultant. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Owner/Consultant. The Successful Bidder shall render all help with instruments, materials and men to the Owner/Consultant for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Owner/Consultant. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Consultant's/Owner's approval of the materials shall be obtained by the Successful Bidderbefore procurement. If desired by the Owner/Consultant, test certificates for the materials and samples shall be submitted by the Successful Bidder. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation shall be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the

formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent shall be mixed with water which shall be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent shall be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N /Sq. mm
Flexural Strength	-	25 to 30 N /Sq. mm.
Tensile strength	-	15 N Sq. mm (approx)
Bonding strength to concrete	-	3 N / Sq. mm (approx)
Bonding strength to steel	-	20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm . The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %

The maximum permissible dosage of admixture shall be 2% (two percent) by weight of cement. The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof

concrete around 410 Kg/ Cm.m a melamine based super plasiticizer shall be preferable.

a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Owner/Consultant. The Successful Bidder shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Owner/Consultant.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Owner's/Consultant's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Consultant. If desired by the Owner/Consultant, the Successful Bidder shall have the work supervised by the manufacturer's supervisor. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375ºF) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400ºF) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Owner/Consultant, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely.

In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous

emulsion/rubber protective coating of approved manufacturer for waterproofing purpose.

3.26.05 Protective Coating on Inside Surface

Unless otherwise specified, Two coats of cement based two-components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/ floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing. If required by the Owner/Consultant, tests as specified in relevant IS Codes shall be arranged by the Successful Bidder.

The Successful Bidder shall execute this work in direct collaboration with one of the well-known specialists approved by the Owner/Consultant.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. included in scope.

3.26.07 Polyethylene Films : Application in Walls or base of Structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6

ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed.

On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is

to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures shall be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Owner/Consultant, by using bitumen emulsion protective coating of approved manufacturer applied with two coats of Hot bituminous painting of grade 20/30 over a coat of Bitumen Primer except where special water proofing is specified for specific structures mentioned elsewhere.

3.28.00 Waterproofing by Pressure /Chemical Grouting

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non- shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Successful Bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Successful Bidder shall get the specimens tested in a laboratory approved by the Owner/Consultant and submit to the Owner/Consultant the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples shall be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Owner/Consultant.

4.03.00 Aggregates

The Successful Bidder shall carry out any or all the tests aggregates as may be required by the Owner/Consultant in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS:3550 shall be carried out by the Successful Bidder at regular intervals and whenever directed by the Owner/Consultant. The final acceptance criteria in case of doubt shall be as per IS:3025 & IS:456.

4.05.00 Admixture

4.05.01 Air Entraining Agents (A.E.A)

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete shall be established by the Successful Bidder by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Owner/Consultant, the Successful Bidder shall check-up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Successful Bidder.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Owner/Consultant may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Successful Bidder every two hours or as directed by the Owner/Consultant. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 15 of IS:456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Successful Bidder. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good to the satisfaction of the Owner/Consultant.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS:456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test

Load tests of structural members may be required by the Owner/Consultant, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456.

If load testing is decided by the Owner/Consultant, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Owner/Consultant. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Successful Bidder. Alternatively, if permitted under Statutory Regulations and at the discretion of the Owner/Consultant, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Successful Bidder. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same shall be made good by the Successful Bidder to the satisfaction of the Owner/Consultant.

6.00.00 LIST OF I.S. CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Consultant, shall be followed :-

IS : 73 - Indian Standard Specification for Paving Bitumen

IS : 216 - Indian Standard Specification for Coal Tar Pitch

IS : 269 - Indian Standard Specification for 33 grade Ordinary Portland Cement

IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
IS : 455	-	Indian Standard Specification for Portland Slag Cement
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 457	-	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS : 516	-	Indian Standard Specification for Methods of Test for Strength of Concrete
IS : 737	-	Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose. IS:1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200	-	Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.
IS : 1200	-	Indian Standard Specification for Method of (Part-V) Measurement of Formwork
IS : 1322	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
IS : 1489	-	Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2
IS : 1566	-	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
IS : 1609	-	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
IS : 1786	-	Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement
IS : 1791	-	Indian Standard Specification for Batch Type Concrete Mixers

IS : 1834	-	Indian standard specification for hot applied sealing compound for joint in concrete.
IS : 2062	-	Steel for general structural purpose.
IS : 2185	-	Indian Standard Specification for Hollow and solid / solid light wt. Cement Concrete Blocks - Part - 1 & 2
IS : 2210	-	Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
IS : 2430	-	Indian standard specification for method of sampling of Aggregate for concrete.
IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS : 2505	-	Indian Standard Specification for Concrete Vibrators Immersion Type
IS : 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators
IS : 2514	-	Indian Standard Specification for Concrete Vibrating Tables
IS : 2645	-	Integral Cement water proofing compound
IS : 2722	-	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1 : Pull out Test
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - art - 1 to 37
IS : 3201	-	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.

IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4
IS : 3384	-	Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing
IS : 3414	-	Code of practice for Design and Installation of joints in Buildings
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS : 3696	-	Safety Code for Part-1 : Scaffolding and Part 2: Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for Use as Pozzolone& Admixture
IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
IS : 4090	-	Indian Standard Specification for Design of Reinforced Concrete Archs
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers
IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground

IS : 4995	-	Indian Standard Specification for Design (Part-I of Reinforced Concrete Bins for the Storage & II) of Granular and Powdery Materials
IS : 4998	-	Indian Standard Specification for Design of (Part - I) Reinforced Concrete Chimneys
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
IS : 5513	-	Indian Standard Specification for Vicat Apparatus
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use
IS : 6909	-	Indian Standard Specification for Supersulphated Cement
IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
IS : 7242	-	Indian Standard Specification for Concrete Spreaders
IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete
IS : 7251	-	Indian Standard Specification for Concrete Finishers
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus
IS : 7861	-	Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting

IS : 7969	-	Safety Code for Storage and Handling of Building Materials
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement
IS : 8043	-	Indian standard specification for hydrophobic cement
IS : 8112	-	Indian Standard Specification for 43 grade Ordinary Portland Cement
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS : 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction
IS : 10262	-	Recommended Guideline for concrete Mix Design
IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement
IS : 12330	-	Indian standard specification for sulphate resting portland cement
IS : 12600	-	Indian standard specification for low heat portland cement

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PART-A

SECTION-VI

GUIDELINE
FOR
BORED CAST IN SITU CONCRETE PILE

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SECTION-VI

GUIDELINE
FOR
BORED CAST IN SITU CONCRETE PILE

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast- in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2), Latest Revision shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

Bored Cast-in-situ RCC pile passing through top soil overburden and highly weathered rock layer and terminating in the underlying sand stone layer with a socket length not less than 3D, (where D is the diameter of the pile) within such layer, will be considered. The capacity of the pile will be confirmed by the successful bidder by necessary load testing as per BIS and by design calculations.

To get generalized & tentative idea of sub-surface stratification as a whole, the soil report available with purchaser may be studied. However a confirmatory soil investigation will be done by the contractor after award of work to ascertain the top level of rock layer for their internal assessment of Pile length only. This will in no way affect the pile parameters stipulated in this specification.

2.00.00 GENERAL

2.01.00 Work to be provided by the successful bidder

The work to be provided for by the successful bidder, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of installation on six (6) copies of identification plan. The identification plan will be prepared by the successful bidder as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.

d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.

e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of pile installation equipment.

g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the successful bidder unless specified elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

IS : 8112 - Indian Standard Specifications for 43 Grade Ordinary Portland Cement.

IS : 12269 - Indian Standard Specifications for 53 Grade Ordinary Portland Cement.

IS : 383 - Indian Standard Specifications for Natural Sources for Concrete.

IS : 432 - Indian Standard Specification for (Part - I)Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.

IS : 455 - Indian Standard Specifications for Portland Slag Cement.

IS : 456 - Indian Standard Code of Practice for Plain and

Reinforced Concrete.

IS : 516	-	Indian Standard Specifications for Methods of Test for Strength of Concrete.
IS : 1199	-	Indian Standard Specifications for Methods of Sampling and Analysis of Concrete.
IS : 1786	-	Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement.
IS : 2062	-	Steel for General Structural Purposes
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII.
IS : 2502	-	Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement.
IS : 2722	-	Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.
IS : 2911	-	Code of Practice for Design and Cons-truction of Pile Foundations - Bored Cast-in-situ piles. (Part-I/Sec.2)
IS : 2911	-	Code of Practice for Design and (Part - IV)Construction of Pile Foundations - Load Test on Piles.
IS : 4926	-	Indian Standard Specifications for Ready Mixed Concrete.
IS : 9716	-	Guide for Lateral Dynamic Load Test on Piles.

2.04.00 Conformity with design

The successful bidder will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the successful bidder from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 Materials

2.05.01 General

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 Casing

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 Concrete

Concrete type M35 grade shall be used for piles. Materials and method of manufacture for cement concrete shall in general be in accordance with IS: 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS: 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Successful bidder at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. The water-cement ratio shall not exceed 0.5. To achieve the specified slump using specified water cement ratio without compromising with strength, suitable plasticiser, if required, may be used at no extra cost, subject to approval of NTPL. If concentration of Sulphate (measured as SO_3) exceeds 0.5% in soil or 1200 ppm in ground water, sulphate resisting cement shall be used. The minimum cement content should be 400 for M35 grade concrete respectively based on subsoil condition requirement besides that required from strength and other considerations.

The physical properties, mechanical properties & gradation of coarse & fine aggregate shall follow IS:383. Testing of aggregate properties (if desired by purchaser) shall follow relevant parts of IS:2386.

Refer General Specification for civil work for construction water.

Preliminary mix design shall be done in accordance withIS:10262 & SP:23 subject to approval of NTPL. Cube tests, slump test & other relevant tests for preliminary mix design and Routine cube test, slump test for regular concreting shall be carried out at site / site laboratory at contractor's own

cost. Concrete cube tests shall be done as per IS : 516. The calibration certificate (not older than one year) of the testing machine.

The calibration certificate (not older than one year) of the testing machine shall be available at site. If purchaser feels any doubt about the calibration, the contractor shall get it checked at an approved laboratory at his own cost. All such tests shall be conducted in presence of purchaser. At least one set (3 cubes for 7 days & 3 for 28 days strength) of cube shall be tested for every 10 piles or at any deterioration in concrete quality if felt purchaser, whichever occurs earlier. Slump tests (apparatus conforming to IS:IS:7320) shall be carried out at least once for each pile or more frequently, if desired by purchaser.

2.05.04 Reinforcement

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786. All bars shall be Corrosion Resistant Steel(CRS). Test certificate for reinforcement steel shall be obtained from recognised agency, before using. The purchaser may desire to check the testing of the same and the contractor shall arrange it in an approved laboratory at his own cost.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realized from the successful bidder's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 Casing

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 Quality Control

The successful bidder shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure

compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

a) Location and plumb : Control survey for accuracy in plan and check for verticality.

b) Driving of casing : Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.

c) Boring : Boring method to suit soil profile.

d) Casting of piles : Check inside casing, reinforcement cage, concrete mix, placing, consolidation and curing.

e) Inspection of pile

f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a `non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS : 2911 (Part - I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The successful bidder shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the bidder bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The bidder will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable

continuous hard strata based on approved soil data. In case the successful bidder is required to drive piles to greater or shallower depths than that is envisaged, no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

IS:2911 (Part 1/Section 2) : 'Code of practice for design & construction of Bored Cast- in- Situ concrete piles', IS : 2911 (part 4) 'Load Test on Piles & IS : 14593 : 'Design And Construction of Bored Cast-in-situ Piles founded on Rocks – Guidelines' will be referred to in conjunction with this specification during the entire design, construction & Load Testing work. These code form the integral part of this specification.

The piles will be bored cast-in-situ cylindrical type RCC piles of 450 mm &/or 550 mm &/or 750 mm &/or 1000 mm dia terminated within underlying sand stone layer with a rock- socket length not less than 3D (where D is the diameter of the pile) , to achieve the design capacity. Minimum center to center spacing between adjacent piles will be 2.5 D.

Sub-surface profile & Level of weathered Rock layer in different locations of the site are furnished in the Soil Investigation report available with purchaser .

The contractor will submit the structural design of pile for approval of purchaser/consultant . The contractor will guarantee the minimum safe vertical compressive design load capacities for piles

Capacity of Single Pile

A) Vertical Compressive capacity

The contractor will submit capacity of piles diameter wise along with design requirement .

B) Uplift Capacity

The Uplift capacity (for tension pile only) of single pile (with 3D rock socket), at this site, will be considered as 25 % of their respective Compressive capacity plus buoyant weight of pile. However, the same has to be confirmed by the successful contractor, by field load test on Trial pile before taking up the working piles.

C) Lateral Capacity

The Lateral capacity of single pile, at this site, will be considered as the minimum of the following:-

i) 5 % of their respective compressive capacity of pile.

ii) Lateral pile capacity assessed by the successful contractor by initial Pile Load Test on Trial Pile at selected representative locations, before taking up working piles. At least 3 Nos. of such tests is necessary, locations for which will be mutually decided by the contractor & purchaser.

The successful bidder shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., qualilty, workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Successful bidder with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Successful bidder to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the above mentioned basic length with no extra cost to Owner for deviation in length above or below the stipulated basic length.

The load test must be satisfactory and accepted by the Engineer. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the test shall be repeated to the satisfaction of the engineer without any extra cost.

3.03.00 Identification of Piles

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 Sequence of Piling

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity

reduced by subsequent boring/driving operation. The Successful bidder shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 Boring

3.05.01 With Casing

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equipment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Successful bidder based on visual inspection of recognizable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Successful bidder to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Successful bidder on such pro- portion of the heaved piles which shall be ordered by the Engineer.

3.05.02 With Drilling Fluid

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in inter- mediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 Spacing of Piles

In general, all piles shall have a minimum spacing on centres of 2.5d (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 Placing of Reinforcement

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 Concreting

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval

of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilized and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete entering the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 Tremie Method of Concreting

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimeters in order to note the difference, if any, between the theoretical quantity that should have been placed and actual quantity that has gone in. This is to locate the position of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

a) The concrete shall be coherent, rich in cement (not less than 400 kg/m3) and of slump not less than 100 mm.

b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.

c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.

d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.

e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.

f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the

laittance from being entrapped within the pile.

g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laittance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A ver- miculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100 cm, concreting may be resumed.

3.08.02 Concreting in Cased Holes

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 Cut-off Level

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 600 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 Steel Pipe or Casing tube

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accordance with IS : 817.

3.10.00 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Successful bidder's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days.

The concreted length of piles shall be measured from the toe of pile to cutoff level of pile.

Boring of any pile shall not be carried out within a clear distance of three times of the pile diameter from the adjacent pile which has been freshly concreted within past 24 hours.

The contractor shall take all necessary actions to prevent side collapse (if any) of pile bore at his own cost.

The contractor shall be responsible for the prompt removal from the site of all spoil due to the boring to places as indicated by purchaser. The cost of such disposal shall be deemed to have been included in the rate of piling.

Founding Strata

All the piles shall be founded on approved bearing strata or upto specified depth as per design requirement & as mentioned in the drawing.

In general, criteria for approval of founding strata shall be agreed between purchaser & contractor based on visual identification of recognisable samples recovered from pile borehole & specified SPT criteria.

In case, pile is socketted in rock strata, a minimum socketted length of Thrice the pile diameter (3D) shall be provided. The founding rock strata shall be identified by recognisable rock piece sample obtained by boring tool from pile bore &/or wash of rock powder in return water, SPT N > 100 at termination level and as decided by purchaser.

Termination criteria may be standardised / modified at site by purchaser depending on actual sub-surface material encountered and rate of penetration through such strata with the available equipment & accessories.

3.11.00 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 Removal of Spoil

The Successful bidder shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the Scope.

3.13.00 Back-Filling of Abandoned Borings

The Successful bidder shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.

All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix M10 so that resistance to lateral forces on neighbouring piles are developed.

3.14.00 Record for Installation of Piles

The Engineer and the Successful bidder shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Successful bidder. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

a) Date of completion, pile number & sequence of installation of piles in a group.

b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.

c) Pile diameter, details of reinforcement and details of mild steel liner where provided along with stiffener.

d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.

e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.

f) Method of cleaning bottom of hole at founding level before concreting.

g) Records of additional borings or other subsurface information obtained during the process of boring.

h) Any other relevant important information.

Any sudden change in the rate of boring which cannot be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Successful bidder. These data along with the load-displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 Defective Piles

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified, such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

When any pile is found defective, the Successful bidder shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

i) Replacement of defective piles.

ii) Providing additional piles.

iii) Alteration in design of pile caps.

3.16.00 Idle Period

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or some idle period, but the successful bidder will not be entitled to any claim due to this reason.

3.17.00 Test Pile

The successful bidder may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part - IV) or as directed by the engineer.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The successful bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the successful bidder shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of RCC

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 Components of Steel

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS : 9595.

4.04.00 Load Tests

4.04.01 General

Initial tests and/or routine tests as indicated in the FQP or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the tests described below shall be carried out as indicated in the FQP or as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 Vertical Load Test [as per IS : 2911 (Part-IV)]

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified below :

From among the completed piles the Engineer at his discretion shall select piles for the purpose of testing.

At least 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an over load of 100% above the working load of the pile.

Load shall be applied in increments of about one-fifth of the design load till the design load is reached and thereafter in increment of 10 tonnes till the test load is reached.

Each increment of load shall be maintained for minimum of half an hour upto design load and thereafter for one hour till the test load is reached. Test load shall be maintained for 24 hours.

For each increment of load, readings of settlement at every ten minutes shall be taken. The next increment of load shall be applied only when the difference in settlement of readings between the last two readings does not exceed 0.02 mm. On application of test load, readings shall be taken at every hour.

Unloading will be done in following decrements of load :

i) Test load to design load

ii) Design load to 50% of design load

iii) 50% of design load to 25% of design load

iv) 25% of design load to complete unloading

Each decreased load shall be kept for a minimum of half an hour and readings of rebound taken every ten minutes. The next decrement shall be applied only when the difference in readings between the last two readings is less than 0.02 mm.

The observation and recording of settlement and rebound shall be done simultaneously by the Successful bidder and the Engineer's representative. Three copies of all the readings for the test shall be supplied by the Successful bidder to the Engineer-in-charge. Actual proforma for recording the results shall be proposed by the Successful bidder and approved by the Engineer-in-charge before the start of the load test.

The pile shall be deemed to be acceptable if the gross settlement at the test load of one and a half times the designed load does not exceed 0.01" per tonne of test load or 1/2" (12 mm) whichever is less.

In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such piles failed and the Successful bidder shall carry out load tests on these piles in the same way as the load tests on the original piles at his own cost. This procedure will be repeated in the case of each failure of pile under/during load test.

The Successful bidder shall arrange at his own expense sufficient amount of knowledge for loading well in advance of the commencement of the load test.

Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Successful bidder to the Engineer-in-charge for checking and approval.

The pile head shall be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement shall be cut-off or bent suitably and the top finished smooth and level. A bearing plate with a hole at the centre shall be placed on the head of the pile for the jacks to rest.

Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and operated by one pump. The Successful bidder shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by minimum two (2) deflectometers of 0.01 mm sensitivity and also by other independent means of direct measurement.

Deflectometers shall be supported independently and in such a way as to be not affected by the settlement of the piles.

4.04.03 Lateral Load Test

The test shall be carried out by introducing hydraulic jack with gauge between two piles under test or the reaction shall be suitably obtained otherwise. When the test is conducted by jack located between two piles, the full load imposed by the jack shall be taken as the lateral resistance of each pile.

Load shall be applied in increments of about one-fifth of the design load. The next increment shall be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes. Displacement shall be read by using at least two (2) deflectometer of 0.01 mm sensitivity spaced by 30 cm and kept horizontally one above the other or by any means as per IS-2911 (Part-4) or as approved by the Engineer. The safe lateral load on pile shall be taken as the least of the followings :

a) Fifty percent (50%) of the final load at which displacement increases to 12 mm.

b) Final load at which the total displacement corresponds to 5 mm.

4.04.04 Pull-out Test

The test shall be carried out to an overload of fifty percent (50%) of the estimated safe load or a displacement of 12 mm total whichever is earlier.

Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull-out set up as per IS-2911 (Part-4) or as approved by the Engineer.

The pull-out load increments and consequent displacement readings shall be same as in the case of Vertical Load Test.

The safe load shall be taken as the least of the followings :

a) Two-thirds of the total load at which the load-displacement is 12 mm.

b) Half the load at which the load-displacement curve shows a clear break (downward trend).

4.05.00 Non-destructive Dynamic Test on Working Piles

4.05.01 "Low Strain" Method for Integrity Investigation of Concrete Piles :

The method of testing shall conform to ASTM D 4945.or equivalent Indian Standards.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Successful bidder. Analysis shall be carried out by exponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 "High Strain" Method for Determining of Pile Capacity

The method of testing shall conform to ASTM D 4945 or equivalent Indian Standards.

All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the successful bidder. For every hammer below, the analyser shall determine the following data :

i) Pile bearing capacity

ii) Transferred energy

iii) Maximum compression force

iv) Maximum tension force

v) Maximum impact velocity

vi) Maximum acceleration

vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 Acceptance Criteria

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

a) The head of the pile shall be within 75 mm of the specified position on the drawings.

b) The pile shall not be out of plumb by more than two percent.

c) The toe of the pile shall be at the approved bearing level in each case.

d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for

this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

e) The results of the load tests incl. non- destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.

f) In case of single pile the positional tolerance shall not be more than 50 mm.

4.07.00 Lateral Dynamic Load Test on Piles

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716 (Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined:

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 INFORMATION TO BE SUBMITTED

5.01.01 Design Data

The successful bidder shall submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 Programme of Construction

The successful bidder will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up, keeping in view the completion dates stipulated in the tender.

5.02.00 After Award

After award of the contract, the successful bidder is to submit the following details :

5.02.01 Execution Plan

The successful bidder will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 Detailed Construction Programme

A detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the bidder is to supply as per the terms and conditions of contract is to be submitted.

5.02.04 Test Results

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.

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PART-A

SECTION-VII

GUIDELINE
FOR
FABRICATION OF STRUCTURAL STEEL WORK

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SECTION-VII

GUIDELINE
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FABRICATION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc. as applicable, the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over and above this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder

The work to be provided for by the Successful Bidder, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following :

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on Successful Bidder's design drawings approved by the Consultants.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and connections developed by the Successful Bidderalong with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the Successful Bidder shall be in adequate quantity to avoid delay in erection.

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.02.00 Work by others

No work under this specification shall be provided for by any agency other than the Successful Bidder, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

LIST OF I.S. CODES - RELEVANT TO FABRICATION OF STRUCTURAL STEEL WORK

IS Codes		Description
IS : 800	-	Code of practice for general construction in steel.
IS : 801	-	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS : 806	-	Code of practice for use of steel tubes in general building construction.
IS : 808	-	Dimensions for rolled steel beams, channels and angle sections.
IS : 812	-	Glossary of terms relating to welding & cutting of metals.
IS : 813	-	Scheme of symbols for welding.

IS : 814	-	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS : 815	-	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS : 816	-	Code of practice for use of metal arc welding for general construction in mild steel.
IS : 817	-	Code of practice for training & testing metal arc welders.
IS : 818	-	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS : 819	-	Code of practice for resistance spot welding for light assemblies in mild steel.
IS : 822	-	Code of practice for inspection of welds.
IS : 919 (Part - 1&2)	-	Recommendations for limits and fits for engineering.
IS : 1161	-	Steel Tubes for structural purposes.
IS : 1182	-	Recommended practice for Radiographic Examination of fusion welded butt joints in steel plates.
IS : 1200 (Part - 8)	-	Method of measurement of steel work and iron work
IS : 1239 (Part - 1&2)	-	Mild steel tubes, tubulars and other wrought steel fittings
IS : 1363 (Part - 1 to 3)	-	Hexagon head bolts, screws and nuts of product grade C.
IS : 1364 (Part - 1 to 5)	-	Hexagon head bolts, screws and nuts of product grade A & B.
IS : 1365	-	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
IS : 1367 (Part - 1 to 18)	-	Technical supply conditions for threaded steel fasteners.
IS : 1608	-	Method for tensile testing of steel products.

IS : 1730	-	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
IS : 1852	-	Rolling and cutting tolerances for hot-rolled steel product.
IS : 1977	-	Structural steel (Ordinary quality)
IS : 2016	-	Plain washer
IS : 2062	-	Steel for general structural purposes.
IS : 2629	-	Recommended practice for hot-dip galvanising of iron and steel.
IS : 2633	-	Method for testing uniformity of coating on zinc coated articles.
IS : 3644	-	Code of practice for ultrasonic pulse echo testing by contact and immersion method.
IS : 3757	-	High Strength Structural Bolt
IS : 4000	-	High strength bolts in steel structure
IS : 4759	-	Specifications for hot-dip zinc coatings on structural steel and other allied products.
IS : 4923	-	Hollow steel sections for structural use.
IS : 5334	-	Code of practice for magnetic particle flaw detection of weld.
IS : 5369	-	General requirements for plain washers and lock washer.
IS : 6005	-	Code of practice for phosphating of iron and steel.
IS : 6649	-	Specification for hardened and tempered washers for high strength structural bolts and nuts.
IS : 6623	-	Specification for high strength structural nuts.
IS : 7215	-	Tolerances for fabrication of steel structures.
IS : 7280	-	Bare wire electrode for submerged arc welding.
IS : 8500	-	Structural steel micro alloyed (medium & high strength quality).

IS : 8629	-	Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.
IS : 9595	-	Recommendation for metal arc welding of carbon manganese steels.

PAINTING

IS : 117	-	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.
IS : 128	-	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.
IS : 1477 (Part - I & II)	-	Code of practice for painting of ferrous metal in building.
IS : 2074	-	Ready mixed paint, air-drying red-oxide zinc chrome priming.
IS : 2339	-	Specification for aluminium paints for general purposes in dual container.
IS : 2932	-	Specification for enamel, synthetic exterior type - I.
IS : 2933	-	Specification for enamel, synthetic exterior type - II.

2.04.00 Conformity with Designs

The Seller shall design all connections and supply all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Consultant keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Consultant.

Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Owner / Consultant. If desired by the Owner /Consultant, Test Certificates of materials supplied by the Seller in respect of each consignment shall be submitted in triplicate. Whenever the materials are

required to be used from unidentified stocks, if permitted by the Owner / Consultant, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable :

1) IS : 801 - Cold formed light gauge steel structural member.

2) IS : 806 - Steel tubes in general building construction.

3) IS : 1161 - Steel tubes for structural purpose.

4) IS : 1977 - St-42-0 Structural steel (Ordinary quality)

5) IS : 2062 - Steel for general structural purpose

6) IS : 8500 - Structural steel-micro alloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Electrodes

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable:

1) IS : 814 - Covered electrodes for metal arc welding structural steel

2) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

3) IS : 7280 - Base wire electrode for submerged arc welding.

2.05.04 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm^2 and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen : -

1) IS:1367 - Technical supply conditions for threaded fasteners.

2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Consultant.

c) High Strength Friction Grip Bolt : HSFG Bolts shall be high tensile of 20 mm dia or higher diameter and of property class 8.8 (minimum) as per IS – 1367 (Latest) for all major connection. All bolts, nuts and washers shall be procured from the approved manufacturers. The bolted joints shall be designed for friction type connection and the HT bolts shall be tighten to develop the required pretension during their installation.

2.05.05 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

1) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

2) IS : 2062 - Steel for general structural purpose

3) IS : 8500 - Structural steel - micro alloyed (medium& high strength quality)

4) IS : 6623 - High Strength Structural Nuts

5) IS : 6649 - Hardened and tampered washers for high strength structural bolts & nuts.

2.05.06 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Priming.(refer cl 1.00.00(g)/volume IIG1/section III)

2.06.00 Storage of Material

2.06.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the Successful Bidder's yard immediately, failing which, the Consultant shall be at liberty to get the material removed. The Successful Bidder shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in Successful Bidder's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Owner /Consultant, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 Electrodes

The electrodes for electric are welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.07.00 Quality Control

The Successful Bidder shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with QA/QC plan included as Appendix H. In addition to the Successful Bidder's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Consultant or Consultant's representative. As far as possible, all inspection by the Owner / Consultant shall be made at the Successful Bidder's fabrication shop whether located at Site or elsewhere. The Successful Bidder shall co-operate with the Owner / Consultant in permitting access for inspection to all places where work is being done and in providing all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Successful Bidder.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:

a) Steel : Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.08.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.09.00 Shop Drawings

The Successful Bidder shall submit to the Consultant the Schedule of Fabrication and delivery of structural steelwork for approval. He shall start to submit progressively for approval the shop drawings based on the approved Design Drawings and before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings shall be accorded only towards the general conformity with the design requirements as well as specification and shall ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. shall be entirely the Successful Bidder's responsibility.

The approval of the drawing however shall not relieve the Successful Bidder of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following : -

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion.

Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Successful Bidder shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication: Fabrication may be either shop fabricated of Site fabricated.

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600ºC.

3.01.03 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Consultant.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which shall be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep shall be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Consultant.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.02.00 Bolted construction

All bolted connections shall have a minimum of 2 bolts with c/c distance limited to minimum spacing as per IS: 800.

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.02.02 Assembly

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Consultant.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the

Drawings. For base plates at any level, the minimum thickness of the washer plate shall be 0.8 times of base plate thickness.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.03.02 Preparation of Material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as shall avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Consultant, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Consultant.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that shall ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

Minimum size of fillet weld based on thickness of thicker element connected shall be

(a) 6 mm for plate up to 20mm thick

(b) 8 mm for 21 to 30 mm thick

(c) 10 mm for 31 to 50 mm thick

(d) 12 mm for 51mm & above

All members shall be welded to the gusset for full contact length available.

Minimum fillet weld thickness for site welds shall be 8 mm with plates of thickness more than 8 mm.

Spacer plates for double and starred angle members shall be provided at a spacing of not more than 40 r (min) for compression elements and 80 r(min) for tension elements, where r (min) is rxx and ryy of the single angle respectively.

All gussets shall be of minimum 8mm thick. In the drawings thickness of gusset plate corresponding to forces in members shall be

(a) 8 mm gusset plate for forces up to 15 tonnes.

(b) 10 mm gusset plate for forces 16 – 25 tonnes.

(c) 12 mm gusset plate for forces 26 – 40 tonnes.

(d) 14mm gusset plate for forces 41-60 tonnes.

(e) 16 mm gusset plate for forces 61 - 80 tonnes.

(f) 18 mm gusset plate for forces 81 - 100 tonnes.

(g) 20 mm gusset plate for forces 101 ton and above.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg. C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be accepted by the Owner.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 Lacing bars

The ends of lacing bars shall be neat and free from burrs.

3.07.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.00 Shop connections

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Successful bidder will have to make the desired changes.

3.11.00 Castings

Steel castings shall be annealed

3.12.00 Shop erection

3.13.00 The steelwork shall be checked for accuracy of fit before despatch..
Shop painting

3.13.01 General

Unless otherwise specified, steelwork which shallbe concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given final coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Consultant.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the pre-cleaning, the metal surface shall immediately be painted with primer as per cl 1.00.00(g)/vol IIG1/sec III.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be as per cl 1.00.00(g)/vol IIG1/sec III.

3.13.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.03 Contact surfaces

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.00 Galvanizing

3.14.01 General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport

and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Owner/Consultant.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all work shall be made by the Owner /Consultant at the place of manufacture prior to delivery. The Owner /Consultant shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Successful Bidder shall provide such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Owner/Consultant to carry out inspection and/or tests in accordance with the Contract.

The Successful Bidder shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Successful Bidder shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items

The Successful Bidder shall get the specimens tested in a laboratory approved by the Owner /Consultant and submit to the Consultant the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by the Seller shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. .

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

Steel shall conform to IS : 2062 (latest) for rolled structural steel members.

4.02.03 Testing Criteria for checking Lamination in raw steel plates

All raw steel plate of thickness more than 20 mm supplied by the Seller shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Consultant.

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Consultant.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Consultant requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Successful Bidder. If the plates in the fabricated item is found to be laminated, the component shall be rejected.

4.02.04 Welding

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Owner/Consultant may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of further tests as may be desired by the Owner/Consultant, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Owner/Consultant shall have option to reject or instruct any remedial measures to be taken.

4.02.05 Bolts, nuts and washers

All bolts, nuts and washers shall be procured from reputed manufacturer accepted by the Owner and shall conform to the relevant Indian Standards. If desired by the Owner, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards.

4.02.06 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.07 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Owner/Consultant considers the defects rectifiable. The Owner/Consultant may, at his discretion, check the test results obtained at the Successful Bidder's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the Successful Bidder's shop under the terms of this contract have been successfully carried out, the steelwork shall be accepted forthwith and the Owner/Consultantshall issue an acceptance certificate, upon receipt of which, the items shall be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Successful Biddershall deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as shall permit the most efficient and economical performance of the erection work. theOwner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as shall further facilitate identification and erection.

4.05.03 Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. All packingsshall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following : -

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially :

a) Name of the Seller

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Successful Bidder When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Successful Bidder.

The Successful Bidder shall ship the complete materials or part on board a vessel belonging to an agency accepted by the Owner / Consultant on rail and/or road transport as directed. The Successful Bidder shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case shall the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

Necessary advise regarding the shipment with relevant details shall reach the Owner/Consultant at least a week in advance.

The Successful bidder shall submit periodic test reports of all materials procured and used such as raw steel, paints, electrodes, colour coated sheets, poly carbonate sheets, sheeting fixtures, bolts, nuts & washers etc. The test reports shall indicate conformance to specifications / IS codes etc.

The Successful bidder shall submit test reports for all welds carried out at shop such as UT and RT reports, shall also be submitted along with each inspection call, covering structures offered for inspection.

DFT record of paint applied measured at random covering structures offered for inspection.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 NOT USED

5.02.00 After Award of Contract

After award of the Contract the Successful Bidder is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Owner/Consultant on or before the 7th day of each month, giving the up to date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Results of any test as and when conducted and as required by the Owner/Consultant.

d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

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PART-A

SECTION-VIII

GUIDELINE
FOR
ERECTION OF STRUCTURAL STEEL WORK

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SECTION-VIII

GUIDELINE
FOR
ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful Bidder

The work to be provided for by the Successful Bidder, unless otherwise specified in the Contract, shall include but not be limited to the following:-

a) The Bidder shall provide all construction materials and the Successful Bidder shall provide all transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Owner/Consultant. If necessary, suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets any defect observed in the foundation shall be brought to the notice of the Owner/Consultant. The Successful Bidder shall fully satisfy himself

regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Owner/Consultant.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Owner/Consultant including but not limited to the following :

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting shall be permitted only at the discretion of the Owner/Consultant.

v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.02.00 Work by others

No work under this Specification shall be provided for by any agency other than the Successful Bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

IS-800 : Code of Practice for general construction in steel

IS-456 : Code of Practice for plain or reinforced concrete

IS-7205 : Safety Code for erection of Structural Steel work

IS-12843 : Tolerance for erection of Steel Structures

2.04.00 Conformity with designs

The Successful Bidder shall erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the Owner/Consultant. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Owner/Consultant.

2.05.00 Material

2.05.01 General

The Successful Bidder shall check the quantity, quality and the sizes of the fabricated materials and verify the adequacy of the same in accordance with the Drawings and Specifications. The Successful Bidder shall make good any deficiency, if detected, either by repair or with fresh material as may be directed by the Owner/Consultant.

All consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract shall be supplied by the Successful Bidder for erection work and shall be deemed to have been included in this rates.

2.05.02 Materials to conform to Indian Standards

All materials required to be supplied by the Seller under this Contract shall conform to the relevant Indian Standard Specifications.

2.06.00 Storage of materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Owner/Consultant shall be at liberty to get the materials removed by agency.

2.06.02 Yard

The Successful Bidder shall have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which shall be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments.

The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built.

2.07.00 Quality Control

The Successful Bidder shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Owner/Consultant to assure compliance with the provisions of the Contract and shall submit the records of the same to the Owner/Consultant. The quality control operation shall include but not be limited to the following items of work:-

1) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

2) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

3) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

The Successful Bidder shall salvage, collect and deliver all the packing materials to the Owner.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Owner/Consultant.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.01.03 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

The responsibility of the Successful Bidder in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Owner/Consultant.

3.01.04 Temporary floors for buildings

It shall be the responsibility of the successful bidder to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.01.05 Setting out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Owner/Consultant. Anchor bolts and other anchor steel shall be embedded by other agencies. The Successful Bidder shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Successful Bidder shall set proper screed bars if desired by the Owner/Consultant, to maintain proper level.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following :

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30

over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.08 Holes, cutting and fitting

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Owner/Consultant.

The Successful Bidder shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Owner/Consultant. Wherever such work is specified the Successful Bidder shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Owner/Consultant and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Owner/Consultant or shown on the drawings.

Admixtures like aluminium powder, "ironite" may be required to be added to the grout to enhance certain desirable properties of the grout.

It is preferable that the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like “Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.04.00 Painting after erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Owner/Consultant. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Successful Bidder. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which shall be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel

members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project.

The number of coats and the shades to be used shall be as specified or as directed by the Owner/Consultant.

3.05.00 NOT USED

3.06.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Owner/Consultant, the Successful Bidder shall remove all falsework, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.07.00 Safety Measures during Erection

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slinging, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Owner/Consultant, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the Successful Bidder responsible, to the satisfaction of the Owner/Consultant.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Owner/Consultant.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to1.5 times the specified superimposed

load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole.

Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 times the specified live load, in a manner and to an extent prescribed by the Owner/Consultant. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. here-in-before.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below :

Component	Description	Variation Allowed
I) For Buildings Containing Cranes		
i) Main columns	a) Shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels :	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for length measured between connection levels, but not more than ± 7.0 mm per 30 m length
	c) For adjacent pairs of	

			columns across the width of the building prior to placing of truss.	± 9 mm on true span.
		d)	For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
		e)	For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the same level.	3 mm
ii)	Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord	1/1500 of the span or not greater than 10 mm which-ever is the least
		b)	Lateral displacement of top chord at centre of span from vertical plane	1/250 of depth of truss or 20 mm which-running through centre ever is the least of supports.
iii)	Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
		b)	Deviation to crane rail gauge	± 3.0 mm
		c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
		d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm

iv) Setting of expansion gaps

At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C.

The coefficient of expansion or contraction shall be taken as 0.000012 per Deg.C per unit length.

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Consultant shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract..Acceptance of erected steel structures shall be either after completion of erection of the whole building or in blocks.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 NOT USED

5.01.01 Tentative Programme

The successful bidder shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary Works & Manpower (after award of contract)

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the successful bidder which he

will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted . The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection yard (after award of contract)

A site plan showing the layout and location of the erection yard proposed to be established by the successful bidder shall be furnished indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the successful bidder shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the successful bidder shall submit the following :-

5.02.01 Detailed Programme

The successful bidder shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The successful bidder shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the successful bidder shall also furnish details of fabricated materials in hand at site and the strength of his workers.

6.00.00 MISCELLANEOUS GUIDELINES

SAFE ERECTION PRACTICE

(a) DO'S

(1) Carry out erection only after structures are thoroughly inspected and cleared.

(2) Start erection from braced bay.

(3) Ensure proper packing below the columns to have correct levels (to be checked by survey schemes)

(4) Ensure proper anchoring of column base by tightening of all anchor bolts.

(5) Ensure that guying is done at 2/3rd height in 3 directions 120degree apart.

(6) Ensure that guy ropes are fully tight and anchored .Size of the guy rope should be adequate to take loads

(7) Provide temporary bracing wherever needed.

(8) Outstanding of flanges of beams /columns are to be protected against local bending at location of slinging during erection.

(9) Ensure that cross beam/bracings are erected only after the cleats/gussets are fully welded.

(10) Do the welding of cross beams with cleats, only after ensuring all bolts are in position and are tightened fully.

(b) DON'TS

(1) Don't leave the structures without proper guying in all directions till they are braced.

(2) Don't miss to anchor properly at the base of columns with anchor nuts fully tightened.

(3) Don't use manila ropes in place of steel ropes for guying.

(4) Don't support the cross beams with temporary jigs. Ensure all the bolts are provided and tightened.

(5) Don't use bracings/tie members for fixing lifting tackles/diversion pulleys/cable trays to avoid damages due to erection loads.

(6) Avoid indiscriminate cutting/notching of erected and loaded structures.

(7) Don't use column bases for anchoring guy ropes of structures.

GENERAL INSTRUCTION FOR WELDING

The Contractor shall work out welding procedure for the structures at his own responsibility and submit for Owner's/ consultant's information, considering the following factors.

a) Specification and thickness of steel.

b) Specification of electrode or/and base wire.

c) Welding process (manual arc welding, submerged arc welding).

d) Type of structures to be welded (thickness of components meeting at a joint).

e) Pre and post heating requirement.

f) Preparation of fusion faces.

g) Sequence of welding.

h) Weather condition.

i) Use of jigs and fixtures etc.

j) Type of non-destructive testing to be carried out.

k) Inspection procedure to be followed.

l) Design requirements of the joints.

Welding of any load bearing structure shall be carried out only by the person who has passed welder's qualification as per IS: 7318 (Part-I).

Contractor shall employ competent supervisors, exclusively for welding works, to ensure that the standard of workmanship and quality of materials comply with requirements of this specification.

All metal arc welding shall be carried out as per IS:9595-1996

Submerged arc welding of mild steel and low alloy steel shall be as per IS:4353-1995

Electrode shall conform to as specified in ANNEXURE- E of this specification.

Purchaser may at his own discretion order periodic tests of the Welders and/or of welds produced by them. Such tests shall be at the expense of the Contractor.

Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due any other reason shall not be used.

Low Hydrogen electrodes and flux for submerged welding shall be dried at 250°-300° C for one hour in drying even before use.

For suitability of wire flux combination, procedure test shall be carried out as per IS: 15977-2013 if so required.

Welding shall be done by electric arc process. Generally submerged arc, automatic & Semi-automatic welding shall be employed. Only where it is not practicable, manual arc welding may be resorted to. In case of manual arc welding, recommendations of electrode manufacturer are to be strictly followed.

After completing each run of weld, all slag should be thoroughly removed and surface cleaned before starting the next run of weld. The weld metal as deposited (including tack welds if to be incorporated) shall be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld shall have a uniform and consistent contour and uniform appearance.

Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method, which does not cause grooving and other surface defects on the weld or on the parent metal.

All butt welds shall start and end with run-on and run-off plates. All such plates shall be carefully trimmed off by gas cutting after welding is over.

Fillet welds shall not be stopped at corners but shall be returned round them.

If butt weld is to be ground flush with the surface of the member as per drawing. Adequate reinforcement shall be built up and then the same shall be chipped off and ground flush. The grinding is to done in the direction of stress flow till the transverse marks are eliminated.

Welding shall not be done under such weather conditions, which might adversely affect the efficiency of the welding and arc-strikes on parent surfaces of structures shall be strictly avoided.

Manipulators shall be used wherever necessary and shall be designed to facilitate welding and ensure that all welds are easily accessible to the operators.
Stress relieving after welding shall be done if especially called for in the drawing or specification. Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

CONTROLS IN WELDING

The extent of quality control in respect of welds for structural elements for both statically and dynamically loaded structures shall be as follows and shall be conducted by the contractor at his own cost. Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

a) Visual Examination

All welds shall be 100% visually inspected to eliminate the following defects like Presence of undercuts, Visually identifiable surface cracks in both welds and base metals, Unfilled craters, Improper weld profile and size, excessive reinforcement in weld, Surface porosity etc.

b) Dye Penetration Test (DPT)

This shall be carried out in accordance with IS: 11732 – 1995, used for steel castings, for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following like Surface cracks, Surface porosity. Severity Level 3 shall be considered for acceptance.

c) Ultrasonic testing

Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by purchaser, to detect the following like Cracks, Lack of fusion, Slag inclusions, Gas porosity.

All butt welds shall be tested for 100 % length by Ultrasonic tests and report shall be submitted.

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-96 Chapter -6: Part F.

Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d) Radiographic Testing (X-ray and Gamma-Ray Examination)

This test shall be conducted to a minimum of 2% of length of welds of each element of each butt joint for welds made by manual or semi- automatic welding and 1 % of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by purchaser to detect the following defects like gas porosity, slag inclusions, lack of penetration, lack of fusion, cracks.

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWS D1.1-96 Part E.

Any surface irregularity like undercuts, craters, pits etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than 0.75 x focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

ACCEPTABLE LIMITS OF DEFECTS IN WELD

Limits of Acceptability of welding defects shall be as follows.

a) Visual inspection & Dye Penetration Test –

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 6.9 & clause 6.10 of American National Standard ANSI/AWS D1.1-96 or equivalent Indian Standards for statically as well as dynamically loaded structures respectively.

b) Ultrasonic Testing –

The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 6.13.1 & clause 6.13.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C or equivalent Indian Standards for statically and dynamically loaded structures respectively.

c) Radiographic testing –

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clauses 6.12.1 & 6.12.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C or equivalent Indian Standards for statically and dynamically loaded structures respectively.

RECTIFICATION OF DEFECTS IN WELDS

In case of detection of defects in welds, the rectification of the same shall be done as follows.

a) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.

b) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.

c) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

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PART – A

SECTION-IX

GUIDELINE
FOR
ROADS AND DRAINAGE

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PART-A

SECTION-IX

GUIDELINE
FOR
ROADS AND DRAINAGE

1.00.00 SCOPE

This specification covers all work required for the construction of R.C.C road including box-cutting, edging, Subgrade, sub-bases preparation, RC slab etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 All the required roads within the battery limit of FGD Package, shall be under the scope of the bidder including formation of sub-grade, sub-base and laying of RCC. All the required roads in the plant area within the battery limits of FGD package and connecting the same with the plant main roads will be executed by respective successful bidder. Approach roads to all the buildings, structures, facilities for this FGD package shall be provided by the successful bidder.

Work to be provided for by the Successful Bidder

The work to be provided for by the Successful Bidder, unless specified otherwise, shall include but not be limited to the followings:

a) Furnish all labour, supervision, services, tools and plants, transportation etc. required for the work. All materials and equipment shall be supplied by Seller.

b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.

c) To carry out and submit to the Owner/Consultant results of tests whenever required by the Owner /Consultant to assess the quality of work.

2.02.00 Work to be provided for by Others

No work under this specification shall be provided for by any agency other than the Successful Bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC: SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

5. IS: 2212 Code of Practice for Brickwork.

6. IS: 783 Code of Practice for Laying of Concrete Pipes.

7. IRC: 15 Code of practice for construction of Concrete Pavement.

8. IRC: 58 Guidelines for the Design of plain jointed Rigid Pavement.

9. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Owner/Consultant shall be followed.

2.04.00 Conformity with Designs

The Successful Bidder shall carryout the work as per the Bidder's drawings which are approved by the Consultant and/or the Consultant's instructions.

2.05.00 Materials to be Used

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Owner/Consultant.

2.06.00 Quality Control

The Successful Bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Owner/Consultant. Permitted tolerances for road works are described hereinafter.

2.07.00 Concrete Road and Rigid Pavement.

Plant Roads:

Access within the plant site shall be provided by a system of roadways. All roads within this FGD package are RCC roads only including approach roads to the buildings/structures.

All building shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement. Access roads shall also be provided to areas such as transformer areas, steam generator Area and other equipment area shown in the plot plan, where access is necessary for inspection, operation and maintenance.

The sub base over the well compacted subgrade of all plant service roads within the battery limit of FGD package will initially be made of well graded granular material like locally available crushed stone as per IRC-63 and 100mm DLC with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement.

All Roads where there is heavy vehicle movement shall be of RC concrete roads with hard RC shoulder.

All roads within battery limit of FGD package shall have rectangular RCC side drain along both sides.

All RCC Roads and parking area shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice and MOST specification (MORT&H) for movement of heavy equipment.

The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design shall be laid over 100mm DLC on a crushed stone sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.

All the roads inside the plant area shall be of reinforced cement concrete of minimum 250 mm thick.

The sub-grade whether in cut or fill shall be well compacted to utilize its full strength. The R.C.C roads of required thickness as per design shall be laid

over 100mm DLC on a crushed stone base/sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size. A separation layer of 125micron thick impermeable Plastic sheeting shall be provided below the RCC slab.

The width of the carriage, shoulder and drains shall match with the existing connecting roads.

All the roads shall be constructed before start of construction activities for buildings and shall again be repaired / made good after completion of construction of activities i.e at the time of handover / project.

All type of roads shall have a minimum turning radius as per relevant IRC codes (IRC-38).

Boulders shall be provided alongside of all type of roads near equipment which requires protection. Spare duct bank shall be provided under all type roads spaced at 100m intervals.

Signs shall be provided for vehicle management and shall meet the indian standards. All signs shall be dual worded in both English and the local indian language. Finished top (crest) of roads shall be as per CEA guide lines. Geometric design of road shall be in accordance with IRC: 73. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 25.

The shoulder shall be laid with slope of 1 in 30.

Top level of parking area shall be flushed with crown connecting roads with cross slope. Parking area shall be provided rigid pavements & shall be provided with anti-skid concrete paver blocks.

On either side of roads, open drains shall be provided. Minimum clear width of drains shall be 600mm or the connecting drains whichever is higher..The drains shall be designed and built using RCC. Drainage lines and other underground services shall be located at least 1m clear from the edge of the roads. All service and utility lines crossing the roads shall be taken through NP3 class RCC pipe designed for impact loading. All culverts carrying storm water shall be cast in place RCC box culverts.

No underground service piping except for drainage and sewage system shall run directly below the road (including upto 1 m. from edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The roads must be designed for the heaviest equipment of the plant and before designing the CBR test to be carried out. Road shall be designed as per IRC & MOST standards. (MORT&H).

The Cross section for Concrete road in general shall be as follows:

i) The Sub-grade, whether in cut or fill shall be well compacted to utilize its full strength. The Sub-grade shall have no soft spots or voids and undulations and shall be well compacted to achieve a minimum 95% dry density.

ii) crushed stone sub-base of 230 mm consolidated thickness with 63 mm downgraded aggregate size.

iii) 100mm thick dry lean concrete (DLC).

iv) A separation membrane shall be used between concrete slab and the sub base. The membrane shall be impermeable plastic sheeting of 125 microns thick laid flat without creases.

v) Pavement of 250mm thick M35 mix, with double mat reinforcement of 10tor @ 200 c/c both ways or as per the design whichever is higher.

vi) The drainage system shall be designed for precipitation intensity of 100mm per hour.

The above specified description is minimum and indicative and the successful bidder has to design and provide roads as per actual functional requirements and design criteria stipulated in relevant codes.

The detailed methodology for construction of concrete /rigid pavement including construction and expansion joint shall be prepared by the successful bidder for approval of Owner.

2.08.00 Road Side Drains

2.08.01 Formation of Drains

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 125 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads.

Inside surface of the drain shall have screed concrete with 12mm blue metalchips in M20 and smooth neat cement finish over screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The slope of the drain shall be 1:1000 longitudinally in general. However, discharge velocity shall be within non-silting & non-scouring condition.

2.09.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Owner/Consultant after clearing the

site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable. The top level of the Culverts shall match with the top level of road.

2.10.00 Shoulders

The sub grade shall be compacted well and the sub base shall be 230mm consolidated thickness of stone boulders/ soling as per specification over which P.C.C (M20) shall be laid to required thickness. The level of the shoulder shall be in line with the road top level or at higher level based on the location which will be decided during detailed engineering. Necessary chutes if required to the adjoining drain shall be provided.

2.11.00 Kerbs

P.C.C (M20) Kerb for full depth of the pavement shall be provided on both sides of carriage way of concrete roads. Kerbs shall be laid and set in place before completing the concrete wearing surface as well as the concrete wearing surface of shoulder. Setting shall be done in mortar where so specified They shall be laid and set in such a way as to obtain straight lines in the finished work, the top surface matching with the finished surface of shoulder if the shoulder is at higer level of the road.Where the road edge forms a curve, thekerbs shall follow such curve. Gaps may be left as shown in drawings or as may be required to provide for drainage. They shall be fixed true to line and level and secured in position by approved means.

The Kerbs shall be painted as per IRC- 35 (latest edition).

3.00.00 EXECUTION

3.01.00 Drainage Pipes

3.01.01 Materials

The drainage pipes unless otherwise shown on drawings or instructed by the Owner/Consultant shall be made of R.C.C. and shall be NP3. No pipe culverts are permitted for drainage crossings.

All pipes shall meet the requirements of IS: 458- Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The Successful Bidder shall specifically mention the particular manufacturer's product he proposes to use. Cement shall be ordinary Portland Cement as per IS: 8112 - Latest edition.

Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS: 383 - Latest edition.

3.01.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Owner/Consultant. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/permitted by the Owner/Consultant. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc. as required shall be done by the Successful Bidder without the Owner. Side slips, if there be any, shall be removed by the Successful Bidder. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the Owner/Consultant. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Owner /Consultant. Pipe sections and collars shall be inspected carefully for defects before laying in the trenches. Broken or defective pipes shall not be used and shall be properly marked and removed from the site as soon as the defects are detected

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Owner/Consultant and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe. In no case, the pipe shall be laid directly on the bed rock or boulder strata

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection

ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earth filling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS: 783.

When indicated on the drawings or directed by the Owner/Consultant, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Owner /Consultant. The pipe shall be laid on the concrete bedding before the concrete has set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) NOT USED

e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS: 783 - latest edition.

g) All storm water drain crossing shall be of RCC box culverts only.

3.01.03 Relation with Water Supply Pipeline

Unless specifically cleared by the Owner/Consultant, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.02.00 Manholes and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water-tight under test. The channel or drain at the bottom of

chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Consultant. The covers shall be close fitting so as to prevent gases from coming out.

3.03.00 Masonry

3.03.01 Brick Masonry (If specified)

All bricks shall be of first class (Class A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free lime.. Bricks shall be soaked in water for at least two hours prior to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of Items or directed by the Owner/Consultant, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing.

Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS:1077. Bricks shall have minimum crushing strength of 50 kg/Sq.cm.

3.03.02 Stone Masonry (If specified)

All stones shall be from approved quarries, hard, tough, durable, compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. A stone shall not absorb more than 5 percent of its weight of water after 24 hours immersion. Samples shall be submitted by the successful bidder and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.03 Pointing to Masonry

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean. The pointed surface shall be kept wet for at least three days for curing.

3.04.00 Plaster to Masonry and Concrete

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned, plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall than be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used. Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS:1661- latest edition.

3.04.01 Finish

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Owner/Consultant. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Owner /Consultant the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire

area shall be uniformly treated with a paste of neat and rubbed smooth with a trowel.

3.05.00 Cement Concrete (Plain and Reinforced)

Shall be as laid down in "Guideline for Cement Concrete (Plain and Reinforced)" Vol - II G- Part – A Section - V.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Successful Bidder as per direction of the Consultant. No extra payment shall be made for such tests.

4.02.00 Masonry and Plastering

Masonry and finish to masonry and concrete shall fully comply with the drawings, approved samples and instructions of the Consultant with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

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SECTION-I

GUIDELINE FOR PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

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PART-B

SECTION-I

GUIDELINE FOR PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

1.00.00 SCOPE

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 MATERIALS

a) **Bricks**

i) Common Burnt Clay Bricks : Bricks for general masonry work shall conform to IS: 1077-1970 and for face brick work shall conform to the specifications in IS: 2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws warpage or nodules or free lime, having a frog 100mm in length 40 mm in width and 10mm to 20mm deep on one of its flat sides and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc.

Compressive strength shall be as per table-1 below. The bricks, when tested, shall have a minimum average compressive strength for various classes as given in Table-1 below. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any brick tested exceeds the upper limit for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table-1 for the purpose of calculating the average compressive strength.

The average value of water absorption of bricks when tested shall not be more than 20% by weight.

All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The rating of efflorescence shall not be more than 'moderate'.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be up to the specification and defective bricks shall be removed immediately from site at the Bidder's own cost.

TABLE-1

Class Designation	Average compressive strength			
	Not less than			
	N/mm^2	(kg/cm^2)		
12.5(125)	12.5	(125)		
10 (100)	10	(100)		
7.5 (75)	7.5	(75)		
5 (50)	5	(50)		
3.5 (35)	3.5	(35)		

ii) Fly Ash Lime Bricks (FLAG Bricks): The Fly Ash Lime Bricks (flag Bricks) shall conform to IS 12894. The dimensions of the Fly ash bricks shall be 190x90x90mm. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with frog on one flat side and without frog on other flat side. Fly ash shall confirm to IS 3812. The average compressive strength shall confirm to class 5 as given in the table above.

Note : Fly ash bricks will be operated only for non-load bearing walls and above ground level.

Sand : Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime : Lime shall conform to class 'C' hydrated lime of IS 712

Additives : Any suitable additive considered not detrimental to the durability of bricks may be used.

Alternatively Lime may be replaced by Cement in manufacturing of Fly ash bricks. The cement shall be blended at the rate of 8 to 12%.

iii) **Mechanised Autoclave Fly Ash Lime Brick:** These bricks shall be machine moulded and prepared in plat by appropriate proportion of fly ash and lime/cement. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and the frog shall be of 100/80 mm in length, 40 mm width and 10 to 20 mm deep on one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

b) **Stone**

For all concrete works Blue Granite Metal shall only be used.

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion and for laterite this percentage is 12%. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Bidder and approved samples shall be retained by the Engineer for comparison of bulk supply. The compressive strength of common types of stones shall be as per Table below.

TABLE-2

Type of stone	Maximum Water Absorption Percentage by weight	Minimum Compressive Strength kg/sq.cm
Granite	0.5	1000
Basalt	0.5	400
Lime stone(Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800
Laterite(Block)	12	35

c) **Lime**

Lime shall be stone lime and conform to the specification Building Limes - IS: 712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaked with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) **Cement**

Cement used shall be ordinarily Portland cement conforming to Code for ordinary cement in IS: 269 and shall be fresh when delivered. The Bidder shall submit the manufacturer's test certificate for each consignment of cement procured to the Engineer If at any time, the Engineer feels that the cement being used by the Bidder is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Bidder. The Bidder shall also have no claim for this type of suspension of work.

e) **Coarse Aggregates**

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.
Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) **Sand**

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrities, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to

affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS: 383.

Generally River sand shall be used for all the works. In case of scarcity/non-availability of River sand, M-Sand may be used at the discretion of the Engineer-in-charge at site.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS: 226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432 Cold twisted steel bars shall conform to IS: 1786. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanised. All reinforcements shall be Corrosion Resistant Steel(CRS).

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) **Bricks**

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimise breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) **Stones**

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) **Lime**

Lime shall be stored in weatherproof sheds.

d) **Cement**

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Bidder and shall be removed from the site immediately.

e) **Coarse and Fine Aggregates**

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) **Reinforcement**

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

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SECTION-II

GUIDELINE
FOR
ANTI-TERMITE TREATMENT

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GUIDELINE
FOR
ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to prevent the subterranean termites from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites while the building is under construction. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

2.02.00 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contract with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.03.00 **Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		**Concentration by Weight, Percentage**
Chlorpyrifos Emulsifiable (20EC) (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable (20EC) Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable (20EC) Concentrate (IS: 2682 - 1984)	:	1.0
Lindane (20 EC) (IS: 632)	:	1.0

2.03.01 **Treatment**

To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites shall be done as per IS 6313 (Part III).

2.03.02 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (up to a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

If there is a concrete or masonry apron around the building, approximately 12mm diameter holes shall be drilled as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to sock the soil below at the rate of 2.25 litres per linear metre.

2.03.03 **Treatment of Top Surface of Plinth Filling**

Holes 50 cm to 75 cm deep at 100 cm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.03.04 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 cm and a depth of 75 cm at the point where they enter the building.

2.03.05 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.03.06 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 300 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981	:	Code of Practice of Anti-Termite Measures in Buildings (pre-constructional)
IS : 632	:	Gamma-BHC (Lindane) emulsifiable Concentrates
IS : 8944 – 1978	:	Chlorpyrifos emulsifiable concentrates
IS : 8963	:	Chlorpyrifos- Technical specifications
IS : 6439 – 1978	:	Heptachlor Emulsifiable
IS : 2682 – 1984	:	Chlordane Emulsifiable
		Pre-constructional chemical treatment measures.

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SECTION-III

GUIDELINE
FOR
MASONRY AND ALLIED WORK

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GUIDELINE
FOR
MASONRY AND ALLIED WORK

1.00.00 SCOPE

This specification covers furnishing, providing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Soling

2.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per the direction of the engineer in charge. Orientation shall be as desired by the Engineer. After lying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling as specified. in. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.02.00 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.03.00 **Masonry**

2.03.01 **General**

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.03.02 **Mortar**

Mix for mortar shall be specified..

When lime is used hydrated lime shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

Lime shall not be used where reinforcement is provided in brick work.

2.03.03 **Brick Masonry**

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. For brick work in half brick wall, bricks shall be laid in stretcher

bond. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar. At the joint of brick masonry with RCC column/beam/wall, the mortar shall be with rich grade to avoid shear cracks.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. The inside face of the brick work shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.03.04 **Exposed Brickwork**

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified , the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified.. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.03.06 **Cavity Wall**

It is wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50mm and not more than 115mm. Each leaf of the cavity wall shall not be less than 75mm.

The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

2.03.06.01 **Metal Ties**

These may be of galvanized iron, wrought iron, gun metal, brass, copper, stainless steel or ant such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

2.03.06.02 **Bonding Units**

These shall be preferably precast R.C.C. units.

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves plus width of cavity if the leaves are 75mm or 115mm. If the leaves are more than 115mm thick, then the length of a unit will be 2x115+width of cavity. Precast RCC units shall be provided with 2 no. , 6mm mild steel reinforcement bars tied with 2 no. 3 mm. dia. wire/hard drawn wire cross bars placed in the centre of units.
Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1cement: 3coarse sand: 6 graded stone aggregate 20mm nominal size)

2.03.06.03 **Spacing**

Metal ties/bonding units shall be spaced not more than 90cm apart horizontally and 45cm vertically and staggered in each course. Additional ties shall be used near openings.

2.03.06.04 **Restrictions**

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

2.03.07 **Expansion & Separation Joints**

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and as specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.03.08 **Moldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.03.09 **Curing**

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.03.10 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.03.11 **Encasing of Structural Steel**

This shall be done by building masonry work, around flanges, webs etc. of steel members and filling the gap between steel and masonry by minimum 12 mm thick rich mortar. Encased members shall be wrapped with minimum 18G chicken wire mesh when shown on drawings or instructed by the Engineer, before plastering work.

The minimum lap in chicken wire mesh shall be 50 mm.

2.04.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 **Damp Proof Membrane**

Damp proof treatment using fiber or Hessian base bitumen felt shall be 6, 8 or 10 course treatments as specified in IS: 1609. The number of courses shall be as mentioned elsewhere in the specification. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after lying. The Bidder shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **I.S. CODES**

Some of the important relevant codes for this section are: -

IS : 1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS : 2185	:	Code Practice for hollow concrete block.
IS : 1597	:	Code of Practice for Construction of stone Masonry.
IS : 1609	:	Code of Practice for laying Damp-proof treatment Using bitumen felts.
IS : 2212	:	Code of Practice for Brickwork.
IS : 2250	:	Code of Practice for preparation and use of Masonry Mortar.
IS : 5134	:	Bitumen Impregnated Paper & Board.

VOLUME: II-G/2

PART – B

SECTION-IV

GUIDELINE
FOR
FINISH TO MASONRY AND CONCRETE

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PART - B
SECTION-IV

GUIDELINE
FOR
FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Bidder shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not are allowed in pillars/columns less than one metre in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purpose shall be filled and made good before plastering.

Note : In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance.

2.01.01 Preparation of Surface

The cement plaster shall be 6 mm, 10mm, 12mm, 15mm, 18mm or 20mm as specified.

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 **Plastering**

2.02.01 **Mortar**

Mortar for plastering shall be as specified in the specifications.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **Application of Plaster**

Ceiling plaster shall be completed before commencement of wall plaster.

Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the

scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working or over working the float shall be avoided.

All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, provision of grooves at junctions etc. where required shall be done. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not to nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in the plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Thickness

Where the thickness required as 20mm, the average thickness of the plaster shall not be less than 20mm weather the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15mm while in case of stone work the minimum thickness over the bushings shall be not less than 12mm.

Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitable protected from all damages at the Bidder's expense

by such means as the Engineer-in-Charge may approve. The dates on which the plastering is done legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

2.02.03 **Finish**

The plaster shall be finished to a true and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Precaution

Any cracks which appear in the surface and all portions which sounds hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm drawn with any suitable method with the wall while the plaster is green.

ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150mm wide chicken wire mesh should be fixed with U nails 150mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall not be made separately.

iii) Due to faulty construction, if the plaster thickness increases more than 20 mm, the Bidder shall provide chicken mesh to hold the plaster, at his own cost.

Cement Plaster with a Floating coat of Neat Cement

The cement plaster shall be 6mm, 10, 12, 15, 18mm or 20mm thick, finished with a floating coat of neat cement, as described in the specification.

Specifications for this item of work shall be same as described above except for the additional floating coat which shall be carried out as below.

When plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a pest of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quality of cement applied for floating coat shall be 1 kg

per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in above shall apply.

18mm/20 mm Cement Plaster (Two Coat Work)

The specification for scaffolding and preparation of surface shall be as described above.

Mortar

The mix and type of the aggregate specified in the description of item shall be used for the respective coats. Generally the mix of the finishing coat unless otherwise described in the item.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat , unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

Application

The plaster shall be applied in two coats i.e. 12 mm under coat and then 6/8mm finishing coat and shall have an average total thickness of not less than 18/20mm.

12mm under coat

This shall be applied as specified earlier except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

6/8 mm finishing coat

The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified earlier.

Specifications for curing, Finishing and Precautions shall be as describe earlier.

6/10 mm Cement Plaster on Cement Concrete and Reinforced Cement Concrete Work

Scaffolding

Stage scaffolding shall be provided for the work. This shall be independent of the walls.

Preparation of Surface

Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacing of not more than 5 cm. Centers, the pock being made not less than 3mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

Mortars

Mortar of the specified mix using the types of sand described in the item shall be used.

Application

To ensure even thickness and true surface, gauges of plaster 15 x 15 cm. shall be first applied at more than 1.5m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then be applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In the case of ceiling of roof slabs, plaster shall be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Thickness

The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5mm.

Curing

The specification as stated earlier

Precautions

The specification as stated earlier

2.02.04 **Other Finish**

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) **Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) **Neat Cement Finish**

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M. or as per schedule and rubbed smooth with a trowel.

c) **Coloured Plaster Finish**

This shall be done in the same way as specified in clause 6.1.2.2.2 but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition.

Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) **Pebble-dash Finish (In Situ Work)**

The specification shall be the same as for rough cast plaster, except that the washed pebble or crushed stone graded from 12.5 mm to 6.3mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified by hand, so that the finished surface represents a homogeneous surface.

Specification for scaffolding, preparation of surface and mortar shall be as described earlier.

e) **Rough-Cast Finish**

Rough cast finish comprises of a mixture of sand and stone chips in specified proportions dashed over a freshly plastered surface.

Preparation of surface

The joints shall be raked out, dust and loose mortar, shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

Mortar

Mortar of specified mix using the type of sand described in the item shall be used, where coarse sand is to be used, the fineness modulus of the sand shall not be less than 2.5mm

Application

The plaster base over which roughcast finish is to be applied shall consist of two coats, under layer 12mm thick and top layer 10mm.

12mm Under Layer

This shall be applied in the same manner as specified in earlier under 18mm cement plaster except that the finishing, after the mortar has been brought to a level with the wooden straight edge, shall be done with wooden float only.

Top Layer

The top layer shall be applied a day or two after the under layer has taken initial set. The latter shall not be allowed to dry out, before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of rich mix 1: 3 (1 cement: 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well

pitched with the plaster surface. In order to make the base plastic, about 10% of finely grouted hydrated lime by volume of cement, shall be added when preparing mortar for the top layer.

Finish

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 2.36 mm to 12.5mm or as specified and in the proportions as specified accurately to the effect required. The mixture gets well pitched into the plaster base. The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surface of sand mixed with gravel. A sample of rough cast plaster shall be got approved by the Engineer-in-charge.

Specification for other details like precautions etc. as described earlier.

f) **Scraped Finish**

Ordinary plaster as described under Clause 6.1.2.2.2 after being levelled and allowed to stiffen for a few hours shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) **Textured Finish**

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under “Plastering” Clause 6.1.2.2.2. Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) **External Quality Glass Mosaic Tiles**

Glass mosaic tiles to be laid in pattern and profiles on a bed of cement mortar 1:3 (with coarse sand) and set in cement paste or adhesive of approved quality & make, joints filled and finished by neat in pigmented cement or sealant of approved quality & brand and cured including necessary adjustment at edges corners etc. complete, strictly as per the manufacturer's specification & details. in walls, ceiling, soffits up to all elevations in straight or curved surface as murals or wall claddings per drawing & instruction of the Engineer-in-charge.

The following important steps to be followed for installation of “Glass Mosaic” tiles

Preparing the surface

The surface to be tiled must be clean, smooth and clean of dust. It must be in plumb and should be dry.

Application of adhesive

A good quality Latex-Modified thinest to be applied as approved by Engineer-in-charge for fixing of mosaic tiles. Thinset should be compatible with the substrate and environment (i.e. wet areas or exterior areas). The adhesive should be thick enough to avoid mosaic sheets from slipping once placed on the wall. Spread the adhesive uniformly (about 3mm thick) on the wall using the straight edge of the trowel. With the toothed edge of the trowel, comb the adhesive through.

Installation mosaic mounted on paper

Mosaic sheets with the paper side to be faced up. After pressing the sheets firmly in one direction, rubbers float to be used to tap the sheets. A wooden float may also be used but never a metal one. It is to check that all sheets are placed at the exact same distance from each other as the tiles.

After the mosaics have started to set, but before they become fully bonded the paper the paper should be removed. A damp sponge to be used on the surface of the sheets to ensure easy removal of the paper. Paper to be removed carefully by pulling one corner of the paper diagonally across the sheet. This must be done gently to ensure that no tiles are dislodged in the process. Realign any tiles with a spatula and remove excess adhesive at this point. Let the adhesive dry for approximately 24 hrs before beginning the grouting process.

Installation of mosaic mounted on mesh

Mosaic sheets with the mesh backing to be installed by pressing directly on the adhesive. A rubber or wooden float to be used to tap the sheets to ensure a flat and even surface. It is to check that all sheets are placed at the exact same distance from each other as the tiles. Adhesive to be applied as much as possible so that it can be covered with in 10 to 20 minutes or until surface is still wet and tacky. Tiles to be allowed to set until firm. Clean excess adhesive from the surface of the tile to set firm. Clean excess adhesive from the surface of the tile with wet cloth or sponge while the setting material is fresh. Leave the surface to dry before beginning the grouting process.

Grouting

Sponge & warm water to be used to remove any excess adhesive on the sheets. The surface must be free from dust. Using a hard rubber float, spread the grout horizontally and vertically on the mosaic sheet. Cover an area of not more than 2 sq mtr. at a time. Excess grout to be removed with the rubber float by working diagonally across the mosaics. After grouting, wait approximately 20 minutes before cleaning the excess grout.

Material specification

Glass mosaic tiles to be either gloss or mat finish quality with the size 20x20mm to 25x25mm, weight 7.5 kg to 8.7 kg per sqm, thickness 3.8 to 4.5mm, water absorption < 0.1%. It should have excellent stain resistant, UV resistant, frost resistant, thermal shock resistant and chemical resistant property. Size and type of tiles (Gloss or matt finish) to be as per drawing and approval of the Engineer-in-charge.

i) **1st Quality Ceramic Glazed External Wall Tiles**

Ceramic exterior wall tiles of work size 150 x 300mm (textured surface) with thickness varies from 8.5mm to 10mm on a single tile due to 3D surface, applicable only for wet cladding. It should conform to ISO 13006 / EN 159 Group B III. The linear thermal expansion of tiles should be 9 X $10^{-6}K^{-1}$, Max.

Application

Surfaces to be tiled must be dry, clean and free from all contamination and should be dried and cured for at least two weeks.

The adhesive should be added to clean water and mixed thoroughly until a slump-free mortar is obtained. The adhesive is immediately ready – for- use and has a pot life of 3 hours. No further water should be added.

1. Spread not more than 1 sq.m. at a time , apply the adhesive to the wall surface.

2. Comb the adhesive to the required depth (between 3-6 mm) using a suitable trowel.

3. Press the tiles firmly into position with a slight twisting action, checking periodically that good contact is maintained with the back of each tile. Leave no voids behind the tiles when solid-bed fixing.

4. Tiles should be fixed within 20 minutes of the adhesive being applied, depending on the porosity of the surface and

atmospheric conditions. Tiles can be adjusted up to 5-10 mins. after fixing.

5. Leave adequate joints (2-3 mm) between individual wall tiles by using spacer & to be grouted with polymer grout. This has to be maintained to avoid expansion – contraction problem due to climatic change as it will be exposed to sun.

6. Clean off surplus adhesive from the tile face and between joints.

7. Do not use in damp conditions.

8. Grouting should not be carried out for at least 24 hours.

j) **Heritage Granular Finish Work**

Heritage granular finish should be with special silica sand coloured wide inorganic pigments along with acrylic co-polymer bonding agent containing biocides / fungicides and stabilizing adhesive. Application thickness will be 0.8mm to 1.2 mm as per JISA 6909.

The application to be done on plastered surface at all elevations as per design, drawing, manufacturers specification and direction of Engineer-in-charge, complete in all respect

2.03.00 **Pointing to Masonry**

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 **Plaster with Metal Lath**

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers. The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by

volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 6.1.2.2.1. The application, finish etc. shall be as specified under relevant clause above. Where called, a 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 **Lime Punning**

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 **Plaster of Paris Punning**

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 **Stone Facing**

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Bidder shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and

polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings and/or Schedule of Items.

2.08.00 **White Cement Putty Punning**

Plastered surfaces, where specified shall be finished with White Cement Putty punning. The material shall be from approved manufacturers and approved by the Engineer. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 sq.m. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

	PROPERTY	
1.	Tensile Adhesion Strength (N/MM^2) @ 28 Days	> 1.0
2.	Compressive Strength (N/MM^2) @ 28 Days	> 9.0
3.	Setting Time (Minutes) - Initial Final	=> 100 =< 500
4.	Water Absorption Coefficient - $Kg/M^2.H^{1/2}$	< 1.0
5.	Water Capillary Absorption (ML) @ 24 Hrs.	0.8
6.	Water Retentivity %	> 98

Surface Preparation

All loosely adhering materials on the plastered wall surface is to be removed with the help of emery stone, putty blade or wire brush and clean water. The substrate should be cleaned, free from dust, grease and loose materials. Dry and absorbent surface should be moistened with sufficient quantity of clean water.

Mixing

White cement putty should be mixed slowly with 30-35% of clean water to form a paste. Mixing is to be continued for 10-15 minutes to form a uniform paste.

Application method

First coat shall be applied on well moistened plastered wall surface from bottom to upward direction uniformly with putty blade. After drying of first coat the surface shall be rubbed gently with wet sponge or putty blade to remove loose particles. Surface shall be allowed 3 hours to dry before applying the second coat. After complete drying of second coat, loose particles shall be removed by gently rubbing the surface with wet sponge or putty blade. After mixing the putty should be utilized within 2 hours. Total thickness of coats shall not be more than 1.5mm or as per manufacturer specifications.

2.09.00 **Cement Water Proofing Compound**

It shall be used for cement mortar for plastering or concrete work.

Water Proofing Compound

Integral cement water proofing compound conforming to IS 2645 and of approved brand and manufacturer, enlisted by the Engineer-in-Charge from time to time shall be used.

The Bidder shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added.
It shall be measured by weight.

The rate shall include the cost of all labour and materials involved in all the operations described above.

3.00.00 **ACCEPTANCE CRITERIA**

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 **I. S. CODE**

Important relevant code for this Section:

a) IS : 1661 : Code of practice for cement and cement-lime plaster finish on walls and ceilings.

b) IS : 4101 : Code of practice for external facings and veneers.

c) IS : 1200 (Pt-XII) : Method of Measurements of Building and Civil Engineering Works: Part: XII- Plastering and Pointing

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PART – B

SECTION-V

GUIDELINE
FOR
SANDWICH METAL CLADDING

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GUIDELINE
FOR
SANDWICH METAL CLADDING

1.00.00 **GENERAL**

1.01.00 **Description**

1.01.01 This section covers, providing, furnishing and installation of sandwich/double skin metal cladding with insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes, conductors etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The Bidder shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 **Applicable Codes and Standards**

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The Bidder may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/owner's approval.

1.02.02 ASTM - American Society for Testing Materials.

1.02.02.1 A446 - Zinc-coated (Galvanized) steel sheets of structural quality. Coils and cut lengths.

1.02.02.2 A611 - Steel, cold rolled sheet.

1.03.00 **Submittals**

1.03.01 The Bidder shall submit to the owner the following items for review before commencing work.

1.03.01.1 **Samples**

a) Three 300 x 300 mm pieces of each type of pre-coated and preformed metal sheet for top skin and bottom skin.

b) Type of insulation proposed for use and its thickness and density.

c) Fabricated sandwich metal cladding- Sample size shall be 300 x 300 mm three nos.

d) Edge sealing and flashing.

1.03.01.2 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

1.03.01.3 Manufacturer's certification of compliance with each delivery.

1.03.01.4 **Shop Drawings**

Showing fabrication details of sandwich/double skin metal cladding with Insulation, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.03.02 **Test Reports**

Two copies of Test Reports and Source of Quality Control Tests.

1.03.03 **Supplier Certificates**

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.04.00 **Product Handling**

1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.00.00 **PRODUCTS**

2.01.00 **General**

2.01.01 All goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

2.01.02 Roof insulation shall have a minimum R-value of 2.083 M^2 ^oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be interlocking type 150mm wide strip and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.01.04 **Material**

2.01.04.1	Base Material	High tensile steel
2.01.04.2	Metal protection	Zincalume
2.01.04.3	Organic coating	Silicon Modified Polyester (SMP) Fluoro polymer (PVF_2) and plastisols to resist aggressive climate of the jobsite

2.01.05 Material shall be prefabricated sandwich panel with polystyrene insulation/high density rock wool slab insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.60 mm to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick of similar pre coated panel. Wherever single sheets are used for roofing and cladding the thickness of the Zincalume sheets shall be 0.8mm minimum.

2.01.06 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg / M^3 for polystyrene and shall have minimum R-value 2.083 M^2 ^oK/Watt.

2.01.07 Panel size shall be largest available size.

2.01. 08 **Sealants**

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.01. 09 Profile HDPE Filler

2.01.09.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

2.01.09.2 Metal flashing shall be of similar material and colour of top skin.

3.00.00 **DOUBLE SKIN INSULATED METAL CLADDING**

3.01.00 **General**

3.01.01 Metal cladding may be of double skin separated by an approved insulation in between. External sheet shall be of interlocking type.

3.01.02 Providing, erecting, fitting & fixing at all elevations double skin insulated roofing / wall cladding with zincalume and profiled steel sheets made out of 0.6 mm for external and 0.5 mm thick internal sheets (TCT) permanently colour-coated zincalume steel (150gsm Zinc Aluminium alloy coating total of both as per AS 1397:1993) having 550 MPa yield strength. Colour coating shall comprise of Polyester coating of approved colour. The Polyester colour coating shall comprise of 15-20 micron finished coat over 5 micron primer coat on the exposed side and manufacturer's back coat of 5 microns over a primer coat on the inner side.

The external sheet shall be zincalume fixed on to the hat sections with the help of specially designed carriers to hold the external zincalume cladding. The inner sheet shall have 980mm cover width, 28mm high crest at 195mm c/c. with special male / female side-laps and anti-siphoning features to prevent leakage. Two small ribs are there in between the two profiles. The inner sheet along with sub-girths of size 50mm x 50mm x 50mm manufactured out of 1.6mm GI sheet in 'C' / 'Z' shape would be fixed to the purlin by means of self-drilling fasteners (12G - 14TPI x required length). Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer-head Zinc-coated self-drilling fasteners / screws on to the sub-girths. The clips shall be concealed and no fasteners are to penetrate the external sheeting.

3..01.03 Providing and fixing of double skin prefabricated factory assembled rock wool insulated wall cladding system comprising of profiled external sheet manufactured out of 0.6 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 550 Mpa yield strength.

The colour coating shall comprise of SMP / super polyester PVF2. The inner sheeting shall be 0.50mmTCT of SMP / super polyester PVF2 coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the steel runner. The clips shall be concealed and no fasteners are to penetrate the external sheeting. Insulation of density 100 Kg/m3 and average thickness 50 mm. conforming to IS 8183 having a thermal conductivity value of 0.034 W/mk at 50 degree C mean temperature. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

4.00.00 **EXECUTION**

4.01.00 **Inspection**

4.01.01 the Bidder shall examine the area, which will be covered, and the masonry wall where the edge of the sandwich/double skin cladding will be fixed and the structural alignments.

4.01.02 Bidder shall correct any unsatisfactory conditions prior to start of work.

4.02.00 **Installation**

4.02.01 Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

4.02.02 Double skin wall cladding shall be installed strictly as per manufacturer specification and details.

4.02.03 All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

4.02.04 Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 **Clean-Up**

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

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PART-B

SECTION-VI

GUIDELINE
FOR
CARPENTRY AND JOINERY

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GUIDELINE
FOR
CARPENTRY AND JOINERY

1.00.00 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the specification. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified in the “Schedule of Fixtures”.

2.00.00 INSTALLATION

2.01.00 Materials

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from decay, fungal growth, boxed heart, pitch pockets or steaks on the exposed edges, splits, large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter’s work, the Tendered shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Ply wood shall be BWP grade or BWR grade as per IS 303. Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of B W R grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush door shutters shall have a solid core with commercial or decorative or non-decorative (Paintable type as per IS 2202 Part I) faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Bidder shall give a guarantee that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified elsewhere in drawing/specification The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS 1708.

Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0mm and 3.0mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5mm for commercial veneers and between 0.4 mm and 1.0mm for decorative veneers, provided that the combined thickness of both is not less than 2.2mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8mm to 10mm. The rebating shall be either splayed or square type as shown in the drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

Opening for glazing

When required, glazing shall be provided and unless otherwise specified the opening for glazing shall be 250mm in height and 150mm or 200mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25mm. Opening for glazing shall be provided where specified or shown in the drawing.

Tolerance

Tolerance on the width and height shall be +3 mm and tolerance on nominal thickness shall be ± 1.2mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

e) **Panelled Glazed or Panelled and Glazed Shutters**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per “Schedule of Items” and as per drawing or as recommended and approved by Engineer in charge.

Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any wrap or bow and shall have smooth well planed face at right angles to each other.

Other considerations shall be as mentioned in item (d) above.

Window and Ventilator Shutters

Window and Ventilator shutters shall conform to IS 1003 (Part 2)

f) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber door frames and shutters shall conform to IS 14616

Material

i) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued tighter having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5mm.

ii) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects or cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of ± 5 percent.

iii) **Adhesives :** Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

iv) **Preservatives :** Veneers used for LVL shall be given preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall than be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m^3 Veneers shall be scarf joined only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600mm.

Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

g) **Laminated Veneer Lumber (LVL) Door Shutters**

This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals, etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

The material of each lot shall be supported by a certificate to that effect:
Each lot of LVL materials shall be accompanied by the test reports. Fabricated shall take up manufacturing of shutters only if provisions of clause mentioned above fulfilled, failing which, shutters so manufactured are liable for rejection.

Panelling Materials

Plain Particle Board : Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848.

Pre-laminated Particle Board : Pre-laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per stated above.

Medium Density Fiber Board : Medium density fibre board used for panels shall confirm to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

Pre-laminated Medium Density Fiber Board : Pre-lamination in pre-laminate medium density fiber board shall confirm to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board shall be as per stated above.

Glass: Glass for glazing shall confirm to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass may also be specified by the Engineer-in-Charge.

Wire Gauze : Wire gauze shall generally confirm to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm.

h) **Construction and Workmanship**

Laminated Veneer Lumber (LVL) paneled, glazed and panelled and glazed shutter shall be constructed in he form of LVL framework of stiles and rails with panel inserted conforming (as per stated above) of

plain or perlaminated particle board, plain or perlaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beadind as specified. The stiles top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints. Rails having width of 150 mm or more shall have plain double tenon joints. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutters complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon and mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubberwood /plantation wood lipping. Lipping shall be seasoned and chemically treated. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m^2.

All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any wrap and bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

Beading : All the panels except glass and wire gauze shall be fixed with grooves but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable handless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401–1982.

Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Muliions and glazing bars shall be stubtenoned to the maximum depth which the size of the member wood permit or to a depth of 25 mm, whichever is less.

The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL shutters shall be manufactured in factories under controlled conditions.

i) **Panelling**

Plain and perlaminated Particle Board Panelling : The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

Wire Gauze Panelling : Wire gauze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

j) **Rebating**

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or squire type as per IS 1003 (part-1).

k) **Gluing of Joints**

The contact surfaces of tenon and mortice shall be treated before putting together as per IS 1003 (part-1). All the tenon and mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

l) **Tolerances**

Tolerance on the size of door shutter shall be +3 mm and in thickness +1.2 mm.

m) **Location of Fittings and Accessories**

Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50 mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described above.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per scheduled by the user. The fittings shall conform to specifications as described above.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, size and shape of louver or vision panel opening shall be as specified.

n) **Finish**

All the four edges of the shutter shall be squire. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

o) **Glazing**

Glazing in the shutters of door and window shall be as per in specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

p) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the “Schedule of Fixtures”. However minimum number of fixtures shall be as follows :

1. **For external single leaf door :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer.
- Rain drip

2. **For external double leaf door :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge on both shutters.
- 10mm dia & 300mm long SS tower bolt on inside face on both shutters.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer on active shutter.
- Rain drip

3. **For external single leaf window :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- SS pull ring minimum 6mm thick and 50~75mm dia.
- SS window stay piece.

2.02.00 **Partitions**

These shall be conform to drawings an all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

a) **Materials**

Gypsum Board conforming to IS 2095 (Part-1)

Non asbestos multi-purpose cement board conforming to IS 14862
Tapered edge calcium silicate board

Tapered Edge Calcium Silicate Board is manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminium or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

b) **Installation**

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Jointing & Finishing**

Joints of the boards are finished with specially formulated joining compounding and fiber tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

d) **Fitting and Fixtures**

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

e) **Tolerance**

Tolerance in dimensions shall be ± 5 mm.

2.03.00 **UPVC-Door Frames**

a) **Material**

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desied proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

b) **UPVC Door Frame**

UPVC door fame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extrude UPVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm ± 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm ± 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The fames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the fames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the centre. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

2.04.00 **PVC Door Shutters**

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

24 mm thick PVC Door Shutter
30 mm Thick PVC Door Shutter
Sampling and Criteria for Conformity

a) **General Precautions**

The test specimens shall not have been exposed to a temperature below 400C for 24 hours immediately preceding the test and shall be free from all / visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

If the test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

b) **Sampling**

Sampling criteria for conformity shall be in accordance with IS 4020 (Part-I)

Lot in any Consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to from a lot.

The number of shutters to be selected at random from a lot shall depend upon its size.

c) **Fixing of Shutters**

PVC door shutters shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm / 30 mm. The hinges used should be of stainless steel.

d) **Tolerance**

The tolerance on the width and the height of the door shall be ± 5 mm and the tolerance on the nominal thickness of the door shall be ± 2 mm.

e) **Fittings**

Fittings shall be provided as per scheduled of fittings decided by Engineer-in-Charge. In moisture prone areas M.S fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

2.04.00 **PVC Door Frame**

Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The weight per running metre of the door frame including reinforcement should be a minium of 1.5 kg./sqm. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be jointed to each other using solvent adhesive conforming to IS 14182. A tolerance of ± 3 mm. shall be permitted in the specified dimension of PVC section in the door frames.

The solid PVC door frames shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge.

Fixing of Frames : As stated earlier

2.04.00 **Panel PVC Door Shutter**

Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-Charge.

a) 30 mm thick panel PVC door shutters.

2.05.00 **Fibre Glass Reinforced Plastic (FRP) Door Frames**

Door frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up to resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./sqm. and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat.

a) FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

b) **Tolerance :** Tolerance of size of frame to be ± 2 mm. and on size of rebate to be +1 mm.

c) **Finish :** The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour bolts and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour and shade as approved by Engineer-in-Charge.

d) **Fixing of Frame :** As stated earlier.

2.06.00 **Fibre Glass Reinforced Plastic (F.R.P.) Shutters**

a) F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

b) Blocks of any seasoned hard wood of bulk density not less than 450 kg / cum At 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

c) **Location of Fittings and Accessories :** The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable location by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminium.

d) **Sampling & Criteria for conformity :** As stated earlier

e) **Finish :** Stated earlier

f) **Fixing of Shutter :** Stated earlier

g) **Tolerance:** Stated earlier

2.07.00 **Solid PVC Fome Profile Doors**

a) **Solid PVC Foam Profile Frame**

Solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge. PVC door frame should have shore hardness more than 70.

b) **Fixing of Frames:** Stated earlier

2.08.00 **Solid PVC Foam Shutters**

Solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Door are provided with naturally strong stiffener frame and sandwich paneled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

a) **28 mm Thick Door Shutters**

Profile is cut in required length to make vertical & horizontal site. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. GI 'C' stiffener 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is jointed using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicon sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & 'C' type GI stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look.

The fabrication shall be done in done in factor as per nomenclature of the item and directions of Engineer-in-Charge.

b) **Sampling and Criteria for conformity :** Stated above

c) **Fixing of Shutters:** Stated above

d) **Tolerance:** Stated above

e) **Fittings:** Stated above

2.09.00 **Factory Made Fibre Glass Reinforced Plastic Chajja**

F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chaja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge.

Material

1) Glass Fibre (chopped strand mat) shall be as per IS 11551
2) Unsaturated Polyester Resin shall be as per IS 6746
3) Surface Burning Characteristics of Building Material – ASTM E84-77a
4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
5) Curing Agents – Cobalt Napthanate and MEKP
6) Test of Products – IS 14425
7) Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modules of elasticity, good textile processing and excellent fiver reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

Tolerance

Tolerance of ± 10 mm in overall size of FRP chajja is permissible.

2.10.00 **Workmanship**

2.10.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing (preferably Bitumen Painting).. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood,

block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M. S. grills or guard bars shall be provided to windows where called for in the drawings or schedule of items.

2.10.02 **Finish**

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.10.03 **Surface Treatment**

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 **Door and Window Shutters**

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 **Pelmets, Furniture, etc.**

3.03.01 **General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 **Pelmets**

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.03 **Cupboard Shutters**

Shall operate smoothly without jamming and locks, holding chains, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.04 **Drawers**

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.05 **Loose Furniture**

When placed on level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

IS : 4021	-	Timber door, window and ventilator frames
IS : 1003	-	Timber paneled and glazed shutters.
IS : 2191	-	Wooden flush door shutter (Cellular and hollow core type)
IS : 2202	-	Wooden flush door shutters (Solid core type)

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PART-B

SECTION-VII

GUIDELINE
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, CURTAIN WALL, STRUCTURAL GLAZING, ETC.

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PART-B
SECTION-VII

GUIDELINE
FOR
METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, CURTAIN WALL, STRUCTURAL GLAZING, ETC.

1.00.00 SCOPE

The work in general shall consist of supplying and erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. as shown on drawings with all materials complete excluding supply of glass and glazing. The scope of work shall also include the assembly at site and erection of all doors, windows, louvers, glazed partitions, etc. for which fabricated materials. Supplying and fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to IS: 733 and 1285 for chemical composition and mechanical properties. The stainless steel screws shall be grade AISI 304.The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified in “Schedule of Fixtures” and the best quality from approved list of manufacturers shall only be used. The successful bidder shall specifically state the list of manufacturer’s materials he proposes to use. “Schedule of Fixtures” is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Bidder’s responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated elsewhere in the specification. Each closer

shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix- A.

The Bidder shall submit **three** samples of each type of hardware to the Engineer for approval. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Bidder towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

2.02.00 **Fabrication**

2.02.01 **Steel Doors, Windows, Ventilators, Louvers, etc.**

a) **Door Frames**

Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose “T” masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) **Double Plate Flush Door Shutters**

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centers.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing or called for in the schedule of items the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 16 G sheets.

c) **Single Sheet Door Shutters**

Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required as shown on drawings, provisions for fixing glass panes, louvers, etc. shall be made.

The manufacturing shall be done as specified in “Double Plate Flush Door Shutters”.

d) **Sliding Doors**

These shall be manufactured as per drawings and specification. These shall be fabricated from mild steel sheet.

The shutter shall be double or single leaf shutter as specified. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted/ welded together with 3mm gusset plate at junction to form a rigid frame. Sliding doors shall be either double plate or single plate construction as called for in drawings and schedules made out of 18 gauge steel sheets with adequate stiffeners. The Bidder shall specify the weight of the door in his shop and submit the manufacturer’s catalogue of the sliding gear he proposes to use. Where shown on drawings or call for in them specification, these shall be provided with top and bottom guide rails of specified size angles or T-irons and 25mm diameter pulley or with 25mm diameter ball bearing at the bottom and guide block with steel pulleys at the top. The shutters shall be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of item. Doors shall close positively to exclude rainwater from seeping in. Sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

The guide rail shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can against the walls, giving full opening when so required.

FIXING : The guide rail shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitably fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

The adjoining work damaged in fixing shall be made good to match the existing work.

e) **Door Threshold**

Door threshold shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

f) **Steel Windows, Sashes, and Ventilators etc.**

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 **Aluminium Door, Windows and Frames**

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 0.6 mm thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

Where required factory made evenly baked powder coated coloured aluminium extruded sections shall be used. DFT shall not be less than 0.8 mils. Colour shall be as per Colour Schedule or as per instruction of the Engineer-in-Charge.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.02.03 **Fire Door**

Hollow metal fire rated doors should be as per IS 3614 Part-1 & Part-2.It should be made of pressed Galvanised steel conforming to IS 277. It should be tested at CBRI or ARAI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision lites/ panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates will not be allowed. Proper label conforming the type of door and the hourly rating is mandatory.

Door Frame : Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60mm (16 gauge) minimum thick G.I. sheet (zinc coating not less than 120gm/sqm) duly filled with vermiculite based concrete mix. Suitable for mounting 60 minutes fire rated door shutters. The frame is fitted with intumuscent fire seal strip of size 10 x 4 mm (minimum) all-round the frame and fixing with dash fastener of approved size and make, including applying a coat of approved brand fire resistant primer. Frames shall be metered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the skirting jamb. Frames should be provided with black plate bracket for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry of approved proportion necessary for fire doors on the clear masonry opening.

Door Shutter : Door shutters will be 50 mm thick (unless otherwise stated in the drawing) of 60 minutes fire rating conforming to IS: 3614(Part-II) tested and certified as per laboratory approved by Engineer-in-Charge with suitable mounting on door frame, consisting of vertical styles, lock rail, top rail 100 mm wide, bottom rail 200 mm wide, shall fully flush double skin door with or without vision lite. Door shall be manufactured from 1.6 mm (16 gauge) minimum thick SWG G.I. sheet (zinc coating not less than 120gm/sqm) duly

filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make (if mentioned in the drawing) including applying a coat of approved fire resistant primer. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. All doors shall be factory prepared for receiving appropriate hardware and provided with necessary reinforcement hinges, locks and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. 200 x 300mm Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

The door leaf and frame shall have passed minimum 250hours of salt spray test.

Paint : All doors and frames shall be finished with etched primer coating, stove zinc ethyl silicate primer and thermosetting polyurethane aliphatic grade paint of Post Office Red colour.

Rate : Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

2.03.00 **Structural Glazing**

Aluminium semi unitised vertical Structural glazing system with single glass vision panel and spandrel panel of approved make having main frame of verticals and horizontals made out of specially designed extruded aluminium sections to withstand wind pressure of 175 kg/sq.m at a height of 40m and fabricated, fixed at all levels, elevation and heights to the Masonry / RC walls with necessary clamps, brackets and anchor fasteners. All clamps and brackets shall be Mild Steel Hot dip galvanized minimum 80 microns thick and shall conform to IS: 4759-1996. The extruded aluminium section shall be anodised in approved colour with a anodic coating of minimum 20 microns. Extruded section shall be of 6063 T5 or T6 alloy conforming to ASTM B 221. Any other fastening straps, nuts, bolts, rivets, washers, Fire stops at all floor levels etc. shall be in stainless steel SS 304 grade. All tapes shall be of approved make.

The system shall be designed to withstand a wind pressure of 200 kg/Sqm and shall be fixed to the masonry/RC walls with necessary clamps, brackets and anchor fasteners, clamps and brackets shall be Hot dip galvanized minimum 80 microns thick, all complete as per manufacturer's manual and specifications. The spandrel panel shall have 50mm thick fiber glass insulation of 48 kg/cum density of approved make conforming to IS-8183 and 1.0 mm thick Twiga black tissue conforming to BS 476 Part 7. This insulation shall be enclosed in a GI tray fabricated out of 1mm thk. GI sheet and fixed to the glazing framework with stainless steel fasteners.

The gap between the GI framework and the concrete framework shall be sealed with Aluminium flashing fixed with stainless steel fasteners. All gaps shall be sealed with Silicone sealant of approved brand. Insulation should be provided in between the Structural glazing aluminium frame work (i.e., behind the spandrel glazed panel) and the structure. Providing 6 mm thick toughened fully tempered hard coated glass of blue/green/blue-green or approved colour having VLT = 35 to 50 % ,External reflectance= 6 to 15% ,Internal reflection = 8 to 15%, Solar factor = 0.36 to 0.43, U Factor = 2.8 to 3.0 W/sqm K etc.

2.04.00 **Aluminium Curtain Wall System**

2.04.01 **General**

1) Aluminium Curtain Wall System shall be designed for the following effects :

   a) Permanent Deformation, thermal expansion.

   b) Wind and seismic load

   c) Air and water infiltration or leakage.

   d) Lateral deflection per floor height

2) Unless otherwise specified the design of the system shall be prepared by the specialized firm for executing such works and submitted to the EIC / Department for approval after detailed scrutiny and checking design calculations and drawings.

3) The work shall bear five years guarantee. It will be obligatory on the part of the Bidder to execute the work systematically and conduct the necessary mock-up unit tests, before taking up the work to the satisfaction of EIC / Department.

2.04.02 **Specification for Materials used for Curtain Wall**

1	Glazing	Glazing work shall be as specified in the description of the item and / or as described under the chapter Glass & Glazing of this book.
2	Framing system	Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.
3	Sealant	As specified in the item or silicon sealant
4	Insulation	50 mm thick rock wool of minimum density 48 kg/cum sandwiched with black polythene sheet 100 micron on one side and aluminium foil of 100 micron on the other side or as specified by manufacturer at spandrel area. The surface after fixing insulation shall be plain without any distortion

5	Heat Reflective Toughened Glass	As specified elsewhere in the specification. Colour of any shade approved by the Engineer-in-Charge.

2.04.03 **Aluminium Alloy Extruded Sections**

Extruded sections to be used for fabrication of framing system for curtain walls shall be manufactured and supplied by approved reputed companies. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works. Dimensions and weights of the sections shall be as per approved drawings.

2.04.04 **Components, General specifications, Glazing, Panelling etc. for Curtain Wall System :** These shall be generally as per relevant Chapters in this book.

2.04.05 **Scope of Work**

2.04.05.01 **Preliminary Requirements**

i) The Bidder shall design, test, fabricate, deliver, install and guarantee all construction necessary to provide a complete curtain wall system, all in conformity with the drawings and approval of the Engineer-in-Charge.

ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawings,

iii) **The curtain wall system shall also include the following activities :**

a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure, windows etc.

b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.

c) All thermal insulation associated with the system. (d) All fire protection associated with the system.

d) All copings and closure and metal cladding to complete the system.

e) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.

f) Isolation of dissimilar metals and moving parts,

g) Anticorrosive treatment on all metals used in the system, (i) Polyester powder coating aluminium sections,

iv) **The Bidder shall also be responsible for providing the following :**

a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.

b) Mock-ups, samples and test units.

c) Performance testing of the curtain wall framing and glazing assembly. (d) Co-ordination with the work of other trade.

d) Insulation with glass wool 48 kg/cum at spandrels area.

e) All final exterior and interior cleaning and finishing of the curtain wall system.

f) Protection.

g) As built record drawings and photographs.

h) All hoisting, scaffolding, staging and temporary services.

i) Conceptualising and design of a suitable maintenance system for curtain glazing,

v) The water tightness and structural stability of the whole curtain wall system shall be the prime responsibility of the Bidder. Any defect or leakage found within the defect liability period shall be sealed and made good all at the risk and cost of the Bidder.

vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should be designed to accommodate thermal and building movements.

2.04.06 **Design Requirements**

i) Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.

ii) All curtain walling, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following requirements.

2.04.06.01 **Basic requirement**

The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However the Bidder may propose alternatives on the construction details for approval of the Engineer-in-Charge, provided that all basic functional and architectural requirements are fulfilled.

2.04.06.02 **Quality Consideration and other Activities**

i) The Bidder while submitting the detailed design calculations should submit the following information on the quality of materials to be used and other aspects as detailed below:

1) Metal quality, finishes and thickness

2) Glass quality, coating and thickness and proposed manufacturer's brand names.

3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer's brand name and also the name of agency proposed for fabrication work.

4) Arrangement and jointing of components.

5) Field connections especially mullion to mullion and transom to mullion.

6) Fixing and anchorage system of typical wall unit together with structural calculations.

7) Drainage system and provision in respect of water leakage in the curtain wall system.

8) Provisions for thermal movements.

9) Sealant and sealing methods.

10) Glazing Method

11) Wind load and seismic load and any other specific load considered in the design

ii) Design concept over lighting protection link-up system of the curtain wall for connection and incorporation into the lighting conductor system of the building (Lighting conductor system of the building shall be done by other approved specialized agency).

iii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

2.04.06.03 **Tolerances :** Any parts of the curtain wall, when completed, shall be within the following tolerances:

1) Deviation from plumb level or dimensioned angle must not exceed 3 mm per 3.5 m length of any member, or 6 mm in any total run in any line.

2) Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.

3) Change in deviation must not exceed 3mm for any 3.5 m run in any direction.

2.04.06.04 **Samples :** The Bidder shall also submit samples of aluminium extruded sections; mullion and transom sections in lengths of 300 mm with the same finish and workmanship as per the tender proposals and 300 mm x 300 mm samples of glass for approval of the EIC. (samples to include exposed screws and other exposed securing devices if any).

2.04.06.05 **Ancillary Requirements to be fulfilled by the Bidder**

i) The Bidder / approved specialized agency shall submit a maintenance manual for the curtain wall system inclusive of all metal parts, glass and finish etc.

ii) During detailed design scrutiny and also during the actual execution of the work any additions and extra provisions that will have to be made as per theoretical requirements or site conditions shall be implemented and executed by the Bidder at his own cost, without claiming any thing extra under any circumstances.

2.04.07 **Execution of work**

2.04.07.01 Performance Testing - General Requirements

i) Mock-up units shall be constructed by the Bidder and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the face of the building.

ii) After the approval of structural calculations and the drawing for construction of the curtain wall, one test unit for performance testing of

the curtain wall shall be constructed by the Bidder at an independent laboratory or at a laboratory approved by the Engineer-in-Charge.

iii) Erect mock-up under manufacturer's / Fabricator's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

iv) The Bidder shall submit to the Engineer-in-Charge the test procedures to be adopted, test schedule and location for testing before the work of actual testing is taken up.

v) Prior to the fabrication of test units, the Bidder shall submit shop drawings and design calculations of the test unit for approval of the Engineer-in-Charge.

vi) The Bidder shall not start the work of erection of curtain wall on site till the approval for the successful completion of the mock up test and clear instruction in writing to start the work is received from the Engineer-in-Charge.

vii) The decision of the Engineer-in-charge in respect of the procedure to be adopted, in conducting the mock-up test and the judgment over the net results, shall be final and binding on the Bidder.

2.04.07.02 **Test of Wind Pressure**

i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the "pressure chamber" at which the test unit is fixed.

ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.

iii) The variation of dynamic pressure shall be of any approximate sine curve line.

iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.

v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

vi) The deflection on the main structural parts in this condition shall not exceed :

1) 1/175 of the span between supports or 20 mm, whichever is less for vertical elements.

2) 1/250 of the span between supports for horizontal elements.

3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

2.04.07.03 **Test of Lateral Deflection per floor height**

i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.

ii) The deflection of every ± 2.5 mm shall be increased up to ± 13 mm on the test unit (static deflection test)

iii) The dynamic deflection shall be applied up to ± 13 mm.

iv) The variation of dynamic deflection shall be of an approximate sine curve line, one period of 3 seconds.

v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the damage shall be observed.

vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

2.04.07.04 **Water-tightness Test**

i) Water shall be sprinkled to the Test Unit' under wind pressure.

ii) Pressure shall not be applied to the test unit.

iii) The volume of the sprinkling water in one minute shall be 5 litres per sqm minimum.

iv) All water leakage and drainage system at the joint and the open able sash of the curtain wall system shall be observed from the outside of the chamber.

v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.

vi) Water leakage shall not be observed inside at all parts of the test unit during first water-tightness test.

1) Install the test unit.

2) Hold first water-tightness test.

3) Hold test of wind pressure as described above.

4) Hold second water-tightness test.

5) Lateral deflection test.

2.04.07.05 **Test Report :** The Bidder shall submit five copies of test report to the Engineer-in-charge.

2.04.07.06 **Cost of Performance Test**

i) The Bidder shall allow in his tender for the cost of the performance testing and fabrication, erection, corrections to and demolition of the test units including any special provision required in the testing laboratory for the tests mentioned above.

ii) The Bidder shall allow for amendments and adjustments to the mock-up unit as instructed and required by the Engineer-in-Charge / Architect or the consultant.

iii) If the mock-up test unit fails to pass the initial testing, the Bidder shall make the necessary corrections to the test unit and shall get the test unit retested by the testing laboratory until it passes the test.

iv) Cost of corrections to the test unit and the cost of retesting shall be borne by the Bidder.

v) The Bidder shall be allowed six calendar months time after the work is awarded to set up the test unit and conduct the required test as described above to the satisfaction of the Engineer-in-charge.

vi) In case the Bidder fails to conduct the necessary tests as described above or fails to meet the required test results, without any genuine cause within the allotted period of six months, the Engineer-in-charge shall be free to rescind the contract with all costs including the forfeiture of E.M.D. and any other securities deposited by the Bidder under the condition of contract.

2.04.07.07 **Record of Test and Drawings**

i) The testing laboratory shall keep the approved copy of the shop drawing and calculations of the test unit at testing laboratory during testing of test unit.

ii) The testing laboratory shall accurately and nearly record on the above mentioned shop drawings all changes, revisions, modifications etc. made to test unit, which shall become the record drawing.

iii) On completion of testing and after approval of the test reports the testing laboratory shall submit the final record drawings to the Engineer-in-charge.

2.04.07.08 **Fabrication and Erection**

i) Frames shall be square and flat, both the fixed and openable frames shall be constructed of sections, which have been cut to length, mitred and mechanically jointed at the corners, Sub-dividing bar of units shall be tenoned and riveted into frames.

All frames shall have corners welded to true right angles. For jointing hollow sections flash butt welding, argon arc welding or mechanical jointing by inserts shall be used. (Gas welding or brazing shall not be done). Concealed screws shall be used for joining the sub-units.

ii) The grid for the curtain wall system shall be fabricated carefully with aluminium extruded sections like mullions and transom in the exactly same pattern as per the final drawings with amendments if any received from the laboratory after conducting the mock-up unit test.

iii) The sizes of different members of the curtain wall system shall be exactly as adopted for the mock-up unit tests and the grid shall be fixed to the building member as shown in the drawing, received after conducting the mock-up unit test.

iv) Care should be taken to see that any gap between the frame and support and the frame **itself is sealed with silicon sealant.**

v) Finish of grid frame shall be either anodized, organic coating, backed enamel finish or as specified in the item of work, no visual variation in anodizing / colour shall be accepted.

vi) Care shall be taken to see that the curtain wall system is not deformed, damaged during erection and it shall be protected from direct contact with wet or intermittent wet cement concrete mortar etc.

2.04.08 **Representative of the Bidder**

Full time attendance of a qualified civil engineer with sufficient experience in construction of curtain wall system shall be provided for erection of test unit, all testing and later on actual construction.

2.05.00 **Aluminium Sun Louver With Stringer System**

Plain panel Aluminium Sun Louver system as per manufacturers specification of approved colour, shall consists of panel 84 mm wide x 16 mm deep x 0.6mm thick in standard length of upto 6m. The panel shall be coil coated in a continuous paint line, double baked and roll formed from stove enameled corrosion resistant aluminium Alloy AA 5050/3005 for higher strength and roll forming characteristics. The panel shall be clipped on to a backed & enamelled aluminium stringer 33mm wide x 86mm deep made from 0.95mm

thick backed & enamelled aluminium alloy AA 5050 (sl.mg.) in standard length of 5 m in white colour with cutouts to hold the panels in a module of 86mm c/c. The first stringers shall be fixed at 150mm from both ends and thereafter at a distance of 0.75mm c/c depending on wind load. The stringer shall be fixed to a suitable sub-structure/wall with Nut/Bolt and washer.

Paint Finish

Panel shall have exterior paint finish which will be of 3 layers:

The Anorcoat Pretreatment

The colour coating and transparent top coat

The paint used shall be epoxy based & finished with a polyamide/Nylon coating. The paint system shall have the following characteristics.

Coating thickness	:	24-32 Microns
Gloss	:	28 (+/-5)
Gloss Variation	:	+/-3 units (within delivery)
Adhesive Impact/Bending	:	No Loss of Adhesive
Durability	:	Higher Category
Humidity Resistance	:	Blisters less than size 2

2.06.00 **Shop Coat or Paint**

The shop paint for steel doors, windows, etc. shall be best zinc ethyl silicate primer paint from approved manufacturer conforming to IS 2074. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called, all steel doors, windows, etc. shall be hot dip galvanised to give a coating weight of 1-1/2 - 2 Oz per sft. One coat zinc ethyl silicate primer coat shall then be applied as shop paint.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc ethyl silicate primer.

2.07.00 **Handling & Storage of Fabricated Material**

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Bidder shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.08.00 **Assembly & Erection at Site**

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081 and as shown on drawings. The Bidder shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Bidder shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Bidder and made good again as per original, after installation
After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Bidder shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. For all frames supplied by either the Owner or the Bidder mastic shall be supplied by the Bidder and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **For Fabricated Items**

a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

h) Provisions for hardware and fixtures to be installed at site.

I) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

3.02.00 **For Installed Items**

a) Installations shall be at correct location, elevation and in general on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 After Award

a) Names of manufacturers for doors, windows, etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

c) Before starting fabrication of all metal doors, windows, etc. the Bidder shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

d) He shall submit a programme of work to be done for the approval of the Engineer.

e) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Bidder towards the end for final incorporation in the job.

5.00.00 I.S. CODES

Following are some of the important I.S. Codes as relevant to this section :

Steel doors, windows and ventilators	-	IS : 1038
Steel windows for industrial buildings	-	IS : 1361
Aluminium doors windows and ventilators	-	IS : 1948
Aluminium windows for industrial buildings	-	IS : 1949

Steel doorframes	-	IS : 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS : 1081
Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineer Purposes) – Specification	-	IS : 733
Wrought Aluminium and Aluminium Alloy sheet, and strip for General Engineer Purposes - Specification	-	IS : 737
Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) –Specification	-	IS : 1285
Anodic coating on Aluminium and its Alloys – Specification	-	IS : 1868
Specification for Aluminium equal leg angles	-	IS : 3908
Specification for Aluminium unequal leg angles	-	IS : 3909
Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.	-	IS : 3965
Method of testing anodic coating on aluminium and Its alloys	-	IS : 5523
Measurement of coating thickness by Eddy Current Method	-	IS : 6012
Floor springs (Hydraulically regulated) for heavy doors Specifications		IS : 6315
Dimensions of extruded hollow section and tolerances	-	IS : 6477

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PART-B

SECTION-VIII

GUIDELINE
FOR
ROLLING STEEL SHUTTERS, GRILLS AND COLLAPSIBLE DOORS

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PART-B
SECTION-VIII

GUIDELINE
FOR
ROLLING STEEL SHUTTERS, GRILLS
AND COLLAPSIBLE DOORS

1.00.00 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/collapsible doors with motor drive operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick of CR grade for shutters upto 4.5 M wide and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats

c) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

d) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M

e) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

f) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

g) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. .

h) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

i) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

j) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 **Power Operated Shutters**

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in , externally mounted shutters shall be operated by control mechanism located inside the building.

2.03.00 **Rolling Shutters**

Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitably fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type/Mechanical and electrically operated

Shutter : The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90mm for the shutters up to 3.5m width and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure of 100 kg/sq.m. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section

at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

Spring : The spring shall be coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454 - Part I.

Roller and Brackets : The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161 to carry the tortional load with a maximum deflection of 1/360th of span. For shutter up to 6 metre width and height not exceeding 5 metre, steel pipes of 50mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters up to clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5m and up to 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

When the width of the opening is greater than 3.5 mtr, the cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearings with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15 mm and at least 4 number flats running throughout length of roller shall be provided.

In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

Guide Channel : The width of guide channel shall be 25mm the minimum depth of guide channels shall be as follows :

Clear width of shutter	Depth of guide channel
Up to 3.5 m	65mm
3.5m up to 8m	75mm
8m and above	100mm

The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

Cover : Top cover shall be mild steel sheets not less than 0.90mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

Power unit : Power unit shall be suitable for 3 phases, 50 cycles, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

Fixing : The arrangement for fixing in different situations in the opening shall be as per IS 6248.

Brackets shall be fixed on the lintel or under the lintel as specified with rawl plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and brackets shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in workmen like manner that the operation of the shutter is easy and smooth.

2.04.00 **Shop Coat**

Shutters shall be painted with one coat of zinc ethyl silicate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc ethyl silicate for adhesion of field coat. Wherever galvanized door not

specified, the door shall be painted with aliphatic polyurethane paint with two coats

2.05.00 **Erection**

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

2.06.00 **Collapsible Gate / Door**

2.06.01 These shall be of approved manufacture and shall be fabricated from the mild steel sections.

2.06.02 The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

2.06.03 **Fixing**

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centers alternatively in the two flanges of the T- iron. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T-iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee-section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

2.06.04 **Painting**

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given Same as specified for Rolling shutters.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the successful Bidder shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

4.00.00 I.S. CODE

IS : 6248 - Metal rolling shutters and rolling grills.

IS : 10521 - Collapsible Gate

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SECTION-IX

GUIDELINE
FOR
MISCELLANEOUS METAL

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GUIDELINE
FOR
MISCELLANEOUS METAL

1.00.0 SCOPE

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described elsewhere in the specification

2.00.00 INSTALLATION

2.01.00 Fabrication/Casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 S hop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with the IS : 816. Use of metal arc welding for general construction in Mild Steel.

c) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other

open spaces. All paint shall be applied to dry surfaces. When specified , steel work shall be galvanised or non galvanized steel work shall be painted with a coat of zinc ethyl silicate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc ethyl silicate primer.

2.02.00 **Erection**

2.02.01 **Bracing**

The Bidder shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

2.02.02 **Temporary Bolting-Up**

As erection precedes the Bidder shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 **Turned Bolt**

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 **Welding**

Where specified on drawings, welding shall be done in accordance with IS : 816 for steel and IS: 2812 for Aluminium and Alloys.

2.02.05 **Cutting and Fitting**

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Bidders. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 **Drifting**

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer

and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 **Grouting**

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Bidder and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done as specified in G1/section II.

2.02.08 **Anchor Bolting**

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Bidder shall submit the manufacturer's literature showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.02.09 **Pipe Joints**

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.02.10 **Spot Painting**

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint or equivalent.

2.02.11 **Making Good**

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be of correct shape, size, weight etc. shown on drawings

b) For installed items, the tolerances shall be follows:

i) Permissible deviation from straightness - 1 in 1000.

ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks and other blemishes.

4.00.00 SCOPE

The Bidder ‘s scope shall include for supply of materials, fabrication, shop paint and erection. This shall also include transporting the fabricated materials to the site, unloading storing and erection, including furnishing necessary temporary bracings guys, staging and planking. This shall also include cutting and drilling to

steel, concrete or masonry and welding, bolting grouting and making good damages after erection and removing all rubbish and clearing the site upon completion of erection.

5.00.00 I.S. CODES

IS: 226 - Structural Steel (Standard Quality)

IS: 800 - Code of practice for use of structural steel in general building construction.

IS: 816 - Use of metal arc welding for general construction in mild steel.

IS: 2812 - Arc welding of Aluminium and Alloys

IS: 3150 - Hexagonal Wire Netting

IS: 4948 - Welded steel wire fabric for general use.

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SECTION-X

GUIDELINE FOR GLASS AND GLAZING

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GUIDELINE
FOR
GLASS AND GLAZING

1.00.00 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc wherever required as shown on drawings and specifications, supply of metal glazing beads and neoprene gaskets shall be included in this scope.

2.00.00 INSTALLATION

2.01.00 General

The Bidder shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions from approved manufacturer, shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Clear glass shall be float glass and should be approved by the Engineer-in-Charge and shall be at least 6 mm thick for windows and for doors & glazed partitions shall be minimum 8mm thick or as indicated in doors' and windows schedule. It shall be clear, float transparent toughened and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900. The thickness of float glass shall be measured with micrometers or a calliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.

b) Wired glass of 5.5mm thick minimum shall be provided for all buildings except office rooms, control rooms and A/c rooms.

c) Obscure glass shall have a cast surface in one side.

d) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.

e) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

f) The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer-in-Charge shall only be used. The Bidder shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table below :

SL. No.	Description	Standard Follow	Specification
1	Tensile strength kg.f/cm^2	ASTM-D 412	70 Min.
2	Elongation at break %	ASTM-D 412	250 Min.
3	Modulus 100% Kgf/cm^2	ASTM-D 412	22 Min.
4	Compression set % at 0º CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

Quality of glass

a) All glass shall comply with ECBC 2007 requirements.

b) Single glass panels shall have properties like –
VLT = 35 to 50%, external reflection=6 to 15%, internal reflection=8 to 15%, solar factor=0.36 to 0.43, U value=2.8 to 3.0 W/sqm K to be provided.

c) Double glazed panels with glass having properties like-
VLT = 30 to 45%, external reflection=8 to 20%, internal reflection=15 to 30%, solar factor=0.26 to 0.29, U value=1.8 to 1.9 W/sqm K. shall be provided.

2.02.00 **Reflective Glass**

Definitions

i) **Shading Coefficient** : The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.

ii) **Luminous Efficiency Constant (Ke)** indicates a windows relative performance in rejection solar heat-while transmitting day light. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar near-infrared energy has a Ke close to 1.0. The solar radiation contains about 50% invisible near-infrared & ultra violet light. Therefore, a perfectly selective glazing, which would all allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have Ke of about 2.0.

iii) **Resistance to Heat Conduction (R-valve) :** It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of R-value is termed as U-value.

Reflective Glass

This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks day light more than solar heat.

Types of Coatings : There are two types of reflective glass, Pyroltic (Hard) coated and vacuum (soft) coated.

i) **Pyroltic :** It is a coating applied during glass manufacture. The coating is fused in to the glass at 1200ºC.

ii) **Vacuum Coated Glass :** It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than Pyroltic products.

Performance of Reflective Glass : The performance of reflective glass 6 mm of nominal thickness is given below:

Sl. No.	Parameter	Threshold Ratio in %age
1.	Visible Light - Transmittance (%) - Reflectance (%)	 15-46 12-24
2.	Total Solar Energy: - Transmittance (%) - Reflectance (%)	 16-24 8-12
3.	Ultra Violet Rays: - Transmittance (%)	 2-10
4.	U-Value - Summer - Winter	 0.58 0.45
5.	Shading Coefficient	0.25-0.35

Testing : The reflective glass shall be tested for the followings :

i) Physical/Field Test: In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.

ii) Laboratory Test: In the laboratory, the reflective glass shall be tested for the parameter specified in the table above.

2.03.00 **Glazing, Setting and Finish**

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Bidder.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Bidder.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Bidder. The Bidder shall be responsible for damage of glass , during handling, transportation, fixing etc.

After completion of glazing work, the Bidder shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly

acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Bidder's own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 IS CODES

Following are some of the important I.S.Codes relevant to this Section;

IS : 3548 - Code of practice for glazing in building.

IS : 1083 - Code of practice for fixing and glazing metal doors, windows and ventilators.

IS : 14900 - Transparent Float glass - Specifications.

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SECTION-XI

GUIDELINE
FOR
FLOOR FINISHES AND ALLIED WORKS

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GUIDELINE
FOR
FLOOR FINISHES AND ALLIED WORKS

1.00.00 **SCOPE**

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below:

a) **In Situ Finishes**

i) Integral finish to concrete base

ii) Granolithic finish

iii) Patent Stone

iv) Metallic Hardener like “Ironite” or equivalent finish

v) Mastic Asphalt finish

vi) Chemical Resistant finish

b) **Tiled Finishes**

a) Glazed tile

b) Chemical Resistant

c) Rubber, Vinyl etc.

d) Stone slab (Marble/Granite)

e) Vitrified tiles

1.01.00 **Base**

The base to receive the finish is covered under other relevant specifications.

1.02.00 **Sequence**

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view

the activities of other agencies working in that area. However, the Bidder for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires that the Bidder shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Bidder. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 **In Situ Finishes**

2.01.01 **Integral Finish to Concrete Base**

Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah, courtyard, kitchens & baths shall have slope ranging from 1:48 to 1:60 depending upon location and decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer-in-Charge to drain off washing water. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6mm to 10mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it. While the surface of the concrete laid as per specification for 'Cement Concrete has been fully compacted and levelled but the concrete is still green thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin a possible by using 2.2 kg. of cement per sq.m. of area. in verandah, courtyard.

Laying

Panels : Flooring of specified thickness shall be laid in the pattern including the borders given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450mm in width and the joints in the boarder shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitred for provision of strips.

Laying of Flooring with Strips : Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4mm thick glass strips or 2mm PVC strips or 2mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun.

Concreting : Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge. Surface of flooring be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the

labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

Laying of Flooring without strips : Laying of cement concreting flooring in alternate panels may be allowed by the Engineer-in-Charge in case strips are not to be provided.

Shuttering : The panels shall be bounded by angles iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

Concreting : The concreting shall be done in the manner described earlier. The angle iron/flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1:2 (1 cement: 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

Finishing

The finishing of the surface follow immediately after the cessation of beating. The surface shall be left for some time till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 2 to 2.2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

The edge of the sunk floors shall be finished & rounded with cement mortar 1:2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.

The junction of floor with wall plaster, dado or skirting shall be rounded off where so specified.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

Curing

The curing shall be done for a minimum period of ten days. The surface shall be kept in shade for 24 hours and then cured for at least 10 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. The marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

Precautions

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4ºC. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot whether, precautions shall be taken to see that the temperature of wet concrete does not exceed 38ºC. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

2.01.02 **Wax Polishing**

Application, Polishing and Precautions

Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the flooring/skirting.

When the layer of the wax is shifted and surface of the floor is saturated with the polish, polishing shall be restored with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

The fresh polished wall surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed.

2.01.03 **Cement Concrete Flooring with Metallic Hardener Topping**

Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of

concrete, unless the use of a metallic hardener is justified on the basis of cost.

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is “Green”.

a) **Thickness**

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth(top layer of 50mm thick floor finish).

b) **Material**

The hardening compound shall be of approved quality consisting of uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) **Mix**

The top layer shall consist of 12mm thick layer of mix 1: 2 (1 cement: 2 stone aggregate 6mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1:4 (1 metallic concrete hardener: 4 cement) by weight or as per manufacturer’s specification relevant to medium/heavy duty floor. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6mm nominal size or as otherwise specified in the ratio of 1:2 (1 cement :2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

d) **Laying**

The concrete floor shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The mixture so obtained shall be laid in 12mm thickness, on cement concrete floor while the concrete under bed is still very “green” within 2 to 4 hours of it’s laying. The topping shall be laid true to provide a uniform and even surface without trowel marks, pin holes etc. It shall be firmly pressed into the bottom concrete so as to have good bond with it. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.04 **Mastic Asphalt Finish**

This is a one-layer treatment on concrete or brick base.

a) **Thickness**

The thickness shall be as specified in the drawing or schedule of items.

b) **Materials**

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick and 10 mm chips for thicker finish.

c) **Composition**

Bitumen mastic shall conform to IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be re-melted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the re-melting and mixing process, shall the temperature exceed 205^{o} C.

d) **Laying**

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.5 **Acid or Alkali Resistant Tiles**

Manufacture and Finish

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100ºC and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogeneous. The tiles shall be sound, true to shape, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour.

Dimensions and Tolerances

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 x 98.5 mm, 148.5 x 148.5mm and 198.5 x 198.5mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be ± 2 percent.

Shape

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for square ness and warp as per IS 4457.

Performance Requirements

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark. Manufacturer's batch number and year of manufacture.

Each tile may also be marked with the ISI certification mark.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The average thickness of the bedding shall be

10mm or as specified while the thickness for dado/skirting to be 12mm or specified on item(the overall thickness of the floor finishing shall be 50mm).

Alkali resistant mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of acid alkali resistant cement per square metre over an area up to one square metre. Tiles shall be socked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tile has been laid surplus cement slurry shall be cleaned off.

Pointing and finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout the lugs remaining exposed. The floor shall then be kept wet for 7 days. After surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

2.02.00 **Tiled Finish**

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 **Pressed Ceramic Tile Flooring**

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tile shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1, 3, 5 and 7 of IS 15622 give the modular preferred sizes and table 2, 4, 6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width up to 2 mm for uncertified floor tiles and up to 2mm for uncertified floor tiles and up to 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tile shall conform to table 10 of IS 15622 with water absorption to 3% to 6% (Group BII)

The tiles surface of the tiles shall be glazed. Glazed shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50% of the surface area of the edges.

Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

Decorative Tiles

The type and size of the decorative tiles shall be as follows :

i) **Decorated white back ground tiles**

The size of these tiles shall be as per IS 15622

ii) **Decorative and having coloured back-ground**

The sizes of the tiles shall be as per IS 15622.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20mm or as specified while the thickness under any portion of the tiles not to be less than 10mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per squre metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

Pointing and Finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

2.02.02 **Pressed Ceramic Tile Flooring (Vitrified Tile Flooring)**

Tiles shall conform to Table 12 of IS and the joint thickness in flooring shall not be more than 1mm.

a) **Materials : Vitrified Tiles**

The tiles shall be of approved make and shall generally conform to the approved standards. They shall be flat and true to shape, free from

cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm or as per tender schedule / drawings or as directed by the Engineer-in-Charge. Thickness shall be as per recommendations of the approved manufacturers. However the floor tile thickness shall not be less than 10mm and the overall thickness of the floor finishing shall be 50mm.

Technical specifications of the tiles shall be generally conforming to the following standards:

Technical Specifications For Vitrified Tiles

No.	Property	Expected Standards
1	Deviation in length	(+/-) 0.6%
2	Straightness of sides	(+/-) 0.5%
3	Rectangularity	(+/-) 0.6%
4	Surface flatness	(+/-) 0.5%
5	Water absorption	< 0.50%
6	Mohs. Hardness	> 6
7	Flexural strength	> 27 N / mm2
8	Abrasion resistance	< 204 mm2
9	Skid resistance (friction coefficient)	> 0.4
10	Glossiness Min.	85% reflection

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-in-charge before bulk procurement for incorporation in the work.

b) **Preparation of Surface for Flooring**

Following procedure shall be followed :

- **Sub grade**

  Concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

- **Mortar and bedding**

  Cement mortar for bedding shall be prepared of mix 1:4 or as specified. to a consistent paste and shall conform to the specification for materials; preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

  Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water.

  Apply on an average 20 mm thick bedding of mortar over an area of 1 sqm at a time over surface of the area for laying tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

c) **Laying Of Tiles for Flooring**

The tiling work shall be done as per the pattern shown in the drawing or as directed by the Engineer-in-Charge. As a general practice laying of tiles shall be commenced from the centre of the area and advanced towards the walls. Cut tiles, if any, shall be laid along wall with necessary border pattern as shown / directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall /floor. White cement slurry to the back of the tile to be applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile. Do not use an iron hammer or some heavy material to press the tile. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with white / matching colour cement slurry. After fixing the

tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

d) **Fixing Tiles For Dado & Skirting / Facia**

The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

DAE / DCSEM: 102: SPN-CVL

The back of tiles shall be cleaned off and covered with layer of approved adhesive like BAL-ENDURA or equivalent with proper trowelling as per manufacturers recommendations.

The edges of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive. The joints shall be kept in straight line or as per the approved pattern.

While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials.
The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles faces shall be in one vertical plane.

e) **Grouting Of Joints In Floor / Skirting / Dado**

The joints, if specified, shall be cleaned off and all dust and loose particles removed. Joints shall then be filled with approved adhesive like BAL-ENDURA or equivalent grouts.

After finishing the grouting process, after 15 minute, wipe off excess grout with a damp sponge and polish the tiles with a soft & dry cloth for a clean surface. The Finished work shall not sound hollow when tapped with a wooden mallet.

f) **Cleaning**

As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives should not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the

floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.

g) **Cleaning Agents for Vitrified Tiles**

Vitrified tiles are resistant to all chemicals (except hydrofluoric acid and its derivatives), hence commercially available detergents and cleaning agents can also be used for regular maintenance. Any spills and stains must be removed immediately. If left dry they may leave stains, which may be difficult to remove completely.

Cleaning Agents for Vitrified Tiles

Stains	Cleaning Agent
Robin Blue	Household detergent / Warm water
Marker ink	Turpentine / Acetone / Trichloroethylene
Pen ink	Acetone / Isopropyl alcohol
Methylene blue	Isopropyl alcohol / Acetone
Sauce	Ammonia solution
Cement	Turpentine / Acetone / Trichloroethylene / Conc. HCL
Tea	Hydrochloric acid / Bleaching powder
Coffee	Sodium hydroxide / Potassium hydroxide
Beer	Sodium hydroxide / Potassium hydroxide
Diesel	Acetone / Petrol
Lab indicator	Acetone / Isopropyl alcohol
Cement and grouting	Hydrochloric acid
Pencil mark	Benzene or Toluene or Xylene
Plaster of Paris (POP)	Ammonium sulphate solution

Stains	Cleaning Agent
Iodine (Tincture iodine)	Sodium hydroxide / Potassium hydroxide
Hair dye	Per chloric acid
Paan	Lemon juice or citric acid
Marker pen	Acetone

2.02.03 **Pressed Ceramic Tiles In Skirting And Dado**

The tiles shall be approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze or more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however,

any glaze if unavoidable shall be permissible on only up to 50% of the surface area of edges.

The glaze shall be free from welts, chips, craze specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

Dimensions and Tolerances

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5, & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when joined together (with 1mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs and capping beds shall be of the shape and dimensions as required and thickness of fittings shall be the same as the thickness of tiles given above.

Preparation of Surface

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

Laying

12mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and joined. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these

shall be cut (swan) to the required size and their edges rubbed smooth. Skirting/ dado shall not project from the finished "surface of wall" by more than the thickness, undulations if any shall be adjusted in wall.

Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

2.02.04 **Chemical Resistant Tiled Finish**

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) **Tiles**

The chemical resistant tiles shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm^2. The surface shall be abrasion resistant and durable.

b) **Laying**

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.05 **Rubber, Vinyl or Vinyl Asbestos Tiles Finish**

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) **Thickness**

The thickness of the tiles shall be mentioned in the specification elsewhere or in drawing.

b) **Tiles**

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be non-fading and uniform in appearance, insoluble in water and resistant to alkalise, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) **Mix: Underbed**

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty: 1 part cement: 4 parts coarse sand mixed with just sufficient water to make it workable.

d) **Laying**

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable

tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) **Finishing**

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.06 **Stone Slab Finish: Marble, Granite Stone and Similar Fine Grained Stone**

a) **Dressing of slabs**

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waive ness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surface is in contact with every point on it. The sides and top surface of slabs shall be machined rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

b) **Thickness**

The underbed shall be average 20 mm thick. The thickness of the slabs shall be 18, 30, or 40mm as specified. Tolerance of ± 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of ± 2% shall be allowed. The overall thickness of the floor finish shall be 50mm.

c) **Stone Slab**

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

d) **Mix: Underbed**

Same as in previous clauses.

e) **Laying**

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as given in the description of the item.

The average thickness of the bedding mortar under the slab shall be 20mm and the thickness at any place under the slab shall be not less than 12mm.

The slabs shall be laid in the following manner :

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/streaks or as directed by the Engineer-in-Charge.

The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

f) **Polishing, Finishing**

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing if required and finishing shall be done as specified under previous clauses . However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for. Cement slurry with or without pigment shall not be applied on the surface before each polishing.

2.02.7 **Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish**

Generally clause 2.02.10 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed up to ± 3 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

2.02.8 **Marble Stone In Risers Of Steps And Skirting**

Marble Stone Slabs and Dressing of slabs shall be as specified in Clause no. 2.02.09 except that the thickness of the slabs shall be 18mm. A tolerance of ± 3% shall be allowed, unless otherwise specified in the description of the item.

Preparation of Surface

It shall be as specified in 2.02.05 where necessary; the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

Laying

The riser of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed in to the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1cement: 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but nor more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.
The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Curing, Polishing and Finishing

It shall be as specified in 2.02.01(e) as far as possible, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

2.02.9 **Kota Stone Flooring**

Kota Stone Slabs

The slabs shall be selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the Bidder shall get the samples of slabs approved by the Engineer-in-Charge.

Dressing

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the sides of the stone shall be in full contact with it. The sides (edges) shall be table rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25, 30, or 40 mm as specified in the description of the item. Tolerance of ± 2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

Preparation of Surface and Laying

The specification as described in 2.02.10 except that the edges of the slabs to be joined shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.

Polishing and Finishing

The specifications shall be as described in 2.02.10 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement

slurry with or without pigment shall not be applied on the surface before polishing.

2.02.10 **Kota Stone In Risers of Steps, Skirting and Dado**

Kota Stone Slabs and Dressing shall be as specified already except that the thickness of the slabs shall be 25mm or as specified. The slabs may be of uniform size if required.

Preparation of surface shall be as specified in previous clauses.

Laying shall be as specified already except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

Curing, Polishing and Finishing shall be as specified already except that first polishing with coarse grade carborundum stone shall not be done.

2.02.11 **Anti Static PVC Flooring**

PVC flooring of 2mm thick should be of approved make & brand with scratch proof, flexible & impregnated polyurethane reinforced (PUR) permanently static conductive Vinyl sheet, consists of impregnated polyurethane homogeneous mixture of PVC, plasticizers, urethane, colour pigments and filler calendared of approved colours and pattern detail. The material should be fixed with synthetic acrylic adhesive after preparing the floor, leveling & smoothening when necessary with suitable putty, as per the design & instruction of the Engineer-in-charge. Electrical resistance should be min $R10^8$ ohm as per ESD approval, SP-method 2472. Anti-static sheets should be confirming clean Room Test Class A as per ASTMF 51/100.

3.00.00 **ACCEPTANCE CRITERIA**

The finish shall be checked specially for :

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 **I.S. CODES**

Important relevant codes for this section:

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	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.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.
IS: 4457	:	Specification for ceramic unglazed vitreous acid resisting tiles
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: 4832 (part I)		Specification for chemical resistant mortar: silicon type.
IS: 4832 (part II)		Specification for chemical resistant mortar: resin type.
IS: 4832 (part III)		Specification for chemical resistant mortar: sulphur type.
IS: 13753	:	Specification for dust pressed ceramic tiles with water absorption of E>10%
IS: 13755	:	Specification for dust pressed ceramic tiles with water absorption of 3%, E6% (Group B11a)

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PART-B
SECTION-XII

GUIDELINE
FOR
FALSE FLOORING

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PART-B
SECTION-XII

GUIDELINE
FOR
FALSE FLOORING

1.00.00 SCOPE

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

2.00.00 FALSE FLOORING SYSTEM

2.01.01 Base

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

2.01.02 Supporting Structure

The supporting structure shall comprise of fabricated jacks made out of 25 mm. dia. MS rounds having 150 mm. threads at top. This jack shall be welded to 100 mm x 100 mm x 6 mm thick MS base plate pedestal. Pedestals shall be vertically true and located at 600 mm. centre to centre to conform to the size of the floor panels and shall be fixed to the RCC floor slab with ARALDITE. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The capital shall be of aluminium alloy die cast and shall receive cold rolled MS floor supporting channels of size 40 mm x 40 mm x 3.15 mm thickness as per drawings, both for main and cross runners. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

2.01.03 Floor Panel

The floor panels shall be made of phenol formaldehyde bonded particleboard treated with fire resistant paint as per schedule items. Size of each panel shall be 600 mm. x 600 mm. with all panel edges finished to a tolerance of $\pm$ 0.25 mm. on the diagonals. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel shall have 0.05-mm. thick Aluminium foils, which shall be fixed to the particleboard with resin-based adhesive.

3.00.00 **STRENGTH**

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

4.00.00 **SURFACE FINISH**

All removable panels shall have the top surface finished with 2 mm thick Antistatic Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

5.00.00 **SKIRTING**

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

6.00.00 **INSTALLATION**

All steel surfaces are to be protected by pointing over a primer, as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with Kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

7.00.00 **METALLIC FALSE FLOORING**

7.01.00 **Laminated Panel**

Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of **49 hemispherical and 36 reverse cones** and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non combustible cementitious compound at high pressure to fill in all the

crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate – PVC / Conductive PVC on a semi - automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black **Conductive PVC edge trim** 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

7.02.00 **Sub Structure-Pedestal Assembly**

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of **65 mm to a maximum of 600 mm** from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of leveling and accurately align panels for a maximum of ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement.

The Pedestal head assembly shall consist of a 75 x 75 mm x 3.5 mm embossed head mechanically riveted to a 100mm long 19 mm Dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-irrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 22.20 mm OD pipe of thickness 1.6mm mechanically locked on a press for perpendicularity and then welded to a base plate of 100 x 100 x 2mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

7.03.00 **Stringers**

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x 570 mm length.

PERFORMANCE CONFORMING TO MASTER SPECS 10270 / 096900 (USA)

A. **Structural Performance : CISCA A/F, 'Recommended Test Procedures for Access Floors'**

- **Concentrated Loads**

  540 Kgs (1200 lbf) with a top-surface deflection under load and a permanent set not to exceed , respectively, 2.54 & 0.25 mm (0.10 & 0.010 inch) according to CISCA A/F, Section I '' Concentrated Loads''

- **Ultimate Concentrated Load**

  1350 Kgs (3000 lbf) without failing according to CISCA A/F, Section II '' Ultimate Loading''

- **Rolling Loads**

  270 kgs (600 lbf) of the following magnitude, with a combination of local and overall deformation not to exceed 1.02 mm (0.040 inch) according to CISCA A/F, Section III '' Rolling Loads''

  CISCA AF Rolling Load: 10000 Passes

- **Stringer Load Testing**

  204 Kgs (450 lbf) at the centre of the span with a permanent set not to exceed 0.25mm (0.010 inch) as determined by CISCA A/F, Section IV, '' Stringer Load Testing''

- **Pedestal Axial Load Test**

  22 Kn axial Load per pedestal, according to CISCA A/F, Section V, ''Pedestal Axial Load Test ''

- **Pedestal Over Turning Moment Test**

  113 N x meters, according to CISCA A/F, Section VI, ''Pedestal Overturning Moment Test''

B. **Other Optional Structural Parameters**

- **Floor Panel Impact – Load Performance**

  100 lbf when dropped from 36 inches (914 mm) on to 1-Sq.Inch (6.5 sq.cm) area located anywhere on Panel without failing.

- **Uniformly Distributed Load (UDL)**

  1620 kg/m^2 with a maximum permissible deflection of not more than 1.52 mm as per definition of “Uniform load” of CISCA tested over an area of 300x300 mm square for 100kgs load

Note : The uniform load rating of an access floor panel as specified here in should not be confused with the “uniform live load” as specified in seismic zone application.

C. **Other Non structural Parameters**

- **Fire Rating**

  The Panels shall confirm to Class O & Class 1 Fire Ratings tested as per BS 476 Part 6 (Fire Propagation) & 7 (Surface spread of flame) as also ASTM E84 1998 (Flammability) and ASTM E136 (Combustibility)

- **Electrical Resistivity**

  As per ASTM F150/ NFPA 99 / ANSI S7.1 but modified for surface to ground to place one electrode on the floor surface and to attach the other electrode on the pedestal. Resistance to be tested at 500 volts

  1. Conductive range : $2.5x10^4$ – $1x\ 10^6$ Ohms (surface to ground)
  2. Static dissipative range : $1x10^6$- $1x10^9$ Ohms (surface to ground)
  3. Anti static range : $1x10^9$ – $2x10^{10}$ Ohms (surface to surface)

- **Fabrication Tolerance**

A.	Floor panel flatness	:	± 0.76 mm in any direction
B.	Floor panel width or length from specified size	:	± 0.25 mm
C.	Floor panel squareness	:	± 0.38 mm

7.04.00 **Acceptance Criteria**

The false flooring system shall be checked specially for :

a) Level

b) Alignment of joints

c) Thickness of joints

d) Surface finish

e) Colour and texture

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PART-B

SECTION-XIII

GUIDELINE
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.

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SECTION-XIII

GUIDELINE
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces on wood work, masonry, masonry surface with lime punning or white cement putty, concrete plastering, plaster of Paris punning, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Bidder shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting Bidder shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing those results.

Before commencing painting, the painting Bidder shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations. Bidder shall keep record of number of coats of painting. Before applying second coat, the Bidder shall obtain prior approval of Engineer in Charge

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be Grade-1 quality from well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained from the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) **Acrylic Washable Distemper**

Materials

Acrylic washable distemper (IS 428 water based instead of oil based) of approved brand and manufactures shall be used. The primers where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the Bidder in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the Bidder and the Engineer-in-Charge. The empty tins shall not be removed from the site of the work, till this item of work has been completed and passed by the Engineer-in-Charge.

Preparation of the Surface

For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing & scrubbing. The surface shall then be allowed to dry for that at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again

with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat : The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described before.

Note: If the wall surface plastered has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surface if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint confirming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hang down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

The specifications in respect of scaffolding, protective measures shall be as described before.

b) **Cement Primer Coat**

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints.

Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.
Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application : The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

The specifications in respect of scaffolding, protective measures shall be as described before.

c) **Exterior Painting on Wall**

Material : The paint shall be (Textured exterior Emulsion paint / Acrylic smooth exterior Emulsion paint / premium acrylic smooth exterior Emulsion paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the Bidder in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The material shall be kept in the joint custody of the Bidder and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has

been completed and permission obtained form the Engineer-in-Charge.

Preparation of Surface : For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection before painting is commenced.

Application :

Base coat of water proofing cement paint – All specifications in respect of base coat of water proofing cement paint shall be as described before.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with portable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-Charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

The specifications in respect of scaffolding and protective measures shall be as describe before.

3.00.00 PAINTING

Materials

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved paints, oil or varnishes shall be brought to the site of work by the Bidder in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Bidder and the Engineer-in-Charge. The empties shall not be removed from the site of the work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Commencing Work

Painting shall not be started until the Engineer-in-Charge has inspect the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

Application

Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, to or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure

(large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by through ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need to be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

Brushes and Containers

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint dose not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

4.00.00 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

Primer

The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

Primer for plaster / wood work / Iron & Steel / Aluminium surfaces shall be as specified below.

Table-2

Sl. No	Surfaces	Primer to be used
1.	Wood work (hard and soft wood)	As specified in elsewhere in the specification
2.	Resinour wood and plywood	
3.	(A) Aluminium and light alloys	
	(B) Iron, Steel and Galvanized steel	
4.	Cement/Concrete/RCC/brickwork, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	

The primer shall be ready mixed primer of approved brand and manufacture.

Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg :1 litre : 1 litre.

The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

i) **White Lead :** The white lead shall be pure and free from adulterants like barium sulphate and whiting. It shall confirm to IS 103.

ii) **Red Lead:** This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall confirm to IS 102.

iii) **Raw Linseed Oil:** Raw linseed oil shall be lightly viscous bit clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note: The oil shall be mellow and sweet to the taste with very little small. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall confirm in all respects to IS 75. The oil shall be of approved brand and manufacture.

iv) **Double Boiled Linseed Oil:** This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall confirm in all respects to IS 77. The oil shall be of approved brand and manufacture.

Turpentine : Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall confirm to IS 533.

All the above materials shall be approved manufacture and brought to site in their original packing in sealed condition.

4.01.00 **Preparation of Surface**

4.01.01. **Wooden Surface :** The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material confirming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the woo work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

4.01.02. **Iron and Steel Surface :** All rust and scales shall be removed by scrapping or by brushing with wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

4.01.03. **Plastered Surface :** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

Application

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described before.

Treatment on Steel for Aggressive Environment

A second coat of ready mixed zinc ethyl silicate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat is to be applied after placing the member in position and just before applying Paint.

5.00.00 **PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS**

The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint, aluminium Paint or other type of Paint as specified

Painting New Surface

Preparation of Surface : The surface shall be prepared for priming coat as described earlier.

Application : The number of coat of painting over the priming coat shall be as stipulate in the description of the item. The application of Paint over priming coat shall be carried out as specified above.

Painting on Old Surface

Preparation of Surface : If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application : The specifications for application shall be as described earlier.

6.00.00 PAINTING WITH WOOD PRESERVATIVE

Oil type wood preservative of specified quality and approved make, confirming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

Painting on New Surface

Preparation of Surface : Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

Application : The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

7.00.00 COAL TARRING

Coal tar of approved manufacture confirming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

Coal Tarring on New Surface

Preparation of Surface : This shall be done as specified in 4.01.00 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

Application : The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitable done to ensure this.

Coal Tarring on Old Surface

The work shall be done in the same manner as specified above (Coal Tarring on New Surface) except that only one coat using 0.12 litre per sqm. area shall be done.

8.00.00 **SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE**

The work shall include a priming coat of 'Distempering Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completions, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade.

Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application

Priming Coat : The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

Painting Coats : When the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with every fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish.

If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture.

Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

9.00.00 SPRAY PAINTING WITH FLAT WALL PAINT ON OLD SURFACE

Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

The flat wall Paint shall be of approved brand and manufacture and of required shade.

Preparation of Surface

The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down tightly.

Application

The paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

10.00.00 **WALL PAINTING WITH PLASTIC(Acrylic) EMULSION PAINT**

The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

Plastic emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

Painting on New Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, morter droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commended.

Application : The number of coats shall be as stipulated in the specification. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Precautions

a) Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water.

   Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.

b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

Painting on Old Surface

Preparation of Surface *:* This shall be done, generally as specified in 4.01.01 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.

Application : The number of coats to be applied shall be as in description of item. The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Except the above the thinning with water shall not normally be required.

11.00.00 PAINTING WITH ALUMINIUM PAINT(If specified)

Aluminium Paint shall be (confirming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

Preparation of Surface

Steel Work (New Surfaces) : All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

C.G.S. Sheets (New Surfaces) : The preparation of surface shall be as specified in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting New Surface'.

Steel Work or C.G.S. Sheets (Old Surfaces) : The specifications shall be as described in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting Old Surface'.

Application

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

12.00.00 PAINTING WITH ACID PROOF PAINT

Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

Preparation of surface and application shall be as specified in earlier clauses for new/old surface as the case may be.

Other details shall be as specified in earlier clauses as far as they applicable

13.00.00 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT

Ready mixed Paint (confirming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

Preparation of surface and application shall be as specified in previous clauses for Painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

Other details shall be specified in 3.00.00 as far as applicable.

14.00.00 FRENCH SPIRIT POLISHING

Pure shellac confirming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready made polish confirming to IS 348 can also be used.

Polishing New Surface

Preparation of Surface : The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

Application : The number of coats of polish to be applied shall be as described in the item.

A pad of wooden cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to given an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

Other details shall be as specified in earlier clauses as far as they are applicable.

Polishing Old Surface

Preparation of Surface : If the old polished surface is not much solid it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to do done like new work and will be paid for as such.

Application : The specifications shall be same as described above and as far as applicable.

Other details shall be as specified in earlier clauses as far as they are applicable.

15.00.00 EPOXY COATING/PAINTING

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

15.01.00 **Protection**

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

15.02.00 **Cleaning up**

In addition to provisions in general conditions the Bidder shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

16.00.00 **ACCEPTANCE CRITERIA**

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

17.00.00 **I. S. CODE**

Important relevant IS Codes for this Sections are listed below :

IS: 348	:	Specification for French polish
IS: 427	:	Specification for Distemper, dry colour as required.
IS: 428	:	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS: 2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS: 2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS: 2932	:	Specification for enamel, synthetic, exterior, type-I.
IS: 5410	:	Specification for cement paint, colour as required.

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PART-B

SECTION-XIV

GUIDELINE FOR SUSPENDED CEILING

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GUIDELINE
FOR
SUSPENDED CEILING

1.00.00 SCOPE

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, plaster of paris boards. Perspex etc. together with the suspension system as shown on drawing or specified in Schedule with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer. All wood supports shall be painted with two coats of “Solignum” or other approved wood preservative before erection.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2

centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

2.02.00 **Ceiling Panels**

2.02.01 **Materials**

Ceiling panels shall be best quality material in thickness and properties call for in the specification. The Bidder shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of the following types :

a) Plaster of Paris boards

b) Expanded polystyrene insulation boards

c) Fibre insulation boards

d) Wood particle boards

e) Glass fibre reinforced polystyrene sheets

f) Glass Reinforced Gypsum Board / Gypsum Board or Tiles

g) Mineral Fibre Board

h) Aluminium Panel – Linear / square / plank type false ceiling

i) Calcium silicate Board or tiles

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvers etc. shall be from approved manufacturers and in thickness as specified.

2.02.02 **Installation of Ceiling Panels**

Installation of ceiling panels shall be strictly as per manufacturer's instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and schedule of items, 6 mm thick cement : lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.03.00 **False ceiling systems with different materials**

2.03.01 **Glass Reinforced Gypsum (GRG) or Gypsum Moisture Resistant Tiles / Board**

1. Load bearing galvanized light gauge sections shall be used for supporting of (seamless) finished ceiling. G.I. channels of size 0.55 mm thickness having one flange of 300 mm. and a web of 27 mm. shall be fixed along with perimeter of ceiling, screw fixed to brick wall/ partition with the help of nylon sleeves & screws at 610 mm centres. Then suspending G.I. intermediate channels of size 45 mm. 0.9 mm. thick with two flanges of size 15 mm. each from the soffit at 1200 mm centres with ceiling angle of width 25 mm X 25 mm X 0.55 mm thick fixed to soffit with G.I. cleat and steel expansion fastner. Ceiling section of 0.55 mm thickness having knurled web of 51.5 mm and two flanges of 26 mm each with lips of 10.5 mm are then fixed to the intermediate channel with the help of connecting clips and in direction perpendicular to the intermediate channel at 457 mm centres. 12 mm thick GRG/Gyp MR Board is then screw fixed to ceiling sections with 25 mm dry wall screws at 230 mm centres. The board shall be joined and finished to have a flush look.

2. For profiled and curved surface, supporting structure from galvanized steel shall be made in required shape. Board shall be formed in to the curved shape while wet before fixing.

2.03.02 **Mineral Fibre Board**

For laying Mineral Fibre Board in tile of 600 mm X 600 mm the supporting grid system shall be formed by light gauged galvanized steel T- sections. Supporting grid system shall be rolled formed double web galvanized tees and shall meet the requirements of ASTM C-635. Nominal size of T-section shall be 24x38 mm for main runner. Exposed flange surface i.e. 24 mm wide shall be precoated or provided with a matching coloured cap. Main supporting section shall be suspended from RCC soffit / steel member with 4 mm dia galvanized rod & spring steel clip @ 1200 mm c/c. Suspensions from RCC shall be taken using expansion fasteners. The main supporting member shall be placed @ 1200 cross T-sections is inserted into the slots provided in main supporting member at 600 mm c/c so as to give a maximum size of 1200 mm x 600 mm.

Mineral Fibre Board Tiles shall be laid onto the grid 4 nos. of PVC holding clips shall be provided for each panel.

Aluminium Panels – Linear / Square tiles (lay-in or lay-on type) / planks

Aluminium panel ceiling, perforated or un-perforated as per requirement, of approved make, colour consisting of panel 150 mm wide x 15.5 mm deep x 0.5 mm thick with bevel edge, panel length up to 6 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 5050(Al.mg) for higher strength and good roll forming characteristics. The Panels about each other with a narrow V grove. Panel shall be clipped to a baked enamelled Aluminium Panel carrier of 32 mm wide x 39 mm deep x 0.95 mm thick in standard length of 5 mtr made of double baked enamelled Aluminium alloy AA 5050 (Al.mg) black with cut-outs to hold the panels in a module of 150 mm closed at a distance 1.00 mtr. Panel carrier shall be suspended by means of G.I. suspension rod 4-mm diameter and a Galvanised suspension spring clip at a distance of 1.7 mtr c/c. Paint Finish: Aluminium Panels shall be chromatised for maximum bond between metal and paint enamelled twice under high temperature, one side with a full primer and finish coat the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.

Or tile of 600mm wide and 600mm long manufactured out of 0.7mm thick Aluminium alloy AA 5050(Al.mg). Tile ends will be raised with pips and stops to ensure positive engagement into the spring to enable for de-mounting of individual panels. The Tile sides will be sufficiently high to ensure a minimum deflection across the length of Tile. All Tiles will be bevel edged. The Tile shall be Polyester based, powder coated in white colour. The Tile shall be clipped into clip in profile of 0.5mm thick G.I. The clip in profile shall be supported from slab by means of rigid suspension of 4mm G.I. Rod, Hold on Clamp with Clip. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.
Or Aluminium lineal ceiling system shall be “Luxalon 84˚C or approved equal and the installation shall be strictly as per manufacturer’s instruction/ specification subject to approval of the Engineer. Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 12mm dia 50mm long anchor bolts and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 **ACCEPTANCE CRITERIA**

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 **I. S. CODES**

IS: 2441 - Code of Practice for fixing ceiling coverings.

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PART-B

SECTION-XV

GUIDELINE
FOR
ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

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GUIDELINE
FOR
ROOF WATER PROOFING, INSULATION
AND ALLIED WORKS

1.00.00 SCOPE

This specification covers providing, furnishing, installation, repairing, finishing, curing, testing,, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract. Roof water proofing shall be followed as specified in section IV / vol G1. However the following section gives the methods of waterproofing for general guidance.

2.00.00 INSTALLATION

2.01.00 Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to take the fiber cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

2.01.01 There is no necessity of hacking the surface to be treated shall be cleaned including removing the mortar dropping from the surface.

2.01.02 **Grading Underbed**

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of

25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.03 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 **Concrete**

The concrete shall be used where the sub-grade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.
The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 **Insulation**

The successful bidder shall furnish specification of insulating materials he proposes to use and the proposed method of laying to the owner for approval. Before bulk supply, the Bidder shall send samples of insulating material to the Engineer, and after approval of the samples, the Bidder shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Bidder shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.03.01 **Foam Concrete**

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings and elsewhere in specification. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.03.02 **Expanded Polystyrene Blocks**

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Bidder shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Bidder shall have to secure manufacturer's supervision.

Material: Expanded polystyrene shall conform to IS 4671. It is of two types given below :

Type N-Normal

Type SE – It shall be of self extinguishing type when tested in accordance with IS 4671.

Dimensions : The size of the finished boards shall be 1.0 x 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100mm.

Tolerance : The tolerances on the length, width and thickness of the finished board shall be ± mm.

Requirements for Expanded Polystyrene for General Use :

Sl. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
1.	Thermal conductivity (k. value) (a) at 0ºC (b) at 10ºC	 0.34 0.37	 0.32 0.35	 0.30 0.33	 0.29 0.32	 0.28 0.30	IS 3346
2.	Compressive strength at 10% deformation in kg/sq.cm Minimum.	0.7	0.9	1.1	1.4	1.7	IS 4671
3.	Cross breaking						

Sl. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
	strength in kg/sq.cm Minimum.	1.4	1.6	1.8	2.2		IS 4671
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671
6.	Water absorption	Less than 0.5% by volume (after 24 hrs. immersion)					IS 4671

Sampling : In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judgment conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table given below. The sample shall be taken at random from the lot.

No. of items in the lot	No. of sample items	Permissible number of defective sample items
1	2	3
Up to 25	3	0
26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

General : Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled ober the suspended false ceiling.

2.03.03 **With Resin Bonded Fiber Glass Wool (Bonded Mineral Wool)**

Material : The material shall be mineral wool made from sock slag or glass processed from a molten state in to fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall be 25, 40, 50, conform to specifications of group I of IS 8183.

Dimensions : The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded material wool shall be 25, 40, 50, 65 or 75 mm.
Tolerance : For width and length, the dimensional tolerance of the bonded material wool shall be -1/2 %. For nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

Requirements for Fiber Glass Wool

Sl. No.	Characteristics	Group I	Test Reference
1.	Bulk density	12 to 15 kg/cum	IS 3144
2.	Recovery after compression	Not less than 90% of original thickness	Annexure. A of IS 3144
3.	Shot content max	500 micron-5% 250micron-15%	IS 8183
4.	Moisture content and absorption	Not more than 2%	IS 3144
5.	In combustibility	Incombustible	IS 3144
6.	Thermal conductivity deg. C at mean temperature 50 deg. C	0.49 mw/ cmºC	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

General : Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

2.04.00 **Fillets**

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.05.00 **Water proofing by epoxy resin based application**

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, and light traffic. The application shall be resistant to growth of fungus and proof against saltpeter

action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Bidder shall arrange the demonstration by providing free the materials and labours for the application.

2.06.00 **Flashing**

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.
Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.07.00 **Elastomeric Membrane**

2.07.01 **Primer Coat**

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per liter depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigorous brushings, fungal growth with proprietary fungicide as recommended. Priming coat shall not be applied to damp substrate.

2.07.02 **Finishing Coats**

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform joint less elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by at least 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.07.03 **Surface Finish**

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3 (using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound to ensure perfect waterproofing.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS: 13801 shall be provided. The tiles shall be laid as per IS 1443.

2.08.00 **Under Deck Insulation**

2.08.01 Insulation material shall be Closed Cell Elastomeric Nitrile Rubber

2.08.02 Density of Material shall be between 40 to 60 Kg/m3

2.08.03 Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C

2.08.04 The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990

2.08.05 Material should be FM (Factory Mutual), USA approved.

2.08.06 Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

2.08.07 Under-deck insulation thickness shall be as per HVAC requirement and calculation.

2.08.08 Under-deck insulation shall be provided for all AC areas having roof/floor exposed to sun/hot environment.

2.09.00 Spray able Insulation and waterproofing system(If specified)

2.09.01 **For roofs with structural slope:**

Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro flouro carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

2.09.02 For roofs having no structural slope:

Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro flouro carbon (CFC free), polymeric M.D.I based closed cell (96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m^3 as per ASTM D1622 , and a

thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

2.09.03 For vertical surfaces (Parapet)

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc. and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls(2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: ***Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person.***

3.00.00 **ACCEPTANCE CRITERIA**

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

4.00.00 **I.S. CODES AND STANDARDS**

a) IS:73 : Paving Bitumen

b) IS:702 : Industrial Bitumen

c) IS:1203 : Methods of testing tar and bitumen

d) IS:1322 : Bitumen felts for waterproofing and damp proofing

e) IS:1346 : Code of Practice for waterproofing of roofs with bitumen felts

f) IS:3384 : Bitumen primer for use in waterproofing and damp proofing.

g) IS:2645 : Specification for integral water proofing compounds for cement mortar and concrete.

h) IS:3144 : Methods of test for mineral wool thermal insulation materials.

i) IS:4641 : Expanded polystyrene for thermal insulation purpose.

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PART-B

SECTION-XVI

GUIDELINE
FOR
SHEET WORK IN ROOF AND SIDE WALL

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PART-B
SECTION-XVI

GUIDELINE
FOR
SHEET WORK IN ROOF AND SIDE WALL

1.00.00 SCOPE

This specification covers the erection of Zincalume sheet plain /corrugated/trough covering to roof and side walls at various elevations and the fabrication and/or installation gutters, flashings etc., as shown on drawings

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Bidder in proper way to prevent all damage. If the materials are issued at site by the Owner, the Bidder shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Zincalume Sheeting

The wall cladding for buildings shall be of double skin sandwiched(wherever specified) prefabricated factory made Rockwool/PUF TR panels comprising of outer metal colour coated profile steel sheet of minimum depth 34.5 mm at 333 mm pitch & inner slightly ribbed or plain permanently colour coated steel sheet made out of 0.6 mm TCT high tensile zincalume steel (150 gsm. Zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for top sheet and 0.5 mm TCT zincalume steel (150 gsm zinc – aluminium coating total of both sides as per AS:1397) & min. 550 MPa yield strength for inner sheet, having colour coating with silicon modified polyester finish of thickness 20 microns over 5 microns (DFT) back coat. The permanently colour coated sheet shall meet the general requirements of IS:513, IS:277 & IS:14246. In between the metal sheet, there will be lamellar mineral wool insulation having density 100 kg/m3 and average thickness 50 mm conforming to IS:8183 having a thermal conductivity value of 0.040 W/m2K at 50oC mean temp. Alternatively insulation shall be PUF having density of 40- 42Kg/m3 and a thermal conductivity value shall be as per

IS:12436. The prefabricated Rockwool/PUF panels shall be supplied up to max. length of 12 m and finished with profile sheet overlap jointing arrangement. The panels shall be directly bolted on to the horizontal runners. The double skin cladding with single skin on either side of the horizontal runners without insulation wool in the middle shall also be used as per the requirement and as specified.

Note: For single skin wall cladding/ roofing, specification for outer sheet as mentioned above is to be followed and the thickness of the sheet shall be 0.8mm minimum. Flashings shall be of same material that of sheeting.

The work is to be executed by the in-house/authorised applicator of the manufacturer, under the supervision of the authorised representative of the manufacturer

Purlins : Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters and the spacing will be as specified in the drawing.

Slope : Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal or as specified in the drawing. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

Laying and Fixing : The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridges, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Sheet shall not generally be fixed in to gables and parapets. They shall be bent up along their side edges close to the wall and junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.
The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the Purlins or other roof members such as hip or valley rafters etc. with galvanized J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washers filled with white lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron Purlins, and L hooks are used for fixing the sheet to R.S.

joists, timber or precast concrete Purlins. The length of the hook bolt shall be varied to suit the particular requirements. Alternatively Sheets may be fixed to Purlin with self-driven screws with neoprene washers as recommended by the Sheet manufacturer. Sheeting to sheeting fixing may also be done with self-driven screws with neoprene washers.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

The galvanized coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanized coating should conform to IS 1367 9pt. XIII). The mass of coating per square meter of the surface shall be as under:

Mass and Equivalent Thickness of coating

Minimum Mass (g/m²)	Average Thickness(µm)	Minimum Mass (g/m²)	Individual Thickness(µm)
375	54	300	43

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron bolts and nuts 25 x 6 mm size, each bolt provided with bitumen and a G.I. limpet washers or a G.I. limpet washers filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

Finish : The roof when completed shall be true to lines, and slopes and shall be leak proof.

Ridges and Hips of Plain Zincalume Sheets

Ridges and Hips : Ridges and hips of Zincalume. roof shall be covered with ridge and hip sections of plain Zincalume sheet with a minimum lap of 20 cm on either side over the C.G.I. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.I. sheet, 0.6mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.`

Fixing : Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together with Zincalume sheet by galvanized iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

Finish : The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

Valley and Flashing of Plain Zincalume Steel Sheets

Valley and Flashing : Valley shall be 90 cm wide overall plain sheet 1.6 mm thick or other size as specified bent to shape and fixed. They shall lap with the corrugated. sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain Zincalume sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick or as specified bend to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not less than 25 cm.

Laying and Fixing : Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonry with the mortar of mix 1:3 (1cement: 3 coarse sand).

Finish : The edges of valley and flushing should be straight from end to end. The surface should be true and without bulges and depressions.

Gutters Made of Plain Zincalume Sheets

Gutters : Gutter shall be fabricated from plain zincalume sheets of thickness as specified

Eaves gutters shall be of the shape and section specified in the description in the item. The overall width of the sheet referred to their in shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form rounded edges. The ends of the sheets at junction of pieces shall be hooked in to each other and beaten flush to avoid leakage.

Slope : Gutters shall be laid with a minimum slope of 1 in 120.

Laying and fixing : Gutters shall be supported on and fixed to GI. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap rafter not less than 30 cm and the connecting bolts shall be at 12 cm centers.

Where the brackets are to be fixed to the purlins, the bracket shall consist of 50 x 3 mm GI. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 nos. of 10 mm diameter bolts, nuts and washers. The bracket will be stiffened by provision of 50 x 3 mm GI flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 no. 10 mm dia bolt, nut and washer. The overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

The gutter shall be fixed to the brackets with 2 nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of . sheet of the same thickness as the gutter and reverted to the gutter, the other end tailing in to the socket of the rain-water pipe. Wherever stop ends, angles etc., should be provided.

Finish : The gutters when fixed shall be true to line and slope and shall be leak proof.

2.02.02 **Polycarbonate Sheeting Work**

Solid Polycarbonate sheet of minimum 4mm thick should be of UV resistant and high temperature resistant. Sheet should be of approved brand and quality, colour and transparency for ceiling/ roofing on plain, sloped, curved surfaces to any pitch or height including fixing purlins with polymer quoted galvanized self drilling, self tampering metal screws and fasteners and EPDM washers, rubber gasket with closing caps, adequate adhesive and sealants as per manufacturer's specification etc. complete but excluding the cost of

purlins, rafters, trusses etc.(if any). Polycarbonate sheets shall be uniform pigmentation and thickness with out air pockets and shall conform to IS: 14443: 1997 and including cutting to required length and size including profile machine bending of sheets to achieve the desired profile by conforming minimum joints and laps as per drawing.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing

4.00.00 IS CODES

The following are some of the important IS Codes relevant to these sections:

IS : 3007	:	Code of practice for laying of asbestos cement sheets
IS : 2527	:	Code of practice for fixing rain water gutters and down pipes for roof drainage
IS : 1626	:	Specification for asbestos cement building pipes gutters and fittings
IS : 277	:	Specification for galvanised steel sheets (plain and corrugated)
IS : 1200 (PT.IX)	:	Method of measurements of building and civil engineering works: Part – 9 Roof covering (including cladding)
IS : 2633	:	Method of testing uniformity of coating on zinc coated articles.
IS : 3144	:	Method of test for mineral wool thermal insulation materials.

IS : 3346 : Method of the determination of thermal conductivity of thermal insulation materials.

IS : 8183 : Bonded mineral wool

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SECTION-XVII

GUIDELINE FOR WATER SUPPLY

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PART-B
SECTION-XVII

GUIDELINE
FOR
WATER SUPPLY

1.00.00 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

General Requirements

Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the Bidder, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the Bidder. All water supply installation work shall be carried out through licensed plumber.

It is most important to ensure that wholesome water supply provided for drinking and culinary purpose is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be constructed a permissible substitute for complete absence of cross-connection.

Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only in to a cistern, and by a pipe or fitting discharging in to the air gap at a height above the top edge of the cistern equal to twice its normal bore, and in no case less than 15 cm.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such that can cause undue deterioration of the pipe.

Where the laying of any pipe through fouled soil or previous material is unavailable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply

with the above requirements, shall be removed and re-laid in conformity with the above requirements.

The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non-return valves shall not be relied upon to prevent such back flow.

All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water damage to property and the risk of contamination of the water conveyed.

In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance or airlocks, noise transmission and unsightly arrangement.

To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

Change in diameter and direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

Where the service pipe is of diameter less than 50mm the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

In flats and tenements supplied by a common service pipe a stop valve shall be fixed to control the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.

Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.

Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining

properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not under ground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided. Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or claps shall be insulated from the piping by suitable pads.

The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joints.

Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cistern which shall have supply from storage tank.

No service or supply pipe shall be connected directly to any hot water system or to any apparatus used for heating other than through a feed cistern thereof.

1.01.00 **Materials**

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Bidder shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Bidder to procure the materials selected by the Engineer. Hence order is to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00 **Pipes and Pipe Fittings**

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types:

a) Steel: lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

b) Reinforced Concrete

c) P. V. C.

d) Copper

e) Brass

f) Galvanized Iron- heavy & medium duty pipes- is 1239 & is 4736

g) PP-R Pipes – IS 15801

However for water supply in buildings only GI pipes of Medium class as per IS 1239 shall be used. And all the pipes shall be laid inside the buildings in concealed type

1.03.00 **Water Tanks**

Water tanks shall be made of HDPE, shall be factory made and from reputed brand with proper test certificates. The capacity of tanks shall be as per drawing design or as per instruction of Engineer-in-Charge.

1.04.00 **Related Works**

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Bidder unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 **Regulation**

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Bidder).

2.00.00 **INSTALLATION**

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Bidder for approval of the Engineer.

Special attention shall be given by the Bidder to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 **Pipe Lines**

2.01.01 **Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 **Back Flow**

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 **Contamination**

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 **Underground Pipings**

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 **Concealed Piping**

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Bidder may co-ordinate with the building Bidder for leaving the chases, openings, conduits as necessary. However, the Bidder will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 **Jointing of Pipes**

Jointing of pipes shall be completely leak proof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance:

a) **Steel**

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

b) **G I Pipes**

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) **Concrete**

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

d) **P. V. C. / UPVC/ HDPE/PP-R**

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

e) **Tyton Joint**

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the jont fully.

2.01.07 **Painting**

Where mentioned , underground steel pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I/MS/DI. pipes shall be given a coat of zinc ethyl silicate primer, And finish coats as specified in section IV/G12.02.00 **Polythene Water Storage Tanks**

Material

Polythene used for manufacture of tanks and manhole lids may be high density (HDPE),) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminated the water nor impart any test, colour, odour or toxity to water.

Manufacture and Finish

The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and

external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

Shape, Size and Capacity

The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer's specifications and a clearance of ± 3 percent shall be permitted on these dimensions. Capacity of the tank or up to the bottom of the inlet location whichever is less. Capacity of the tank shall be specified. Extra capacity if any shall be ignored.

Weight and Wall Thickness

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and the location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering of leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter in to the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

Sl. No.	Capacity (litres)	Minimum Wall Thickness (mm)	Minimum Weight of Empty Tank (kg)
1	2	3	4
1.	200	4.4	7.8
2.	300	4.4	9.0
3.	400	5.5	15.0
4.	500	6.0	18.0
5.	700	7.0	23.5
6.	1000	6.6	33.0
7.	1250	7.0	40.0
8.	1500	7.0	47.0
9.	1700	7.0	54.0
10.	2000	7.0	64.0
11.	2500	8.2	81.0

12.	3000	8.2	96.0
13.	4000	8.8	138.0
14.	5000	10.4	191.0
15.	6000	10.7	209.0
16.	7500	10.7	250.0
17.	10000	11.5	363.0
18.	15000	11.5	550.0
19.	20000	13.2	814.0

2.02.00 **Valve, Cocks, Taps**

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.03.00 **Protection**

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 **TESTING AND ACCEPTANCE**

3.01.00 **Inspection Before Installation**

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 **Testing of Mains after Laying**

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main

shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 **Testing of Service Pipes and Fittings**

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All piping, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.00.00 **I.S.CODES**

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)
IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes

IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polythylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks
IS:4736-1986	:	Hot-dip zinc coatings on steel tubes. (Reaffirmed – 2001)

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PART-B

SECTION-XVIII

GUIDELINE
FOR
DRAINAGE AND SANITATION

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GUIDELINE
FOR
DRAINAGE AND SANITATION

1.00.00 SCOPE

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.00.00 INSTALLATION

2.00.01 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 Rainwater Down comers & Soil and Drainage Pipes

Rainwater down-comers shall be standard, UPVC/DI Pipes. .

Rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.01.01 **Unplasticized Polyvinyl Chloride (UPVC) Pipes**

The specification covers requirements for plain and socket end unplasticised polyvinyl chloride (UPVC) pipes with nominal outside diameters 40 mm to 160 mm for use for soil and waste discharge system inside buildings including ventilating and rain water applications. In this specification nominal outside diameter DN of pipes are 40, 50, 63, 75, 90,110,125,140 and 160 mm.

Surface colour of the pipes shall be dark shade of grey. For other details and specifications refer code IS: 13592-1992 (amended to 1995)

Above quality of pipes are divided into two types. Type –A (IS 13592) meant for rain water pipes & Type- B meant for soil pipes.

Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified.

Marking

Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meters.

a) Manufacturer's name or trade mark.

b) Nominal outside dia of pipe.

c) Type 'A'

d) Batch number.

Dimensions

Diameter and Wall Thickness : Mean outside diameter, outside diameter at any point and wall thickness for type-A or type-B manufactured plain or with socket shall be as given in Table-1 of IS 13592.

UPVC rain water/ soil pipe shall of the dia, specified in the description of the item and shall be in nominal lengths of 2, 3, 4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerance on specified length shall be + 10mm and – 0 mm.

Fixing and Jointing

Pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x50x50 mm hard wood plugs, screwed with M.S. screws of required length i/e cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

Installation in Wall/ Concrete

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted in to the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

Fittings

Fittings used shall be of the same make as that of the PVC pipes injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 302 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

2.01.02 **Cement concrete pipes (with and without Reinforcement) (Light Duty, Non-Pressure)**

The pipes shall be with or without reinforcement as required and shall be of class not less than NP2. These shall conform to IS: 458. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete used for the manufacture of reinforced concrete pipes and collars shall not be leaner than 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

2.01.03 **Pipes-Galvanised Iron**

The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HIRW or HFW screwed and socketted conforming to the requirements to IS 1239 Part – I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

Galvanising shall conform to IS 4736 : The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare batches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be clearly finished, well galvanized in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be cleaned and well cut. The ends shall be cut clearly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

All tubes shall withstand a test pressure of 50 kg/sq.cm without showing defects of any kind.

Fittings : The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

2.02.00 **Gutters**

The gutters shall be made of G.I. or as specified elsewhere in the contract. All gutters shall be supplied by reputable specialized firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.01 **Gradients**

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

2.03.02 **Relation with water supply pipe lines**

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03 **Laying**

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04 **Support and Protection on Pipelines**

All pipes shall be laid with sockets leading uphill. For on/above ground level, Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. For underground PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

For above ground level the pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located

close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

Laying Of Cement Concrete Pipes : Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.

If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipe shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia of the pipe subject to the min. of 10 cm and a maximum of 30 cm. The concrete shall extend up to the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over a dia. The pipe shall be laid in this concrete bedding before the concrete has set.

2.03.05 **Entry into structures**

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 **Ducts**

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be

through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 **Traps and Ventilating Pipes**

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 **Manhole and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgment for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.
Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 **Cutting of Pipes**

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 **Jointing**

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer.

2.04.00 **Trenches and other excavations**

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Bidders from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.
The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 **Fixtures**

The successful bidder shall furnish the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the

Bidder shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 **Water closet**

a) **Raised type**

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level PVC flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) **Squatting type**

It shall include glazed vitreous china pan with foot rests and high level PVC flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface.

2.05.02 **Urinals**

It shall consist of wall type glazed vitreous china urinals, PVC/ glazed stoneware automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once in every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated. Sensor based urinals shall be provided at important areas as decided by the Engineer in charge

2.05.03 **Wash basin**

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated. The washbasins preferably oval shaped fitted on Granite Top.

2.05.04 **Sink**

It shall be made of glazed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 **Bathroom mirror**

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 **Glass shelves**

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 **Towel rail**

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 **Soap holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 **Liquid soap dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 **Toilet roll holder**

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Bidder.

3.00.00 **TESTING AND ACCEPTANCE**

3.01.00 **Inspection before installation**

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 **Testing of Pipelines**

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) **Smoke test**

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) **Water test**

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases :

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) **For straightness**

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.03.00 **Fixtures etc.**

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 **CODES AND STANDARDS**

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.

IS: 1172 - Code of basic requirements for water supply drainage and sanitation.

IS: 1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.

IS: 1239 - Mild Steel Tubes and Mild Steel Tubular and other (Pt.I & II) wrought steel pipe fittings.

IS: 1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

IS: 1537 - Vertically cast iron pressure pipe for water, gas & sewage.

IS: 3486 - Cast Iron spigot & socket drain pipes.

IS: 1742 - Code of Practice for building drainage.

IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS: 2470 - Code of Practice for designs and construction of septic tank for small and large installations.

IS: 3076 - Low density polythelene pipes for potable water supplies.

IS: 4984 - High density polythelene pipes for potable water supplies.

IS: 1537 - Vertically cast iron pressure pipes for water, gas and sewage.

IS: 1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.

IS: 1230 - Cast Iron rain water pipes and fittings.

IS: 3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS: 1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.

IS: 1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).

IS: 458 - Concrete pipes (with and without reinforcement)

IS: 783 - Code of Practice for laying of concrete pipes.

IS: 784 - Prestressed concrete pipes.

IS: 651 - Salt glazed stoneware pipes & fittings.

IS: 4127 - Code of practice for laying of glazed stoneware pipes.

IS: 1726 - Cast Iron manhole covers and frames intended for use in drainage works.

IS: 5961 - Cast Iron gratings for drainage purposes.

IS: 5219 (Part 1) - 'P' & 'S' traps.

IS: 771 - Glazed earthen-ware sanitary appliance.

IS: 772 - General requirements of enamelled cast iron sanitary appliances.

IS: 774 - Flushing cistern for water closets & urinals (valve less siphonic type).

IS: 775 - Cast Iron brackets & supports for wash basins and sinks.

IS: 2548 - Plastic water closet seats & covers.

IS: 2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

IS: 1703 - Water fittings- copper alloy float valves (horizontal plunger type) - Specification.

IS: 1795 - Specification for pillar taps for water supply purpose.

IS: 2556 (Part-1, Part-2, Part-3, Part-4, Part-5, Part-6, Part-7, Part-14, and Part-15)
- Part-1: General requirements
- Part-2: Specific requirements of wash-down water closets.
- Part-3: Specific squatting pans.
- Part-4: Specific requirements of wash basins.
- Part-5: Specific requirements of laboratory sinks.
- Part-6: Specific requirements of Urinal & Partition plates.
- Part-7: Specific requirements of accessories for sanitary
- Part-14: Specific requirements of integrated squatting pans.
- Part-15: Specific requirements of universal water closets.

IS: 3989 - Specification for centrifugally cast 9spun) iron spigot and Socket soil, waste and ventilating pipes fittings and accessories.

IS: 4827 - Specification for electroplated coating of nickel and chromium on copper and copper alloys.

IS: 4985 - Unplasticised P.V.C pipes for potable water supply-Specifications.

IS: 4127 - Code of Practice for Laying of Glazed Stone Ware Pipes.

IS: 4885 - Specifications for Sewer Bricks.

IS: 12592 - Pre-cast Concrete Manhole Covers and Frames – Specifications.

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PART-B

SECTION-XIX

GUIDELINE
FOR
FLY ASH BLOCKS / BRICKS

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PART-B

SECTION-XIX

GUIDELINE
FOR
FLY ASH BLOCKS / BRICKS

1.00.00 SCOPE

This document lays down the specific technical requirements regarding classification, general quality, dimensions and physical requirements of pulverized fuel ash – Cement Bricks/Blocks which may be used as per instruction of Engineer-in-charge.

2.00.00 CODES & STANDARDS

The following Indian Standards contain provisions which, through reference in this text, constitute provision of this document.

IS 12894: 2002	:	Pulverized Fuel Ash-Lime bricks - Specification
IS 712: 1984	:	Specification for building limes
IS 1727: 1967	:	Methods of test for pozzolanic materials
IS-269-1989	:	Ordinary Portland cement 33 grade specification
IS-8112-1989	:	Ordinary Portland cement 33 grade specification
IS-12269-1987	:	Ordinary Portland cement 53 grade specification
IS: 3812-2003(PART1)	:	Pulverized fuel ash specifications for use of pozzolona in cement, cement mortar and concrete
IS-3812-2003(PART 2)	:	Pulverized fuel ash specifications for use as admixture in cement mortar and concrete
IS 3495(Part1): 1992	:	Determination of compressive strength of burnt clay building bricks
IS 3495(Part 2)1992	:	Determination of water absorption of burnt clay building bricks
IS 3495(Part 2)1992	:	Determination of efflorescence of burnt clay building bricks
IS 3812: 1981	:	Specification for fly ash for use as pozzolana and admixture
IS 4139: 1989	:	Specification for calcium silicate bricks
IS 5454: 1978	:	Methods for sampling of clay burnt building bricks

3.00.00 GENERAL REQUIREMENTS

Visually the bricks/blocks shall be sound, compact and uniform in shape. These shall be free from visible cracks, warpage and organic matters. The bricks/blocks shall have smooth rectangular faces with sharp corners and shall be uniform in shape, texture and colour. When broken they shall leave no lumps or grit.

4.00.00 CLASSIFICATION

Pulverized fuel ash-cement bricks/blocks shall be classified on the basis of average wet compressive strength as given below:-

Table 1

Class Designation	Average wet compressive strength not less than
10	100 kgf/cm^2
7.5	75 kgf/cm^2
5	50 kgf/cm^2

5.00.00 DIMENSIONS AND TOLERANCES

5.01.00 Dimensions

The Dimension of Fly ash bricks shall be 230X110X75 and that of block shall be 230X220X115

5.02.00 Tolerances

The dimensional tolerance of blocks shall be as outlined in Cl. 5.2 of IS 12894: 2002 and IS 2185: 1979

6.00.00 MATERIALS

6.01.00 Pulverized Fuel Ash (Commonly known as Fly Ash)

Pulverized fuel ash commonly known as fly ash collected from ESP shall conform to Grade 1 or Grade 2 of IS 3812.

6.02.00 Sand/Stone Dust/Aggregates

Contractor shall use available sand/stone dust which is used for concrete work. The following practice generally followed:
Deleterious materials, such as clay and silt in sand/stone dust shall preferably be less than 5 percent as per IS 12894:1990. Field test with the help of measuring cylinder to ascertain percentage of deleterious materials should be carried for every truck load of sand/stone dust.

6.03.00 Cement

Cement used shall be ordinarily Portland cement conforming to Code for ordinary cement in IS 8112:1989 for 43 grades and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

6.04.00 Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

6.00.00 Proportioning of Raw Materials

Fly ash: 50-60%
Sand/stone dust: 30-40%
Cement: 8 to 10%

The strength of the bricks manufactured with above proportion shall be at least of 7.5 N/sqmm after 28 days.
Mix proportions stated above can be utilized as guide lines. Based on the quality of raw materials, the exact mix proportion may be finalized by trial mixes to produce good quality bricks of required compressive strength. The above proportions are tentative and shall be revalidated by getting tested at approved lab. The contractor shall seek approval from the owner before carrying out mass manufacturing. Owner shall check the quantities as and when he deems fit. In any case if a source of any raw material is changed, owner's approval to taken and manufactured bricks shall be tested.

7.00.00 PHYSICAL CHARACTERISTICS

7.01.00 Compressive Strength

The minimum average wet compressive strength of pulverized fuel ash-cement bricks/blocks shall not be less than the one specified in Table 1 (shall satisfy minimum class 5) when tested as described in IS 3495 (Part 1). The wet compressive strength of any individual brick/block shall not fall below the minimum average wet compressive strength specified for the corresponding class of bricks/blocks by more than 20 percent.

7.02.00 Drying Shrinkage

The average drying shrinkage of the bricks/blocks when tested by the method described in IS 4139, being the average of three units shall not exceed 0.15 percent.

7.03.00 Efflorescence Test

The bricks/blocks when tested in accordance with the procedure laid down in IS 3495 (Part 3) shall have the rating of efflorescence not more than “moderate”.

7.04.00 Water Absorption

The bricks/blocks when tested in accordance with the procedure laid down in IS 3495 (Part 2), after immersion in cold water for 24 hours, shall have average water absorption not more than 20 percent by mass.

8.00.00 SAMPLING AND CRITERIA FOR CONFORMITY

Sampling and criteria for conformity of the bricks/blocks shall be as given in IS 5454.

9.00.00 MARKING

Each brick/block shall be marked in a suitable manner with the manufacturer’s identification mark or initials.

35720/2020/PS-SR-PM

एनएलसी इंडिया लिमिटेड
(पूर्व में नेयवेली लिग्नाइट कार्पोरेशन लिमिटेड)
भारत सरकार का "नवरत्न" उद्यम
NLC INDIA LIMITED
(formerly Neyveli Lignite Corporation Limited)
('Navratna' – A Government of India Enterprise)
मुख्य महाप्रबंधक / संविदा का कार्यालय
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CIN:L93090TN1956GO1003507

CORRIGENDUM No.2, Dt: 29.05.2019

Sub: NLC India Limited (NLCIL) - Flue Gas Desulphurisation System Package for 2 x 500 MW Coal based NLC Tamilnadu Power Plant at Tuticorin Tamil Nadu, India – Pre-Bid clarifications- Certain modification/amendment to tender document- Issue of Corrigendum No.2 – Reg.

Ref: 1. Tender No. CO CONTS/ 0009H /NTPL /FGD/2019, Dt.02.03.2019.
2. Corrigendum No.1, dt. 14.03.2019.

******

1.0 In continuation to the Pre-bid meeting held on 10.05.2019, Reply/Clarification to the pre-bid queries of the bidders are furnished as Corrigendum No.2, Dt. 29.05.2019.

2.0 Changes to the Tender document is given as Annexure-I, NLCIL's reply/clarification to the pre-bid queries of the bidders is given as Annexure-II (Commercial: 8 Pages), and Annexure-III (Technical: 74 Pages) for the subject Tender alongwith Autocad drawing of NTPL layout, Technical specification for Bulldozer, Technical specification for Pay Loader Soil Investigation Report, ID Fan to Chimney duct drawing, Editable soft copies of Tender document, Errata.

3.0 Bidders are requested to note that the Clarification furnished to each bidder is applicable to all the bidders.

4.0 All other terms & conditions of the above tender shall remain unaltered.

Note: Bidders are requested to visit NLCIL Website (www.nlcindia.com) / CPP Portal (www.eprocure.gov.in) till the opening of Tender to know about latest clarification / Corrigendum, if any issued by NLCIL.

29/5/19

for CHIEF GENERAL MANAGER / CONTRACTS

35720/2020/PS-SR-PM

NTPL-FGD-ANNEXURE 1

CIVIL CORRIGENDUM

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
1	Volume II-G1 Sec-II, Cl. No. 5.00.00 Page-14 of 28	FOUNDATION DESIGN	FOUNDATION DESIGN **(All foundations shall be on Piling only)**	As per the existing plant soil condition
2	Volume II-G1 Sec-I, Cl. No. 3.00.00 Page-12 of 23	Demolition of existing structures / facilities, if any, and site clearance (The bidder may visit the site to access before quoting)	Demolition of existing structures / facilities **including one workshop building and RCC drains and other structures,** if any, and site clearance(The bidder may visit the site to access before quoting)	As the work is to be carried out inside the existing plant
3	Volume II-G1 Sec-I, Cl. No. 3.00.00 Page-12 of 23	Piling work, **if required** based on the soil investigation report.	Piling work, based on the soil investigation report.	As per the existing plant soil condition no option is permitted.
4	Volume II-G1 Sec-I, Cl. No. 3.00.00 Page-14 of 23	Crusher foundation arrangement shall be **as per OEM proven practice.**	Crusher foundation arrangement shall be on VIS and in separate foundation isolated from the building	As per the proven practice followed in other NLCIL projects.
5	Volume II-G1 Sec-I, Cl. No. 4.04.01 Page-16 of 23	The sub base over the well compacted subgrade of all plant service roads within the battery limit of FGD package will initially be made of well graded granular material like locally available crushed stone or laterite (63mm downgraded) **as per IRC-63** with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design requirement.	The sub base over the well compacted subgrade of all plant service roads within the battery limit of FGD package will initially be made of well graded granular material like locally available crushed stone (63mm downgraded) with hard shoulder on either side of carriage width. After major construction activities are completed the road shall be surfaced with RC concrete slab as per proper design	As the code is not relevant to this

<table>
<tr><th>Sl. No</th><th>Cl. No/Vol. No</th><th>Description(Existing)</th><th>To be read as</th><th>Reason for change</th></tr>
<tr><td></td><td></td><td></td><td>requirement.</td><td></td></tr>
<tr><td>6</td><td>Volume II-G1 Sec-I, Cl. No. 4.04.01 Page-17 of 23</td><td>
<table>
<tr><th>Road Type</th><th>Classification</th><th>Carriage way Width (m)</th><th>Shoulder (m)</th><th>Roadway Width (m)</th></tr>
<tr><td>1.</td><td>Primary Road with Access of crane</td><td>10.0</td><td>1.5</td><td>13.0</td></tr>
<tr><td>2.</td><td>Primary Road without access of crane (internal double lane Road)</td><td>7.5</td><td>1.5</td><td>10.5</td></tr>
<tr><td>3.</td><td>Primary Road without access of crane (internal single lane Road)</td><td>4.0</td><td>1.2</td><td>6.4</td></tr>
</table>
</td><td>This table is considered as deleted.</td><td>As the roads are to be matched with the existing plant roads</td></tr>
<tr><td>7</td><td>Volume II-G1 Sec-I, Cl. No. 4.04.01 Page-17 of 23</td><td>Access within the plant site as well as to building / structures shall be provided as a system of roadwork. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.</td><td>Access within the plant site as well as to building / structures shall be provided as a system of roadwork. Width and Finished top (crest) of roads shall match with the existing/connecting roads. Shoulder and drains shall also match with the existing ones.</td><td>As the roads are to be matched with the existing plant roads</td></tr>
</table>

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
8	Volume II-G1 Sec-I, Cl. No. Page-17 of 23	4.04.01	4.03.01	correction
9	Volume II-G1 Sec-I, Cl. No. 4.03.02 Page-17 of 23	The FGD area will be paved with reinforced cement concrete with 200 mm thickness minimum and sloped to drains.	The **entire** FGD area **within the FGD package battery limits shall** be paved with reinforced cement concrete with 200 mm thickness minimum and sloped to drains.	For more clarity
10	Volume II-G1 Sec-I, Cl. No. 4.03.02 Page-17 of 23	Finished paving level shall be 300mm above FGL.	Finished paving level shall **match with the existing adjacent pavement**.	As the work is to be carried out within the existing plant
11	Volume II-G1 Sec-I, Cl. No. 5.01.00 Page-19 & 20 of 23	Design Document shall comprise **Mechanical/Electrical assignment Drawings,** design data, design assumptions & references, detailed structural analysis (including computer output, if any) & design calculations and design drawings.	Design Document shall comprise , design data, design assumptions & references, detailed structural analysis (including computer output, if any) & design calculations and design drawings	As it is not relevant to civil design document.
12	Volume II-G1 Sec-II, Cl. No. 3.00.00-b-(iv) Page-4 of 28	**Covers for Trenches / Channels** Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall be considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards	**Covers for Trenches / Channels** Self-weight of top slab and a uniformly distributed load of **100 kN/Sqm** on each panel or one **100 kN** central point load, whichever is critical, shall be considered. At road crossings **and entrance of the buildings wherever vehicle/crane movement expected,** the covers shall be designed for vehicular movements as per IRC standards	As per the design requirement.
13	Volume II-G1 Sec-II, Cl. No. 4.00.00-	Reinforcing bars shall be TMT bars of minimum grade Fe 500 conforming to IS-1786 (Latest Revision) and Mild Steel bars conforming to IS: 432 (Grade I) (Latest Revision) of vendor approved by	Reinforcing bars shall be TMT bars of minimum grade Fe 500**(CRS)** conforming to IS-1786 (Latest Revision) and Mild Steel bars conforming to	As it is corrosive environ ment.

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
	b Page-12 of 28	Owner.	IS: 432 (Grade I) (Latest Revision) of vendor approved by Owner.	
14	Volume II-G1 Sec-II, Cl. No. 5.00.00-Page-14 of 28	Pile foundation**, if adopted,** shall be designed in accordance with IS: 2911(Part-I / Sec-I, II and III) (Latest Revision).	Pile foundation shall be designed in accordance with IS: 2911(Part-I / Sec-I, II and III) (Latest Revision).	As only pile foundation is to be adopted due to the existing soil condition.
15	Volume II-G1 Sec-II, Cl. No. 5.02.00-Page-15 of 28	Crusher may preferably be supported on vibration isolation system consisting of steel helical spring units and viscous dampers **(as per OEM proven practice)** which in turn will be supported on RCC foundation system.	Crusher **shall be** supported on vibration isolation system consisting of steel helical spring units and viscous dampers which in turn will be supported on RCC foundation system. **For booster fans the supports as per OEM Proven practice.**	Based on the equipment sizing and vibration intensity and proven practice followed in NLCIL projects.
16	Volume II-G1 Sec-II, Cl. No. 5.02.00-Page-15&16 of 28	All block foundations resting on soil shall be designed using the elastic half space theory or Barkan's theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%.	**This para is to be deleted**	As only pile foundation is to be adopted due to the existing soil condition
17	Volume II-G1 Sec-II, Cl. No. 5.03.00-Page-16 of 28	**Open Foundations**	**Open Foundations(Only Pile foundation is permitted. However open foundations may be allowed for the foundations having SBC requirement upto 5t/sqm)**	As open foundations could not be used for heavy foundations due to the existing soil condition
18	Volume II-G1 Sec-II, Cl. No. 5.04.00-Page-17 & 18 of 28	a) The pile foundation shall be of RCC, Cast-in-situ bored, **precast/cast-insitu** **driven** pile as per IS: 2911 (Latest Revision). Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.	a) The pile foundation shall be of RCC, Cast-in-situ bored, pile as per IS: 2911 (Latest Revision). Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally	As per the design requirement

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
		b) The minimum diameter of pile shall be 450mm for cast-in-situ **and** **300mm for precast piles.** The uplift and lateral load capacity shall be established by field test.	accepted method duly approved by the Owner. b)The minimum diameter of pile shall be 450mm for cast-in-situ . The uplift and lateral load capacity shall be established by field test.	
19	Volume II-G1 Sec-II, Cl. No. 5.04.00-(f) Page-18 of 28	Number of initial load tests to be performed for each diameter and rated **capacity of pile shall be as under:** **Vertical Minimum of 3 Nos. in each mode.** **Lateral Minimum of 3 Nos. in each mode.** **Uplift Minimum of 3 Nos. in each mode.**	f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as stipulated in IS 2911(part 4)	As per the standard practice adopted to avoid the time delay
20	Volume II-G1 Sec-II, Cl. No. 5.04.00-(g) Page-18 of 28	**Number of** routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under: **i) Vertical -1.0 % of the total number of piles provided.** **ii) Lateral -1.0 % of the total number of piles provided.** The routine tests on piles shall be conducted up to test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part-4) (Latest Revision).	g) Routine pile load tests shall be performed for each diameter/allowable capacity of pile as per IS: 2911 (Part-4) (Latest Revision).	As per the standard practice adopted to avoid the time delay
21	Volume II-G1 sec-II cl 4.00.00 page 12&13of 28	c) Higher grade of Ordinary Portland cement namely Grade 43 conforming to IS : 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner. However the Ordinary Portland cement (Grade 53) be used wherever necessary and directed by Owner Grade of cement shall be OPC for underground structures, it shall be minimum 5% - 8% C3A content.	c) Higher grade of Ordinary Portland cement namely Grade 43 conforming to IS : 8112 (Latest Revision) shall be used for construction of all RCC structures and foundations as recommended by Owner. However the Ordinary Portland cement (Grade 53) be used wherever necessary and directed by Owner **Minimum cement content for RCC for aggressive environment like Tuticorin shall not be less than 400 kg/m^3 for M-35 and above**	As per the site soil condition requirement

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
			grade. Ordinary Portland cement conforming to IS with C_3A content from 5% to 8% shall be used for all substructures and structures in contact with soil and for other structures OPC shall be used.	
22	Volume II-G1 Sec-II, Cl. No. 6.01.00- Page-20 of 28	**Minimum Thickness of Structural Elements** Suspended floor / slab / walkways / canopy slabs, etc. 150 mm	**Minimum Thickness of Structural Elements** Suspended floor / slab / walkways / canopy slabs, etc**.(thickness of roof slab and intermediate floors shall be measured excluding the depth of deck sheet trough)** 150 mm	For clarity in design.
23	Volume II-G1 Sec-II, Cl. No. 9.00.00 (9) Page-23 of 28	Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum **M25** grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers. **The minimum drainage slope along line shall be 1 in 500.**	Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum **M35** grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers.	Correction as the work is to be carried out within the existing plant
24	Volume II-G1 Sec-III, Cl. No. 1.00.00 (g) Page-2 of 14	Specific corrosion resistant painting system with protective coatings shall be adopted as per CSIR – CERI recommendations for marine environment with required material, proper application procedure and approved number of coating. Stipulations mentioned in ISO 12944 shall be followed.	PAINTING Structural painting shall be done as per CECRI recommendations: For all internal and external steel structures under civil scope : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO_2) rutile of 50-60 micron shall be applied.	As recommended by CECRI for the existing plant civil structures.

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
25	Volume II-G1 Sec-IV, Cl. No. 1.01.00 Page 2 & 3 of 40	Table for **Building Descriptions** 2.FGD Control Building-G+1 3. Limestone Slurry Preparation building-G 6. Gypsum Dewatering Building with Elevator-Floors(**R.C.C)** 7. Gypsum storage shed-G	Table for **Building Descriptions** 2.FGD Control Building-**G+2** 3. Limestone Slurry Preparation building-**Multi-storeyed** 6. Gypsum Dewatering Building with Elevator-Floors(**R.C.C intermediate floor over metal deck)** 7. Gypsum storage shed-**Multi-storeyed**	correction
26	Volume II-G1 Sec-IV, Cl. No. 3.08.00 Page 9 of 40	***Note**: **Glass thickness and** member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.*	***Note**: member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.*	As glass thickness is specified in this volume
27	Volume II-G1 Sec-IV, Cl. No. 3.13.00 Page 11 of 40	b) 4 mm thick ground glass shall be provided for toilets. e) 6mm thick. Wired glass shall be used for windows / ventilators at higher level for safety.	b) **6** mm thick ground glass shall be provided for toilets. e) **5.5mm** thick. Wired glass shall be used for windows / ventilators **for all buildings except AC rooms,Office rooms and control rooms.**	b) As per the requirement e)As per the availability.
28	Volume II-G1 Sec-IV, Cl. No. 3.16.00 Page 12 of 40	**Plinth Protection** Minimum 1000 mm wide and minimum 100 mm thick P.C.C. M 20 plinth protection along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be provided. The plinth protection shall be laid over prepared sub-grade and base formed with two layers of locally available broken laterite stone. Each layer shall have a pre-compacted thickness of 150 mm and consolidated to 115mm. Thus the total thickness becomes 230mm.	**Plinth Protection** Minimum 1000 mm wide and minimum 100 mm thick P.C.C. M 20 plinth protection along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be provided. The plinth protection shall be laid over prepared sub-grade and base formed with two layers of locally available **broken stone**. Each layer shall have a pre-compacted thickness of 150 mm and consolidated to 115mm. Thus the total thickness becomes 230mm.	As broken stone is easily available
29	Volume	**PAINTING:**	**PAINTING:**	As

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
	II-G1 Sec-IV, Cl. No. 3.18.00 Page 12 & 13 of 40	**Exterior Steel Work :** Two primer coats steel work Zinc silicate 50 microns each. Two finish coats High built epoxy finish of 90 microns each coat. **All Internal Steel Work** : Epoxy Paint two coats over approved primer	**Exterior Steel Work : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO_2) rutile of 50-60 micron shall be applied All Internal Steel Work : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO_2) rutile of 50-60 micron shall be applied**	recommended by CECRI for the existing plant civil structures.
30	Volume II-G1 Sec-IV, Cl. No. 3.19.00 Page 14 of 40	i)-Roof access: All roofs shall be accessible through proper staircase. Where staircase cannot be provided at least cage ladder shall be provided. Roof access stairs may be open outdoor type. Cage ladder height shall not be more than 6.0m at a stretch. One rest platform shall be given at every 6.0M height of the cage ladder if the ladder height is more than 6.0 m.	i)-Roof access: All roofs shall be accessible through proper staircase. Where staircase cannot be provided at least cage ladder shall be provided. **(buildings more than one floor ie. G+1 and above shall necessarily be provided with staircase).** Roof access stairs may be open outdoor type. Cage ladder height shall not be more than 6.0m at a stretch. One rest platform shall be given at every 6.0M height of the cage ladder if the ladder height is more than 6.0 m.	For more clarity
31	Volume II-G1 Sec-IV, Cl. No. 3.23.00 Page 16 & 17 of 40	k) All plumbing and water supply fittings & fixtures, rain water drainage of plants of any building/premises/open area within the SE 1 Battery limits are in the scope of this contract. All the sewerage shall be collected from SE1 battery limit and the same shall be interconnected to the Main Plant Sewer System (SE3 scope) at the RCC manhole located at an approximate distance of 50M away from the SE1 battery limit, as per detailed layout requirement.	k)All plumbing and water supply fittings & fixtures, rain water drainage of plants of any building/premises/open area within the **FGD Area** Battery limits are in the scope of this contract. All the sewerage shall be collected from **FGD Area** battery limit and the same shall be interconnected to the Main Plant Sewer System	Correction.

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
32	Volume II-G1 Sec-IV, Cl. No. 4.00.00 Page 26 of 40	12. Glazing: a. Glazing for windows in general shall be minimum 4~6 mm clear float glass and as mentioned elsewhere in this document.	12. Glazing: a. Glazing for windows in general **for offices,control rooms and A/C rooms** shall be minimum **6 mm** clear float glass and as mentioned elsewhere in this document. **Wired glass of 5.5mm shall be provided except offices, control rooms and A/C rooms.**	As per the requirement for 6mm and As per the availability for 5.5mm.
33	Volume II-G1 Sec-IV, Cl. No. 4.00.00 Page 29 & 30 of 40	14. Painting: f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110 micron DFT. Anti-corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Copolymer coating.	14. Painting: f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall **be As per cl 3.18.00 above.**	As recommended by CECRI for the existing plant civil structures given in the clause.
34	Volume II-G1 Sec-IV, Cl. No. 4.00.00 Page 31 & 32 of 40	17. Stairs: a) All stairs shall have not more than 12 risers in one flight. All staircases shall comply with all staircase related norms of National Building Code 2016, Part-4. Height of risers and width of treads shall be 166 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 150mm (maximum) & 275mm (minimum) for general staircases(for RCC stair cases in both plant and non plant buildings). For steel staircases the riser shall be 180mm maximum and tread shall be 250mm minimum. Minimum width of stairs shall be1200mm for indoor and 1000mm for outdoor stairs.	17. Stairs: a) All stairs shall have not more than 12 risers in one flight. All staircases shall comply with all staircase related norms of National Building Code 2016, Part-4. Height of risers and width of treads shall be 166 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 150mm (maximum) & **300 mm** (minimum) for general staircases(for RCC stair cases in both plant and non plant buildings). For steel staircases the riser shall be **166 mm** maximum and tread shall be 250mm minimum. . Minimum	As per the design requirement.

Sl. No	Cl. No/Vol. No	Description(Existing)	To be read as	Reason for change
			width of stairs shall be1200mm for indoor and 1000mm for outdoor stairs.	
35	Volume II-G1 Sec-IV, Cl. No. 4.00.00 Page 32 & 33 of 40	20. Water Supply and Sanitation : a)- HDPE roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building. b) Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply. All water supply pipes inside the Non plant buildings are to be laid as concealed type.	20. Water Supply and Sanitation : a)- HDPE roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building. **The minimum capacity for HDPE tank should be 1000 litres.** b) **CPVC** Pipe of class I as per IS 15778 upto 50mm DN shall be used for all piping works including concealed type for potable water supply. All water supply pipes inside the Non plant buildings are to be laid as concealed type **wherever possible.**	a) for more clarity b) due to corrosive environment CPVC pipe is recommended.
36	Volume II-G1 Sec-II, Cl. No. 5.05.00 (v)Page 19 of28	Excess/surplus excavated material shall be disposed of by the Bidder as per the instructions of the Owner up to a lead of about 5 km	Excess/surplus excavated material, **debris and other unusable materials as decided by owner** shall be disposed of by the Bidder as per the instructions of the Owner up to a lead of about **10 km**	Correction made based on the site condition.
37	Volume II-G2/Part A/ Sec-II, Cl. No. 2.05.02 Page 3 of 14	Borrow material if required for area filling shall be excavated from approved locations and levels, and shall consist of selected material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail Engineering stage	Borrow material if required for area filling shall be excavated from approved locations and levels **within a lead of 25KM**, and shall consist of selected material, approved by the Owner, free from roots, vegetation, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail Engineering stage	For more clarity.

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

M/s.BHEL

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
1.	IA/3	3.9.1(i)/25	The Bid shall be accompanied by Bid Guarantee either in the form of Bank Guarantee valid for 300 days from the date of opening of the Bids (Part-I) or Demand Draft of equivalent amount drawn in favour of "NLC INDIA LIMITED " payable at Neyveli, without any exception.	The Bid Guarantee shall be either in the form of Bank Guarantee valid for 300 daysfrom the ORIGINAL OR ACTUAL date of opening of Part-I …… Please clarify.	The Bank Guarantee shall be vaild for 300 days from the date of opening of the Tender.
2.	(web) ICB Notice Inviting Bid IA	1.3/ 2 to 4 of 11 1.2/8	**Scope of work** **Part-A:** The scope shall also include comprehensive O&M of FGD system up to completion of warrantee period, including supply of all O&M spares, chemical and consumables along with supply of limestone, and disposal of Gypsum etc. away from NTPL premises, is also under the scope of the bidder within the scope of Part-A **Part-B**: The scope of work under part-B includes the O&M of FGD, incl.…….for period of 2 years from date of completion of warrantee period of the FGD system package under different commercial terms thereof. Brief Scope of work: The scope of work for FGD ------- in respective volumes.	We under that scope work mentioned under at cl. 1.3 at pages from 2 to 4 of (web) ICB, Notice Inviting Bid stand deleted. However, brief scope of work mentioned at cl. No. 1.2 at page no. 8 of Volume-IA of Invitation of Bid shall be applicable for this tender. NLCIL is requested to confirm	O&M is not under the scope of the work.

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
3.	IA	3.9.4 (b)	The Bidder---------shall furnish his/ their audited profit and loss account and balance sheet for the preceding three consecutive financial years ….	We understand the bidder---------shall furnish his/ their consolidated audited profit and loss account and consolidated balance sheet for the preceding three consecutive financial years …. Please confirm.	Tender condition prevails.
4.	IA/3	3.9.5-13 (iv)/32	The Purchaser reserves the right to ask the bidders to provide the certified copies of experience certificates. For installations outside India, experience certificate is to be authenticated by the Indian Embassy in that country / Apostille in lieu of Embassy Authentication and within India experience certificate is to be attested by a Notary Public.	We request NLCIL to waive off the requirement of submission of QR related documents such as Embassy Authenticated/Notarized End User Certificates for this tender. This will save the time required for embassy authentication/ notarization etc. However, if desired copy of documents shall be submitted by BHEL along with Bid.	Noted and agreed. Copy of documents shall be submitted along with the bid.
5.	IA/3	3.9.7/36	(xi) Deviations to the Draft Contract, if any, as per Schedule – F3. (xii) Deviations to Technical Specifications, if any, as per Schedule – F4.	NLCIL may please confirm that Bidders shall be allowed to furnish supplementary price bid (including change of vital parameters such as performance guarantees) in case of any implication arising on account of non-acceptance of the deviation raised by Bidder.	If necessary, bidders will be permitted to furnish addendum price.
6.	IB/1	1.23/19	1.23: Final Take Over 1.37: Provisional take over	Achievement of Final Take Over & Provisional take over shall be	Already ‘Unit wise’ is available in the Tender

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
		1.37/20		in **unit-wise.**	Document.
7.	IB/2	2.12(III)/34	No imported material shall be allowed to be taken out other than imported tools and tackles and instruments brought by the Contractor on draw back basis and provided, he has carried out necessary documentation at the time of bringing such items inside the Plant.	Bidder may be allowed to take back surplus Imported material after proper documentation.	Tender Condition prevails.
8.	IB/3	3.2 (i)/36	…….The customs duty and port clearance charges, inland freight from the port of clearance to **NNTPP** site shall be included in the contract price.	Above clause is for NNTPP, Neyveli site or NTPL Tuticorin site. Please clarify.	…….The customs duty and port clearance charges, inland freight from the port of clearance to **NTPL** site shall be included in the contract price.
9.	IB/3	3.6.4(v)/41	Price adjustment shall be applicable to the cost portion, only if change in the cost of labour and material (either increase or decrease) occur during the scheduled period, which directly affects the cost portion.	Price adjustment shall be applicable to the ~~cost~~**Contract Price** portion, only if change in the cost of labour and material (either increase or decrease) occur during the scheduled period, which directly affects the cost portion. Highlighted text may be inserted.	Tender Condition prevails.

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
10.	IA/36 IB/3	3.9.8 (1)/36 3.7/42	**Part-II** of the Bid shall contain completely filled in schedule of performance guarantees. All taxes and duties along with the respective rates considered in the bid shall be indicated by the bidder in **Part-II** of the Bid.	Please clarify Part-II of bid shall contain PG Parameters only or Taxes and Duties also.	**Part-II** of the Bid shall contain completely filled in schedule of performance guarantees. All taxes and duties along with the respective rates considered in the bid shall be indicated by the bidder in **Part-III** of the Bid.
11.	IB	3.6.4(vii)/41 3.6.5/41	The computed variation in the Ex-works Price of equipment and erection shall be restricted to 10% (ten percent) respectively for the entire contract period.	The ceiling of 10% may kindly be removed in case the time extension granted by the Purchaser for the reasons not attributable to Contractor.	Tender Condition prevails.
12.	IB	3.7/41	The ceiling for taxes & duties shall correspond to the base price. Additional liabilities of taxes & duties arising out of price variation shall be reimbursed against documentary evidence over and above the respective ceiling amounts quoted.	The rates at which ceiling of Taxes & Duties have been defined may also be mentioned in the contract.	Tender Condition prevails.
13.	IA	3.9.2 / 28	Qualifying Requirements (QR) of the Bidder	BHEL has been qualified in FGD tenders of NLCIL - 2X500 MW	Noted and agreed. Copy of documents shall be

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
14.	IA	3.9.5 (13-ii) / 32	The Purchaser reserves the right to ask the Bidders to provide the certified copies of experience certificates. For installations outside India, experience certificate is to be authenticated by the Indian Embassy in that country and within India experience certificate is to be attested by a Notary Public.	NNTPP (NTA4) and NUPPL-3x660 MW TPS (GA4) at Ghatampur. We request NLCIL to waive off the requirement of submission of QR related documents for this tender. This will avoid the time required for embassy authentication/ notarization etc. However, if desired copy of documents shall be submitted by BHEL along with Bid.	submitted along with the bid.
15.	IA	3.9.5 (13-iv) / 32	The Bidder shall submit End User Certificate which is subject to verification for qualification.		
16.	IA	3.13 (3) / 40	Amendment shall be numbered serially. Signed copies shall be enclosed in Part-I of bid.	Bidder shall submit one original signed copy of all the amendments. NLCIL is requested not to insist for Seven Copies of the Amendments. However, copies of other volumes of the techno-commercial offer shall be submitted.	Noted and agreed.
17.	IB	4.9.3/46	The Total liability of contractor towards delay and non-fulfillment of performance guarantee values shortfall shall be limited to 25% of total contract value.	The total liability of the contractor towards delay and non-fulfillment of performance guarantee values shortfall shall be limited to 17.5% of the total contract value (50% of contract value for single unit) in line with previous contracts.	Tender Condition prevails.

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
18.	IA	3.38.6 (ii)	Bid decrement shall be Rs.50,00,000 and its multiples	In our opinion, Bid decrement shall be Rs.50,000 and its multiples in line with other FGD tender of NLCIL. Please confirm/	The bid decrement shall be Rs.50,000/- and its multiples instead of Rs.50,00,000/-
19.	IB	5.3.1(iv)/55	Any Customs Duty variation due to Exchange Rate also will be reimbursed at actual against documentary evidence (based on Bill of entry and Bill of lading respectively), within the contractual delivery period.	Please clarify that impact on custom duty due to exchange rate variation shall be with respect to the base date exchange rate vis-à-vis bill of entry exchange rate.	This clause is deleted.
20.	IA	ANNEXURE-G / 87	Sample Format of Deed of Joint Undertaking (DJU Line no 2 of first Para: Qualified Flue Gas Desulphurisation System Manufacturer (QFGDM) Line no.8 of 4th para. Qualified Flue Gas Desulphurisation System Manufacturer (QFGDSM)	We understand Qualified Flue Gas Desulphurisation System Manufacturer is abbreviated/ defined as QFGDM. Please confirm.	Bidder's understanding is correct.
21.			**General**	Editable soft copy of the tender specifications like Formats, Annexures, such as DJU, Bid Guarantee, Price Schedules, Guarantee Schedule, Mandatory Spares, Tools & Tackles, Data Sheets, etc. that	Attached herewith.

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

Sl. No	Volume/ Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
				are required to be submitted along with the bid may please be provided to the Bidders. Also plot plan, contour drawing/map, soil report etc. required to prepare the bid may also be provided in the AutoCAD/relevant format.	

Commercial Pre-Bid Queries Clarifications for FGD Package 2X500 MW NTPL Tuticorin

Annexure-II

M/s. STAR THERMAL

Sl. No	Volume /Section	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Queries/ Clarifications	Resolution/ Clarification
1	Volume IA Section A	Clause 15 Page 33 of 126	Make in India Policy B. Minimum local content: The minimum local content shall be more than 70%. C. Margin of Purchase Preference: The margin of purchase preference shall be 20%.	Please clarify	Please refer Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce and Industry, Govt. of India, Public Procurement (Preference to Make in India) Order 2017 dated 15.06.2017, which is self explanatory.
2	Volume IA	Annexure A Page 57 of 126	Format of Bid Guarantee 1. This Guarantee should be furnished by a scheduled commercial Bank in India authorized by RBI other than Bank of China to issue a Bank Guarantee in the same format as given below. NLCIL reserves its right to reject the Bank Guarantee if the same is not in the specified format	Please clarify	Tender condition is clear.
3	Volume IA	3. Clause No (x) Page 27 of 126	Confirmation of Bank Guarantee - Confirmation of Bank Guarantee through Structured Financial Messaging System (SFMS) will be done as follows : The bank guarantee issued by the issuing Bank on behalf of Bidder in favour of "NLCIL" shall be in paper form as well as issued under the "Structured Financial Messaging System". The details of beneficiary for issue of BG under SFMS platform	Please clarify	Tender condition is clear. Further you may discuss with your banker.
	General				
1			BID SUBMISSION DATE	We requesting 2 weeks extention for bid submission. Please consider.	Will revert.

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PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: ISG Bangalore

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL & STRUCTURAL					
1	Vol-II G-1/Section-II	3.00.00 d)	Wind loading	Please confirm the value to cyclonic factor k4 applicable for this project as per IS 875 Part-3 2015.	K_4 factor shall be taken as 1.3 as per IS 875,part-3: 2015.
2	Vol-II G-1/Section-III	1.00.00 a)	IS:800(Latest Revision)	Please confirm whether Structural steel design is to be carried out as per LSM or WSM.	Cl 3.00.00/sec III/Vol-II G-1/page 6 of 14 shall be followed.
3	Vol-II G-1/Section-III	5.00.00	Horizontal deflections	Please confirm the permissible lateral deflection limit for Conveyor trestles.	The permissible deflection limit of H/500 along the conveyor and H/1000 across the conveyor shall be

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PRE-BID QUERIES

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					followed.
4	Vol-II G-1/Section-IV	1.00.00	Scope	Please confirm whether Grade slab is required inside the Limestone Storage shed or not? If applicable, then please provide the thickness of RCC slab, lean PCC and boulder soling to be considered.	The grade slab is required. It shall be RCC and cl.6.03.00/Vol-II-G1/sec-II shall be followed.
5	Vol-II G-1/Section-IV	1.00.00	Scope	Please confirm whether Grade slab is required inside the Gypsum Storage shed or not? If applicable, then please provide the thickness of RCC slab, lean PCC and boulder soling to be considered.	The grade slab is required. It shall be RCC and cl.6.03.00/Vol-II-G1/sec-II shall be followed.
6	Vol-II G-1/Section-IV	1.00.00	Scope	1. Please provide us with Civil and structural specifications for Unloading Hopper complex building. 2. Please confirm type of liner applicable for Hoppers. 3. Clarity is sought regarding whether this complex will be overground, partially underground or completely underground. Please confirm.	1 &3. Refer table in section IV of vol G-I. The building is partially underground and partially over ground. Refer flow diagram 17A14-DWG-M-0001A 2. refer

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PRE-BID QUERIES

Annexure-III

					mechanical specification
7	Vol-II G-1/Section-IV	Tables	Building description table and Interior finish schedule table.	Both tables provide different peripheral brick wall height applicable for Crusher House, Lime Shed and Gypsum Shed. Please confirm whether peripheral brick wall will be 3m high or 1m high.	The peripheral wall height is 3m.
8	Vol-II J-Tender Drawings	Tender Drawings	Tender Drawings	Please provide us with the Topographical survey of site.	Since this is retrofitting work in existing plant, this requirement does not arise
9	Vol-II J-Tender Drawings		Site Levelling	We understand that the Limestone handling and Gypsum handling area marked in drawing 17A14-DWG-M-0002B is already levelled to required RL, and only minor grading and levelling works are needed. Please confirm.	Comply with TS All necessary micro leveling, grading and dressing is to be done by the successful bidder as required. Demolition of existing structures/facilities including one workshop

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PRE-BID QUERIES

Annexure-III

					building and RCC drains and other structures if any, and site clearance (The bidder may visit the site to access before quoting)
10	Vol-II J-Tender Drawings	Tender Drawings	Flow Diagram	Please provide us with Flow diagram for Limestone and Gypsum handling system.	Bidder to refer Dwg. No. - 17A14-DWG-M-0001A of Vol-IIJ
11	Vol-II G-1/Section-II		Geotechnical Investigation	Please provide us with Geotechnical investigation report of Existing Main Plant project for proposal stage assessment of soil conditions.	Will be furnished seperately
MECHANICAL					
1.	Tender Dwgs	Dwg No: 17A14-DWG-M-0002 A/B	GLP (Limestone handling system/ Gypsum handling system)	Bidder requests customer, Please furnish AutoCAD copy of plot plan indicating clearly lime handling & gypsum handling facilities.	AutoCAD drawing will be furnished.
2.	Vol II C	Page 30 of 105, Clause	The limestone storage shed will be sized for 15	The space provided in GLP for GHS	Refer Dwg No: 17A14-

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PRE-BID QUERIES

Annexure-III

		6.01.01	days limestone consumption…….	is not sufficient for 15 days storage. Bidder request customer to look into it and mark sufficient space in GLP and furnish the same in AutoCAD for proper sizing of layout.	DWG-M-0002 B Available space for Limestone handling system buildings, Conveyors, Storage shed, FGD control room, Limestone storage silos and Mill building is (129x44)M. Bidder shall optimize the layout accordingly. Bidder shall also refer S. No. 18 of Errata Mechanical
3.	Vol II C	Page 30 of 105, Clause 6.01.03	The limestone storage shed will be sized for 15 days limestone consumption……. The gypsum storage shed will be sized for 15 days gypsum production.	The space provided in GLP for LHS is not sufficient for 15 days storage. Bidder request customer to look into it and mark sufficient space in GLP and furnish the same in AutoCAD for proper sizing of layout.	Refer Dwg No: 17A14-DWG-M-0002 B Available space for Gypsum dewatering building and Gypsum Storage shed is (44x37) M Bidder shall also refer S. No. 19 of Errata Mechanical
4.	Vol II C		Gypsum/ Byproduct : Gypsum Storage Yard for Wet FGD	Please clarify any design margin is to be considered over rated capacity.	Tender condition prevails. Bidder to refer Vol-IIC, Clause 5.01.01

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PRE-BID QUERIES

Annexure-III

5.	Vol II C	Page 17 of 104, Clause 5.01.14	Underground hopper capacity	Bidder requests customer to furnish the capacity of underground hopper to be considered.	Bidder to refer S. No. 3 of Errata- Mechanical
6.	Vol II C	Page 5 of 105, Clause 3.03.03	Sump Pumps	Bidder has considered 02 nos. (1W+1S) sump pumps of capacity 50m3/hr at underground hopper complex. And also the discharge shall be taken to the nearby surface drain.Please confirm.	Tender condition prevails
7.	Vol II C	Page 64 of 105, Annexure-01	Flow Diagram: Belt Weigh Feeders	Bidder is considering reversible belt feeders instead of belt weigh feeders for feeding limestone into 02 nos silos. Please confirm.	Tender condition prevails
8.	Vol II C	Page 4 of 105, Clause 3.01.02	Uncrushed limestone will be dozed to the unloading hoppers UH-1,2,3,4 and fed to Conveyor BC-1A	We are not considering any pay loader, dozer, and any open or closed trucks for transportation of lime stone and gypsum in our scope. Please confirm.	Bidder to refer S. No. 4 of Errata- Mechanical
9.	Vol II C	Page 4 of 105, Clause 3.01.03, 04	In Crusher House, limestone from Conveyor 1A shall be fed to Crusher CR-2 through	As per flow diagram, it is not like as mentioned in the TS. Flow diagram shows different loading system with	Bidder to consider flow scheme as per the flow diagram considering interchangeability using

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PRE-BID QUERIES

Annexure-III

			Rod gate RG 2 and Rack & Pinion gate RPG 2. Similarly, limestone from Conveyor 1B shall be fed to Crusher CR-1 through Rod gate RG 1 and Rack & Pinion gate RPG 1.	reversible belt. But we are following TS and we are not considering interchangeability before crusher. Please clarify.	reversible conveyor. The reversible conveyor feeding to the crushers shall be 2 nos. (1W+1S). Bidder to refer S. No. 5 and 6 of Errata- Mechanical
10.	Vol II C	Page 6 of 105, Clause 4.02.02	TS says about reversible conveyors names, but it is not shown in flow diagram	Please clarify where to use reversible conveyors.	Bidder to refer S. No. 5 of Errata- Mechanical
11.	Vol II C	Page 6 of 105, Clause 4.04.00	TS says about Two (2) Nos. Fixed trippers over the Silos	But flow diagram shows Belt weigh feeders over Limestone Silos. We are providing reversible belt weigh feeders and not fixed trippers. Please clarify.	Flow diagram is self explanatory and may be followed. Bidder to refer S. No. 16 of Errata- Mechanical
12.	17A14-DWG-M-0001A_LIME STONE FGD_Flow Scheme-R1	Flow diagram	Flow diagram shows interchangeability after Belt vacuum filter.	Please clarify whether we need to use flap gates for the same.	Tender condition prevails
13.	Vol II C	Page 7 of 105, Clause 4.19.00	Two (2) Nos. of Passenger cum Goods Elevators, one in Crusher House and the other in	Please mention the type & capacity of Passenger elevators.	Bidder to refer Vol-IIH, Section-III for capacity of elevators.

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			Silo.		
14.	Vol II C		Conveyor Capacity	Bidder requests customer to furnish rated / design capacity for limestone conveyor / bucket elevator.	Bidder to refer S. No. 17 of Errata- Mechanical
15.	Vol II C	Page 21 of 105, Clause 5.07.02	Belt weigher on Weigh Bridge	Please clarify whether weigh bridge is required for both Lime Handling & Gypsum Handling area.	The referred clause is for Belt Weigher.
16.	Vol II C		Pump house for Limestone handling plant gypsum handling plant is also acceptable.	Query-1: Whether one common pump house is acceptable for complete FGD Query-2: Whether tapping from existing CHP water system is allowable nearer to Limestone handling plant gypsum handling plant for service, potable and dust suppression system.	Bidder's query is not clear. Relevant clause shall be indicated for clarification.
17.	Vol II C		Auxiliary Power consumption	Power consumption for limestone & gypsum handling system is not included in list. Hence not considered. If the power consumption is to be considered, then request customer to kindly furnish the list of equipment's to be considered for arriving at auxiliary power consumption along with duty factor.	Bidder's query is not clear. Relevant clause shall be indicated for clarification.

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18.	Vol II C		Stock pile height	Bidder request customer to specify the maximum gypsum & limestone stockpile height to be considered to arrive the size of storage area and shed to make all the bidders at par.	Bidder to refer S. No. 18 and 19 of Errata-Mechanical
19.	Vol II C		DE system at Gypsum shed	Bidder not considering dust extraction system in Gypsum shed as ventilation system is provided. Kindly clarify.	Tender condition prevails
20.	Vol II C	Sec II	Ventilation system for crusher house	It is mentioned that ventilation system is to be considered for Crusher House. As a general engineering practice, we understand that the type of ventilation shall be natural ventilation. Kindly confirm if our understanding is correct or not.	Bidder's query is not clear. Relevant clause shall be indicated for clarification.
21.	Vol II C	Sec II	Service water and potable water system	Customer is requested to furnish the details for designing the service water and drinking water system like, number of tapping points and discharge to be considered, number of users and litres/day of consumption etc	Details for Service water system and drinking water system shall be decided by the bidder. Same shall be submitted for Purchaser's approval during detail engineering.
22.	Vol II C	Page 22 of 105, Clause	Lime sampling	Bidder is considering 01no sampling	Tender condition prevails

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		5.08.00		unit in Crusher only. Bidder is not considering any sampling unit after crusher house as we are using bucket elevators for further lime conveying. Please confirm.	
23.	Vol II C	Page 25 of 105, Clause 5.12.01	Crusher design	Bidder requested to indicate the maximum moisture content and percentage of fines (sieve analysis report) to be considered for the sizing and design of crushers and screens	To be discussed during techno commercial meeting
24.	Vol II C	Sec II Page 29 of 105, Clause 5.17.00	Dust suppression system	Bidder is not considering any dust suppression system for limestone handling applications as we are providing dust extraction system at all transfer towers/ crusher house in line with other past FGD projects. Please clarify/ confirm.	Bidder to refer S. No. 8 of Errata- Mechanical
25.	Vol II C	Page 19 of 105, Clause 5.03.01	Liner for reclaim hopper	NLC to kindly confirm if guneting or sailhard/Tiscral liner is to be considered for reclaim hopper	Tender condition prevails
26.	Vol II C		Counter weights	Customer is requested to clarify if the type of counter weights to be used for VGTU shall be cast iron or	Bidder to refer Vol-IIC, Section-1, Clause 05.01.11 for the same.

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PRE-BID QUERIES

Annexure-III

				RCC	
27.	Vol II C	Page 4 of 105, Clause. 13.02.01	Use of Travelling Tripper. Washed and dewatered gypsum cake from the dewatering system will be fed above the belt conveyors BC 3A and 3B. Conveyors BC 3A and 3B will transfer the product to Gypsum storage area	We are not considering any travelling trippers for gypsum handling system as we are considering direct discharge of BC-3A & BC-3B in gypsum storage area.	Tender condition prevails
ELECTRICAL AND C&I					
1.	II-F, Section-VIII II-F, Section-I	4.01.03 5.35.00	Welding socket outlets shall be provided at every 60m distance. Suitable number of 63A, 3ph., 4 wire, 5 pin, 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m.	Bidder considers that the welding socket outlets shall be provided at every 60m distance.	Bidder considers that the welding socket outlets shall be provided at every 60m distance.
2.	Vol. II-F Section-XIV Illumination System	Annexure-B Page No. 28	If Lux level of any specific area is not covered in above table, Vendor shall	Lux level for the following areas to be provided by the customer.	Lux level for the following areas to be provided by the

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PRE-BID QUERIES

Annexure-III

		/ 38	take specific confirmation from purchaser before finalization of Bid	1. Conveyor/TPs 2. Limestone/Gypsum Storage Shed (if lighting is required) 3. Pipe and cable racks, Trenches and culverts(if lighting is required)	customer. 1. Conveyor/TPs 2. Limestone/Gypsum Storage Shed (if lighting is required) Pipe and cable racks, Trenches and culverts(if lighting is required)
3.	Vol. II-F Section-XIV Illumination System	Annexure-D Page No. 36 / 38	KVA rating (Minimum) : 100 KVA	Requested customer to allow 25/50/75 KVA also as per design requirement	Requested customer to allow 25/50/75 KVA also as per design requirement
4.	Vol. II-E Section-I General Technical Requirements Vol. II-F Section-I General Electrical Specification	8.22.00 Page No. 18 / 26 5. 25.01 Page No. 25 / 45	Vibration Monitoring System shall be provided for all HT drives (160 KW & above). Motors rated up to and including 160kW shall be connected to 415V, 50Hz AC supply.	Customer to confirm 160 KW to be considered as HT or LT Drive.	Customer to confirm 160 KW to be considered as HT or LT Drive.
5.	Vol. II-E Section-I General Technical Requirements	8.25.03 (1) Page 20 of 26	DI & DO signal cannot be routed through the same cable.	Requested customer to allow for Drive Interface between Drives(LT Motors, HT Motors etc) and DCS.	Requested customer to allow for Drive Interface between Drives(LT Motors, HT Motors etc) and DCS.
6.	Vol. II-E Section-I General Technical	8.25.03(2)	Single pair or single triad cable is not acceptable.	Requested customer to allow for cables between instrument and	Requested customer to allow for cables between

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	Requirements	Page 20 of 26	Minimum of 2 pairs or 2 triad cable shall be used.	Junction Box as these are very short in length.	instrument and Junction Box as these are very short in length.
7.	Vol. II-E Section-III Instrumentation & Control For FGD Plant	1.18.01 (b) Page 32 of 111	Local indicating lamp as a special feature is envisaged.	As belt Sway Switch is Auto reset Type, lamp is not required. Requested customer to confirm.	As belt Sway Switch is Auto reset Type, lamp is not required. Requested customer to confirm.

Name of BHEL Unit: ISG-DG

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	Vol. II-H/Section-V Diesel Generator Set	3.04.00/Page 3 of 30	On build-up of the rated voltage and frequency, the D.G. incomer breaker to D.G. PCC will be closed automatically and the D.G. PCC outgoing breakers are normally kept closed. After the automatic closing of the D.G. incomer breaker, the feeder of Emergency Switchboard to DG PCC will be closed automatically.	DG Set being an emergency system, we propose to connect the DG to EMCC without any DG PCC in between. Moreover, DG Set shall be located outdoors, in that case DG PCC shall have to be provided in FGD Control cum switchgear room along with EMCC. Same shall not serve any purpose.	Noted. Bidder to refer Errata- Electrical for revised Specification & SLD.
2	Vol. II-H/Section-V Diesel	6.09.01/Page 8 of 30	Two (2) sets of Battery and Battery Charger for each of the Diesel	One set of battery and Battery charger is sufficient for cranking of the engine. DG Control Panel	Cl: 6.09.01a) modified as:

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
	Generator Set		Generator sets.	supply will be on 220 V DC .	"One set of Battery and Battery Charger for each of the Diesel Generator sets."
3	Vol. II-H/Section-V Diesel Generator Set	6.09.01/xiii)Page 8 of 30	Rated life of each battery shall be at least ten (10) years.	We shall offer lead acid automotive type battery for engine cranking which is recommended by DG Suppliers. The life of such battery is 3 years and shall be supplied during commissioning of DG Sets only.	Cl: 6.09.02/a/xiii stands deleted.
4	Vol. II-H/Section-V Diesel Generator Set	6.10.08/Page 13 of 30	The generator stator and rotor windings core insulation and all connections including main and neutral leads shall have Class-F insulation meeting the temperature rise limitations with Class-B insulation set forth for air cooled machines in IS: 4722.	LT alternators available in market are manufactured with insulation class H. Hence we shall offer alternators with insulation class H and temperature rise limited to class- F.	Cl:6.10.08 modified as:" The generator stator and rotor ..... and neutral leads shall have Class-H insulation meeting the temperature rise limitations with Class-F insulation

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
					..... in IS: 4722."
5	Vol. II-H/Section-V Diesel Generator Set	6.10.19/Page 16 of 30	automatic, high speed, non-dead band type voltage regulator shall be furnished. The regulation system shall be provided with equipment for automatic and manual control.	The offered alternators shall have solid state / Digital AVR as per manufacturer's design. Provision shall be provided for voltage/raise lower from local/ remote.	Tender Condition Prevails. Bidder to confirm compliance to the Technical specification.
6	Vol. II-H/Section-V Diesel Generator Set	6.10.20/Page 19 of 30	The supply and erection of DG control panels in FGD control room are under the scope of this specification.	As DG Set shall be installed outdoors inside an acoustic enclosure, we propose to place DG AMF panel inside the enclosure only. DG Set controller in DG AMF Panel shall carryout auto start in case of Black out, Auto breaker closing, Synchronization and load changeover without any manual intervention. Few controls and annunciations shall also be provided from DCS.	This is only a clarification. Bidder to confirm compliance to the Technical specification.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

FGD

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1.	Vol. – IIB, Section -I	5.07.12/Page 17 of 57	Material of construction of flue gas ducting from FGD outlet to stack inlet terminal point shall be made of cladded sheet of minimum 2 mm thickness of either Titanium (Grade 2 as per ASME SB265) or C-276 over 8 mm thick (minimum) mild steel base metal.	Bidder requests Customer to confirm the MOC of outlet duct as the clauses mentioned here are indicating different MOC.	Vol-IIB, Section-I, Ann.-1, Page 51 of 57, S. No. 3 d "MOC of outlet duct" is modified as MOC of outlet duct - Cladded sheet of minimum 2 mm thickness of either Titanium (Grade 2 as per ASME SB265) or C-276 over 8 mm thick (minimum) mild steel base metal.
	Vol. – IIB, Section -I	Annexure - 1 Specific Design Criteria Of Limestone Based Flue Gas Desulphurisation System/ Page 51 of 57	MOC of outlet duct SS 317 LMN/ Alloy 31, min. 8 mm thick		
2.	Vol. – IIB, Section -I	5.08.03/ Page 25 of 57	The absorber and oxidation tank shall be made of minimum 7 mm thick carbon steel. The absorber tower, oxidation tank, absorber internals & other parts, absorber outlet duct, etc. shall be provided with minimum 2 mm thick lining/ cladding Alloy 59/ C276.	Bidder requests Customer to confirm the MOC of Absorber as the clauses mentioned here are indicating different MOC.	Vol-IIB, Section-I, Ann.-1, Page 50 of 57, S. No. 3 c) (i) "Absorber and oxidation tank" is modified as Absorber and oxidation tank – Minimum 7 mm

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PRE-BID QUERIES

Annexure-III

	Vol. – IIB, Section -I	Annexure - 1 SPECIFIC DESIGN CRITERIA OF LIMESTONE BASED FLUE GAS DESULPHURISATION SYSTEM/ Page 50 of 57	i) Absorber and oxidation tank Minimum 7 mm thick carbon steel with 2 mm thick lining / cladding / wall paper of SS 317 LMN / Alloy 31 or 5 mm thick rubber lining.		thick Carbon steel with minimum 2 mm thick lining/cladding of Alloy 59/ C276.
3.	Vol. – IIB, Section -I	5.08.03 e/ Page 23 of 57	The wet/dry interface in the quenching area / gas cooling zone and the absorber shall be made of solid Alloy 59 or C276 of minimum 6 mm thickness.	Bidder requests Customer to confirm the MOC of wet/dry interface as the clauses mentioned here are indicating different MOC.	Vol-IIB, Section-I, Ann.-1, Page 50 of 57, S. No. 3 c) (ii) "Wet-dry interface" is modified as Wet-dry interface - Solid Alloy 59 or C276 of minimum 6 mm thickness.
	Vol. – IIB, Section -I	Annexure - 1 SPECIFIC DESIGN CRITERIA OF LIMESTONE BASED FLUE GAS DESULPHURISATION SYSTEM/ Page 50 of 57	ii) Wet-dry interface STEN-1 lined with 4 mm thick Alloy C276 / Alloy 59.		
4.	Vol. – IIB, Section -I	5.09.00/ Page 23 of 57	Sufficient number of agitators (minimum 4), as per the proven practice of the contractor, shall be provided for thorough mixing of the re-circulating slurry. The contractor shall offer and demonstrate mixing arrangement such that n-1 numbers of agitators are	As per our FGD design, under normal FGD operation, the jet Air Sparger (JAS) works to keep the slurry in suspension and no agitators are required to be in operation. The Agitators are required only during FGD stoppage to prevent the	Tender condition prevails

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

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			sufficient to avoid the slurry settlement in the absorber tank in case of one agitator under breakdown (n - total no. of installed agitators).	deposit settlement. For this purpose, we are offering two numbers of Agitators. However, to meet tender requirement, two agitators will be provided as a ware house spare.	
5.	Vol. – IIB, Section -I	5.21.03/ Page 33 of 57	Horizontal agitators shall be used for all big tanks and vessels (especially, absorber bottom and emergency drain tank).	As per Bidder's design vertical mounted type agitators shall be provided for all tanks including Emergency Absorption tank in order to have uniform agitation and also for better performance.	Tender condition prevails
6.	Vol. – IIB, Section -I	5.06.03/Page 13 of 57	The slurry pipes shall be lined with replaceable rubber lining of 10 mm thickness. Additional thickness of 2 mm rubber lining shall be provided at bends.	Bidder requests Customer to review the specified rubber lining thickness for slurry pipes.	Tender condition prevails
7.	Vol. – IIA, Section - IX	TABLE-VII / Page 7 of 7	PROPERTIES OF LIMESTONE	Bidder requests customer to Specify Purity of Limestone to be considered for Guarantee point & Design point of the FGD System.	Following Notes are included below Vol. – IIA, Section –IX, TABLE-VII / Page 7 of 7 1. Guaranteed parameters (guarantee on limestone consumption, auxiliary power consumption & gypsum purity) shall be based on available (reactive) CaCO3

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

					content of 89% i.e Limestone purity is considered as 89%. The design of flue Gas Desulphurization (FGD) system & auxiliaries shall be based on available (reactive) CaCO3 content of 79% i.e Limestone purity is considered as 79%. 2. For the purpose of volumetric computations of limestone handling & storage system the bulk density of lime stone shall be taken as 1400 kg/m3. However for torque, drive & structural load requirements the density of lime stone shall be taken as 1700 kg/m3.
8.			Drawings	Bidder requests customer to provide AutoCAD copy of Plant general layout for	AutoCAD drawing will be furnished.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

				incorporating FGD equipment's as per bidder's design.		#

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Gate & Dampers

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	Vol: II-J Tender Drawings	Flow Scheme of LSFO FGD System (DWG NO. 17A14-DWG-M-0001A – REV.1)	In the Flow Scheme of LSFO FGD System Drawing, Guillotine Gate is shown at the Outlet of each Absorber.	As per the Flow scheme, new wet stack is applicable for FGD system. Guillotine Gate at Outlet of Absorber serves no purpose in case of new wet stack arrangement where the FGD treated flue gas enters the new stack. Please note that Guillotine Gate at Outlet of Absorber is required for isolation of FGD system only when the FGD Outlet Duct comes and joins the duct to the existing stack (in case of Existing Stack Arrangement). For all recent FGD retrofit projects where New Wet Stack is applicable, Absorber Outlet Gate is not applicable. Please clarify.	Tender condition prevails

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
2	Vol: II-J Tender Drawings	Proposed Modification Scheme for Inclusion of FGD Plant (DWG NO. 17A14-DWG-M-0001C – REV.1)	In the Proposed Modification Scheme for Inclusion of FGD Plant, Guillotine Gate is shown at the Inlet of each Absorber (between Booster Fan Outlet Gates and Absorber)	Already Guillotine Gates are provided at the Outlet Duct of each Booster Fan for isolation of the FGD Absorber. Therefore, the Guillotine Gate shown (in this drawing) in the duct between the Booster Fan Outlet Gates and the Absorber is redundant and therefore not required. Please clarify.	Guillotine gates provided at Absorber inlet stands deleted. Bidder shall refer DWG NO. 17A14-DWG-M-0001A – REV.1 for the number of Gates / Dampers to be provided.

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PRE-BID QUERIES

Annexure-III

Booster Fan

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	I/IIB	5.07.01 iii/ 14 of 57	The fan casing and impeller blades shall be provided with suitable renewable wear resistant liners of proven design. Suitable proven arrangements shall be provided for prevention of corrosion of fan components.	Bidder would like to clarify that the Booster Fans for the FGD project are of similar construction to that of axial reaction ID fans offered for New Neyveli 2x500 MW as these Booster Fans are handling similar type of flue gas as that of the New Neyveli 2x500 MW ID Fans. The casing for the ID fans for New Neyveli 2x500 MW is of mild steel only and without any liners & blades are of nodular cast iron material and also without any liners. Further to this Bidder would like to clarify that offered FGD Booster Fans casing shall be with mild steel, without any liners and with minimum thickness as per design requirement/ manufacturer's	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
				standard. The blades for these Fans shall be of nodular cast iron material and without any renewable liners. Our clarification was accepted by NLC for New Neyveli 2x500 MW FGD tender and same was updated in the re-tendered Pkg.	
2	I/IIB	5.07.01 iv/ 14 of 57	All stationary parts coming in contact with flue gases shall be provided with suitable lining or made from corrosion resistant materials .Fan casing material shall be abrasion and wear resistant, high BHN steel having thickness minimum 8.0 mm or 12mm mild steel with liner of thickness 10mm (min.).	For the offered FGD Booster Fans all stationary parts shall be of mild steel. Fans casing shall be with mild steel without liners. These are as per OEM's proven design practice and these are also applicable for New Neyveli 2x500 MW ID Fans. Our clarification was accepted by NLC for New Neyveli 2x500 MW FGD tender and same was updated in the re-tendered Pkg	Tender condition prevails

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
3	I/IIB	5.07.01 xiii/ 15 of 57	Overhang type impeller designs shall not be accepted. Shaft shall be carried in bearings on either side of impeller and shall be independent of casing.	Bidder would like to clarify that offered FGD Booster Fans are axial Fans and are overhang type impellers by construction. Impeller is mounted on shaft with mono-block bearing housing as per standard design practice. This is also applicable for New Neyveli 2x500 MW ID Fans	Bidder to refer S. No. 15 of Errata-Mechanical

Electricals

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	Vol. II-F/Section-XIII	Cables / 4.07.05 / Page 4 of 15	For fuse protected circuit, the conductor size shall depend on full load current subject to voltage drop not exceeding 3%. For practical purposes, the minimum size chosen is as below: a) Aluminium : 16 Sq. mm.	For LT power cables, bidder proposes to use Aluminium conductor for cable conductor size more than 2.5 sq. mm and copper conductor for cable conductor size less than or equal to 2.5 sq.mm. Hence	TS prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
			b) Copper : 2.5 Sq. mm.	owner may suitably modify the the minimum size criteria of aluminum and copper cables. This is inline with the configuration for all other FGD projects being followed by various private, central and state power utilities. Owner / consultant may confirm the bidder understanding or issue necessary clarification in this regard.	
2	Vol. II-E/Section-I	8.09.00/ Page 16 of 26	For temperature monitoring functions, temperature elements (TC / RTD) shall be connected to their respective input module of PLC through instrumentation signal / Triad cable in case of RTD type element, extension / compensating cable for K type TC.	Bidder understands that the temperature elements , RTDs & thermocouples, can be connected directly to PLC using instrumentation cable / compensating cable or through suitable temperature transmitters depending on the cable distance.	Bidder's understanding is correct.

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
				Owner / consultant may confirm the bidder understanding or issue necessary clarification in this regard.	
3	Vol. II-F/Section-I	5.19.04 / Page 21 of 45	20% spare margin shall be considered over & above the estimated total load on the L.T. board.	Bidder proposes to consider 10% spare margin for the LT load for determination of service transformer ratings. This is inline with the configuration for all other FGD projects being followed by various private, central and state power utilities	TS prevails
4	Vol. II-F/Section-I	5.19.03 / Page 21 of 45	An appropriate diversity factor with a minimum of 0.9 for continuously running loads & purchaser feeders and 0.4 for intermittent loads like cranes, plug points, sump pumps, elevator and 0.2 for stand-by feeders etc., shall be considered.	Bidder proposes that stand-by feeders needn't be considered for determination of service transformer ratings. This is inline with the configuration for all other FGD projects being followed by various private, central and state power utilities	TS prevails

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: EDN

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1.	Vol. II- E / Section-I General Technical Requirements	2.01.00 Page 1 of 26	FGD control system shall operate under all operating conditions from a dedicated PLC based Control system	Bidder shall offer DCS based control system for the FGD system. PLC based control system is not envisaged. Kindly confirm.	DCS based control system is also acceptable.
2.	Vol. II-E/ Section-II Scope of Work and Terminal Points & Exclusions	2.02.03 Page 2 of 13	Bidder shall provide all necessary interface hardware/software required for satisfactory operation of equipment covered under this specification. This shall include input / output modules, relays, isolators and other necessary hardware/ software for interfacing with station DCS and other C&I systems which are not in bidder's scope.	Required Input/output modules, relays and other necessary hardware/ software in FGD control system for the signals to be interfaced with main plant DCS shall be considered by the bidder. However, any hardware / software / HMI modification required in the Main plant DCS shall be taken care by the Purchaser.	Noted. However for cables, cabling & termination at both ends, the spec shall be complied. Also any co-ordination with the existing DCS vendor regarding the interface shall be in bidder's scope.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

3.	Vol. II-A/ Section-VIII Annexure-1 LIST OF MANDATORY SPARES	C:INSTRUMENTATION & CONTROL Page 33 of 41	LIST OF MANDATORY SPARES INSTRUMENTATION & CONTROL	Spares for Vibration Monitoring System, CEMS and FGD analyzers are not listed in C&I mandatory spares list. Request to kindly furnish the list for the above items if it is required to be supplied.	Please refer the revised mandatory spare list attached.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: PIPING CENTRE

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	Vol IIA – Sec VII – Quality Assurance Requirements	Cl 2.11.00 131 of 189	All the sub vendors proposed by the Bidder for procurement of major BOIs including castings, forging, semi-finished and finished components/ equipment list of which shall be drawn up by the Contractor and finalized with the Owner shall be subject to Owner's review.	BHEL has a very well-established system of assessment, approval and enlistment of vendors in the Company's directory. Inducted vendors are capable of delivering various types of material specifications like Alloy Steels including P92&P91, Carbon Steels, SS and Duplex SS meeting the International/National standards and codes. And also BHEL's product directory vendors have been supplied all types of material specifications to all thermal boilers including super critical upto 800MW rating. **Hence, BHEL approved suppliers may please be considered.**	Tender condition prevails

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Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
2	Vol IIA – Sec V Protective Coating & Painting	Cl 7.04.05 97 of 189	Scheme V : For pipelines (Above ground) Surface preparation : Mechanical chipping/ Power tool cleaning St3 / Wire brushing St2 Primer: Self Priming Epoxy 100-150 micron Under coat : Epoxy Glass Flake (high build) 100-110 micron Top coat: Aliphatic Polyurethane TiO2 (rutile) 50-60 micron. Total DFT = 250-320 micron min	Primer : 2 coat of Red Oxide Zn Phosphate (alkyd base to IS 12744) ; 25 microns each coat Finish : 2 coat of Synthetic enamel long oil alkyd to IS 2932 ; 35 microns each coat Total DFT = 120 microns	Tender condition prevails

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: BPL- SWS

Switchgear

Sl. No.	Volume/ Section/	Clause No./ P. No	Tender Specification Requirement	Bidder's Clarification/Queries	Resolution/ Clarification
1	Volume 4	01.02.01 Pg. 2 of 182	Necessary modification / conversion work in CTs, Relays etc. of these feeders for using as power feeders shall be carried out by the bidder	Customer is requested to confirm the Make & furnish the GA, Layout, scheme drawings of existing switchgear, to enable us to ascertain the modification requirements.	Details/Works are already furnished in the specification. Further details will be given to the successful bidder. Bidder may visit Site, if required.
2		5.03.00 Pg. 84 of	Following minimum tests shall be performed on a representative sample …Impulse. Test, Temp Rise & Internal Arc Test	1. We are submitting valid type test reports for offered design of switchgear. Repeating the type tests, listed at 5.03.00, is not envisaged against this tender.	Type test report shall not be more than 5 years old.

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PRE-BID QUERIES

Annexure-III

	Vol.- II-F	436		2. It may also be noted that Internal Arc Test against the contract is not envisaged because this is a special high-energy test, which can be conducted in Foreign Labs only. We are submitting report for test conducted earlier at KEMA, ZKU, Prague & same was witnessed by M/s NTPC. Customer is requested to accept the above submissions.	

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PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: PS-PEM, NOIDA

<table>
<tr><th>Sl. No</th><th>Section/ Volume</th><th>Clause No./ Sheet No.</th><th>Specification Requirement</th><th>Pre-Bid Clarification</th><th>Resolution/ Clarification</th></tr>
<tr><td colspan="6">HVAC SYSTEM</td></tr>
<tr><td rowspan="2">1.</td><td>V.II-I/Section-I Air Conditioning System</td><td>Clause 1.02.00, page 1 of 11</td><td>
<table>
<tr><th>Sl. No.</th><th>Building</th><th>Area Covered & Type of Air Conditioning System</th></tr>
<tr><td>a)</td><td>FGD Control Room</td><td>Control Room – Non Ductable Split AC with stand-by-unit</td></tr>
</table>
</td><td rowspan="2">In view of the Air Conditioned Area Refrigeration Load (TR) requirement and constraint for availability wall area for mounting of split AC to avoid interference of indoor unit of split AC with other equipment’s/cables, bidder propose type of the air conditioning system as per the following,

1. 25-60TR, D-X type Air cooled Condensing Unit along with AHU shall be provided with 3 x 50% redundancy.
2. 11-25 TR, Ductable Split AC/ Air cooled package AC shall be provided with 3 x 50% redundancy.
3. Upto-10TR, with Hi-wall Split AC/ Cassette AC shall be provided with N+1 redundancy configuration. Where N is number of</td><td rowspan="2">Tender condition prevails</td></tr>
<tr><td>V.II-I/Section-I Air Conditioning System</td><td>Clause 2.01.00, page 2 of 11</td><td>Air Cooled Non Ductable Split Air Conditioners complete……this equipment will serve the control rooms as stated above. (100% stand-by modules are to be provided for each Control room)</td></tr>
</table>

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
				working unit. Customer is requested to review and accept.	
2.	V.II-I/Section-I Air Conditioning System	Clause 4.03.00, page 4 of 11	Relative humidity: Not exceeding 65%	From split AC relative humidity cannot be done. It is not feasible to maintain relative humidity as <65% From split ACs. Customer is requested to review the same.	Clause 4.03.00, page 4 of 11 of Vol-II-I/ Section-I " Relative humidity: Not exceeding 65%" stands deleted
3.	V.II-I/Section-I Air Conditioning System	Clause 4.04.00, page 4 of 11	The fresh air quantity for air conditioned areas shall be 1 air change per hour. Lighting load shall be minimum 1 watts per ft^2 or actual whichever is higher. Cooling load estimation shall be done by allowing 5% margin on room sensible heat and 5% margin on room latent heat and an overall margin of 10% shall be considered in design of AC plant capacity for each area.	For Air Conditioned area catered through split ACs, fresh air supply shall not be applicable. Please confirm.	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
4.	**V.II-I/Section-I Air Conditioning System**	**Clause 5.05.01, page 9 of 11**	Roof over AC space exposed to sun shall be provided with 50 mm thick expanded polystyrene (TF quality) or equivalent. Roof over AC spaces not exposed to sun shall be provided with similar insulation of 25mm thickness. Clause no. 21., page 34 of 41, Vol. II-G1/Section-IV Specific Design Requirements [Architecture] e) Under-deck insulation shall be provided for all AC areas having roof exposed to sun/floor exposed to heat atmosphere.	There is contradiction with the civil specification w.r.t. insulation requirement for the roof area not exposed to sun. Further in general insulation **is not required** for the roof area **not exposed to sun**. Customer is requested to review the same.	Tender condition prevails
5.	**V.II-I/Section-I Air Conditioning System**	**Clause** 5.07.06, page 10 of 11	A detailed experience list about supply for system of similar type for similar application mentioning in each case the salient technical parameters, date of commissioning and name of customers	Split ACs are mass production items of OEM and supplied by HVAC system contractor as part of composite package. In view of the same “experience list about supply for system of similar type for similar application mentioning in each case the salient technical parameters, date of commissioning and name of	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
				customers" would not be possible. However, credential of HVAC vendor (system integrator) shall be provided by bidder. Customer is requested to review the same.	
6.	**V.II-I/Section-I Air Conditioning System**	**Clause** 5.07.07, page 10 of 11	A comprehensive write-up and/or brochure on details of manufacturing and testing facilities in the shop of the manufacturer.	Split ACs are mass production items of OEM. In view of the same "A comprehensive write-up and/or brochure on details of manufacturing and testing facilities in the shop of the manufacturer." would not be possible. However, product catalogue shall be provided during detail engineering. Customer is requested to review the same.	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
7.	**V.II-I/Section-I Air Conditioning System**	**Clause** 5.07.14, page 11 of 11	Shop test reports and certificates	Split ACs are mass production items of OEM. In view of the same "Shop test reports and certificates" would not be possible. Customer is requested to review the same.	Tender condition prevails
8.	**Vol. II-I/Section-II Ventilation System**	**Clause** 1.02.00 SL. NO. A, C, page 1 of 17	Filtered Air supply by means of wall mounted Fan-Filter Unit/s (with pre filters) and air exhaust through Back Draft Dampers.	Bidder understand that wall mounted Fan-Filter Unit/s (with pre filters) and **wall mounted axial flow supply fan (with pre filters)** are same. If both are not same customer is requested to provide the details of wall mounted Fan-Filter Unit/s (with pre filters). Please clarify.	Bidder understanding is correct.
9	**Vol. II-I/Section-II Ventilation System**	**Clause** 4.02.02, page 5 of 17	The following minimum air change rates are to be maintained for the areas indicated below.	Considering the inside condition to be maintain, air change rate seems on lower side.	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
			<table><tr><td>Building / Area</td><td>Air Change/ Hour</td></tr><tr><td>Electrical Rooms (like Switchgear & MCC rooms) & Cable spreader room (with dry ventilation)</td><td>15</td></tr><tr><td>Pump Houses</td><td>10</td></tr><tr><td>Limestone and Gypsum storage buildings</td><td>10</td></tr><tr><td>Toilet / Pantry of all buildings</td><td>20</td></tr></table>	Customer is requested to review the same.	
10.	**Vol. II-I/Section-II Ventilation System**	**Clause** 5.02.04, page 7 of 17	All the fan units shall be reasonably noise and vibration free in operation and therefore of reasonably low speed. RPM of axial flow fans shall be restricted within 1000 to reduce their noise level. Outlet air velocity of all fans shall be restricted within 12 m/s.	In general criteria of fan RPM and size, is followed as under: - The speed of the fan shall not exceed 960 rpm for fan with impeller diameter above 450 mm and 1400 rpm for fan with impeller diameter 450 mm or less. However, for fans having static pressure of 30 mm WC or above the speed of the fan shall not exceed 1440 rpm for fan with impeller diameter of above 450 mm and 2800 rpm	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
				for fan with impeller diameter of 450 mm or less. Customer is requested to review the same.	
COMPRESSED AIR SYSTEM					
1	Vol. II-H/Section-VII Compressed Air System	4.05.00 / Page 4 of 31	The compressed air system shall consist of 2×100% capacity compressors (i.e. one (1) working and one (1) standby for FGD Plant of existing 1x250 MW units)…….	Bidder understands that the common compressor is to be provided for Instrument air & Service application. Pl. confirm.	Bidder understanding is correct.
2	Vol. II-H/Section-VII Compressed Air System	4.13.00 / Page 5 of 31	Each Air Receiver shall be so sized…… T = Bleed down time in minutes, shall be taken as 2 minutes (minimum).	Considering the bleed down time of 2min., the air receiver capacity comes out to be extremely huge. Generally, as per DCPL specs. the bleed down time is 45 sec. and also the min. pressure is increased from 5.5 kg/cm2(g) to 6.5 kg/cm2(g), which is again resulting in higher air receiver	Tender condition prevails

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Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
				capacity. Bidder have considered 5 M3 air receiver cap. as min. defined in the specification. Pl. accept.	
3	Vol. II-H/Section-VII Compressed Air System	6.07.00 / Page 7 of 31	Compressor casing, rotor and shaft	Pl. note that material of construction within the compressor skid shall be as per OEM standard only. MOC outside compressor skid shall be as per customer specification. This is in line with the projects executed by BHEL for M/s NLC and other Power plant customers. Pl. accept.	Tender condition prevails
		6.09.00 / Page 9 of 31	Gear Box		
		6.10.00 / Page 9 of 31	Inter Cooler, After Cooler and Moisture Separator		
		6.12.00 / Page 10 of 31	Intake Air Filter and Silencer		
		ANNEXURE-I / Page 22 of 31	Materials of Construction		
		ANNEXURE-I / Page 26 of 31	Intercooler, After cooler, Moisture Separator, Piping, Valves etc. :		

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Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
		ANNEXURE-II / Page 30 of 31	Clause C: Material Clause D: Supply of accessories And Services For Each ADP		
4	Vol. II-H/Section-VII Compressed Air System	7.02.01 / Page 15 of 31	Each compressor shall operate in 50% or 100% load under load/unload mode of control depending on system demand.	Pl. note that in case of oil free screw air compressors, capacity control is not possible since these compressors operates either at no load or at full load. This is in line with air compressor supplied by BHEL for power plant projects. Pl. accept.	Tender condition prevails
5	Vol. II-H/Section-VII Compressed Air System	7.05.00 / Page 16 of 31	Indication/ Annunciation System	Pl. note that material of construction within the compressor skid shall be as per manufacturer standard only. MOC outside compressor skid shall be as per customer specification. Pl. accept.	Tender condition prevails
		7.06.00 / Page 17 of 31	Interlock		

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Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
6	Vol. II-H/Section-VII Compressed Air System	ANNEXURE-I / Page 23 of 31	E. DM COOLING WATER DATA 1) Design pressure: Bidder to indicate. Shall not be less than the shut off head of DMCCW pump. 2) Maximum pressure drop allowable between inlet and outlet points : 6.0 to 8.0 MWC	1) Pl. note that cooling water pumps are common for boiler, STG and BOP area, the shut-off head may be higher than the design pressure of instrument air & service air compressors. So, pressure reducing valve shall be provided in cooling water line to air compressors. Design pressure for cooling circuit for instrument and service air compressor shall be as per OEM standard design. Pl. accept. 2) Pl. note that pressure drop within compressor skid shall be max. 10 MWC as per OEM standard. Pl. accept.	DMCW pumps referred in the clause are the DMCW pumps under the scope of FGD package vendor. Hence tender condition prevails.
PIPING LAYOUT					

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
HVAC SYSTEM					
1	GENERAL			Please clarify whether existing pipe rack / pedestals can be used, wherever available, for routing pipes related to FGD.	Tender condition prevails
2	Vol. II-A/Section-III	ANNEXURE-I: TERMINAL POINTS Sl. No. 2 (ii) at Pg. 9 of 14	From the terminal point entire DMCW system distribution network & equipment shall be within FGD Plant package vendor scope.	Please clarify whether equipment in DMCW/ACW system are to be kept in pump house (enclosed with side walls) or shed (open from sides)	Tender condition prevails. Bidder to refer Vol-IIB, Section-I, Clause 4.05.07
C&I					
1	Vol.II-E, Section-I	8.25.03 (1) Sheet 20 of 26	DI & DO signal cannot be routed through the same cable.	DI and DO both shall be interfaced through same multi pair cable as both are binary signals. Please Confirm	Tender condition prevails
2	Vol. II-J	Typical drive interface for LTUD/BID/HTUD/LT- breaker optd/ Analog drives:	Separate cable of 1.5 sq mm for interfacing DO has been indicated.	DI and DO it shall be interfaced with DCS with **multi pair cable** of **0.5** sq.mm. Please Confirm	Tender condition prevails

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PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: PS-PEM, NOIDA

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
1	Vol II G1/ Section -I	3.00.00/page 12 of 23	Demolition of existing structures / facilities, if any, and site clearance	Please furnish the list of existing structures/buildings which are to be dismantled.	cl 1.00.00 of sec II/vol II G part A shall be followed. Demolition of existing structures/facilities including one workshop building and RCC drains and other structures if any, and site clearance (The bidder may visit the site to access before quoting)
2	Vol II G1/ Section -I	3.00.00/page 12 of 23	Boundary walls/Fencing in buildings, if required from statutory point of view	Please furnish the list of buildings for which boundary wall/fencing is required.	TS prevails
3		4.03.03/page	**Micro Area Grading** This is an existing site. However, as	Please furnish the Topographical Survey drawing in Auto Cad	Since this is retrofitting work in

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
	Vol II G1/ Section -I	18 of 23	per the present condition, necessary micro leveling, grading and dressing is to be done by the successful Bidder as required. Final Site leveling and micro-grading for the plant area in FGD package shall be within scope of this contract.	format showing contours and spot levels of proposed FGD area. Only micro grading up to 300 mm will be done by bidder. Please confirm.	existing plant, this requirement does not arise. Comply TS
4	Vol II G1/ Section -I	4.03.03/page 18 of 23	**Micro Area Grading** ……..All existing drains/channels in the plant and other areas associated with the plant shall be suitably diverted before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding in adjoining areas.	Please furnish the existing layout of drains/channels which need to be diverted.	Comply TS (cl 1.00.00/vol-II-G2/Part-A/Section-II) The bidder may visit the site to access the quantum of work before bidding
5	Vol II G1/ Section -I	4.03.04/page 18 of 23	**Storm water & Drainage System** RCC rectangular Drains shall be designed as a network covering the plant area within the battery limit of FGD package. All the storm water collected inside the FGD battery limit shall be connected to the plant main storm water network is in the scope of FGD package.	Please furnish the drawing showing the location, invert level and co-ordinates of existing storm water network in which storm water of the proposed FGD area is to be connected.	Bidder may visit the site for ascertaining the details before quoting(cl 1.00.00/volu II G2 part A/section II)

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PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
6	Vol II G1/ Section -I	4.03.04/page 18 of 23	All the sewerage shall be collected from FGD battery limit and the same shall be interconnected to the Main plant Sewer System at the first RCC man hole of sewerage conveying.	Please furnish the drawing showing the location, invert level and co-ordinates of nearest existing RCC man hole of main plant sewerage system.	Bidder may visit the site for ascertaining the details before quoting(cl 1.00.00/volu II G2 part A/section II)
7	Vol II G1/ Section -II	2.00.00/page 1 of 28	**GEO-TECHNICAL SYSTEM** The type, size, depth of the foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.	Owner's soil investigation report is not available in tender document. Please furnish the Geotechnical Investigation Report of the proposed FGD area conducted by owner including bore log details, field test results, lab test results of soil/rock samples, electrical resistivity values, chemical analysis of water etc.	Will be furnished separately.
8	Vol II G1/ Section -II	2.00.00/page 1 of 28	**GEO-TECHNICAL SYSTEM** The type, size, depth of the foundation shall be based on the approved soil investigation report of Bidder/Owner's soil investigation report whichever is conservative.	The foundation system shall be as per approved Geotechnical Investigation Report during detailed engineering. Please confirm.	Comply TS

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PRE-BID QUERIES

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
9	Vol II G1/ Section –II	4.00.00/page 12 of 28	**DESIGN OF REINFORCED CONCRETE STRUCTURES BY BIDDER** The grade of concrete for RCC shall be M-35 for all structures.	Kindly review the grades of concrete mentioned in the table as the same grade of concrete M35 is mentioned for plinth protection, paving, grade slab, drains, trenches, roads, sub structure and super structure concrete etc.	Comply TS
	Vol II G2/ Part-A, Section-V	3.04.02/page 14 of 52	TABLE - I STRENGTH REQUIREMENT OF CONCRETE NOTE: 1 - Concrete Grade M-15 shall be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling. Grades of concrete lower than M-35 shall not be used in reinforced concrete. These mixes need not be designed.		Comply TS
10	Vol II G1/ Section-III	1.00.00/page 2 of 14	**STRUCTURAL STEEL DESIGN** g) Specific corrosion resistant painting system with protective coatings shall be adopted as per CSIR – CERI recommendations for marine environment with required material, proper application procedure and approved number of coating. Stipulations mentioned in ISO 12944 shall be followed.	The referred clauses are contradictory. Please clarify.	All three clauses shall be referred as follows: For all steel works the following specification shall be used: **All Exterior Steel Work** :A primer
	Vol II G1/	3.18.00/page	Painting Exterior Steel Work		

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PRE-BID QUERIES

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
	Section-IV	12 & 13 of 40	Two primer coats steel work Zinc silicate 50 microns each. Two finish coats High built epoxy finish of 90 microns each coat. All Internal Steel Work Epoxy Paint two coats over approved primer		coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO_2) rutile of 50-60 micron shall be applied **All Internal Steel Work** : A primer coat of Zinc Ethyl silicate of 50-60 micron + Under coat of Epoxy Glass Flake(High Build) of 100-110 micron + Top coat of Aliphatic Polyurethene(TiO_2) rutile of 50-60
	Vol II G1/ Section-IV	4.00.00/page 29 & 30 of 40	Design data for Architectural Works 14. f. Painting All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110-micron DFT. Anti-corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Copolymer coating.		

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
					micron shall be applied
11	Vol II G2/ Part-A, Section-I	7.00.00/page 18 of 26	**TESTS FOR DYNAMIC PROPERTIES** For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.	For evaluation of in-situ dynamic and damping properties of soils, cyclic plate load test only shall be conducted. Please confirm.	Comply TS
12	Vol II G2/ Part-A, Section-II	3.06.04/page 8 of 14	Blasting is not permitted since work is to be carried out within the existing running plant.	Owner is requested to allow controlled blasting for excavation in rocky strata.	Comply TS
13	Vol II G2/ Part-A, Section-IV	3.02.00/page 7&8 of 22	Capacity of Single pile Lateral capacity The Lateral capacity of single pile, at this site, will be considered as the minimum of the following: - i) 5 % of their respective compressive capacity of pile. ii) Lateral pile capacity assessed by the successful contractor by initial Pile Load Test on Trial Pile at selected representative locations, before taking up working piles. At	Lateral capacity of pile shall be as per approved Geotechnical Investigation Report during detailed engineering. Please confirm.	Comply TS

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
			least 3 Nos. of such tests is necessary, locations for which will be mutually decided by the contractor & purchaser.		
14	Vol II A/ Section-II	3.04.00	EXCLUSIONS Additional Wet Chimney	Since additional wet chimney is in exclusion, any work viz. Corrosion protection painting for equipment, structures and piping, including retrofitting works of providing corrosion protection lining on existing chimney flues and wet chimney condensate collection system, etc. is excluded from bidder's scope. Please confirm.	Bidders understanding is in order.
	Vol II B/ Section-I	4.08.00/page 9 of 57	Corrosion protection painting for equipment, structures and piping, including retrofitting works of providing corrosion protection lining on existing chimney flues and wet chimney condensate collection system, etc. as required.		
ELECTRICAL					
1	Vol. II-F/ Section-I	Clause No. 5.32.05/ Page 31 of 45	FRP Trays	There is no applicable area in FGD system for FRP trays. Hence, we understand that this is not applicable. Please Confirm	Tender Condition Prevails. Bidder to confirm compliance to the Technical specification.

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
CIVIL					
2	Vol. II-F/ Section-XIII	Annexure-IV/ Page 12 of 15	1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES & 1.1KV GRADE COPPER CONDUCTOR FS CONTROL CABLES	There is no applicable area in FGD system for FS cable. Hence, we understand that these type of cables are not applicable. Please Confirm	Tender Condition Prevails. Bidder to confirm compliance to the Technical specification.
3	Vol. II-J	Page 15 of 40 (Drg. No. 17A14-DWG-E-001)	General	We understand that rating of transformer/ feeders & quantity is tentative only & may change depending on the total loading for the FGD system. Please Confirm	Noted

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PRE-BID QUERIES

Annexure-III

Name of BHEL Unit: PEM

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	Vol. II-B/Section-I	9 D) Page 53 of 57.	Roof Top Mounted Cooling tower	In the absence of datasheet/ parameters for cooling tower design, we shall provide FRP Cooling tower (Induced draft) with single cell considering Design Inlet WBT as 28.5 deg. C. and design Cooling water Temperature as 33 deg. C for cooling tower design.	Bidder to refer Sr. No. 13 Errata Mechanical
2	Vol. II-B/Section-I	5 c) & d)	DMCW & ACW temperature rise not to exceed 6 deg. C	Temperature rise limit on DMCW & ACW may please be removed as both primary (DMCW) & secondary (ACW) circuits is in bidder scope.	Tender condition prevails
3	Vol. II-B/Section-I	4.05.07	2x100% Capacity Self-cleaning strainer on ACW side	MOC of Self Cleaning strainer is not specified, same shall be as under: Body: Carbon steel. Strainer/filter element: SS 316	Bidder to refer S. No. 12 of Errata-Mechanical
4	Vol. II-D/Section-I	ANNEXURE-I, II & III	Piping, Valves & Specialties	We understand that quality of Process water/ACW falls under Service water (Clarified water) category and accordingly MOC of Piping, valve, fittings for Process water/ACW to be provided & shall be same as for service (clarified) water as per specification. Please confirm.	Tender condition prevails

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Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
5	Vol. II-B/Section-III	ANNEXURE-I, Page 10 of 13	DATA SPECIFICATION SHEET- HORIZONTAL CENTRIFUGAL PUMPS	We understand that DMCW & ACW Pumps falls under “Pump Handling Clear Water” category of DATA SPECIFICATION SHEET- HORIZONTAL CENTRIFUGAL PUMPS and accordingly same shall be referred for DMCW & ACW Pumps. Further SS 304 is indicated for impeller, however impeller being casted component, equivalent Casting grade of SS 304 shall be provided. Please confirm.	Bidder to refer S. No. 14 of Errata-Mechanical

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Annexure-III

Name of BHEL Unit: PSSR

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
1	Section 2 Volume - 1B	2.7.1/ 31	Land for labour colony will be allotted on nominal rent as follows. ii) Nominal rent will be charged by Owner, Facilities for labor colony shall be the sole responsibility of the Contractor. After completion of the work, land shall be handed over as per terms of conditions indicated in the sub paras of this clause below	Kindly indicate the rental charges which may be size & charges for land for Labour colony per sqm	Rates as applicable will be charged.
2	Section 2 Volume 1B	2.1g/ 24/203	Dismantling and rerouting of pipe trestle, rerouting of interplant piping, shifting of roads shall also include in the scope of work.	1. Kindly clarify if any dismantling of existing facilities is required apart from the Flue gas duct. If so, Kindly provide the detailed scope of dismantling. 2. Kindly provide drawing of existing facilities to be dismantled & for those which are to be dismantled & rerouted. 3. While in the case, dismantling & disposal, kindly clarify the ownership of dismantled material 4. Similarly, in case of dismantling & rerouting, kindly clarify the ownership of dismantled material.	Tender condition prevails
3	Section1, Volume 2B	4.01.01	a) Dismantling of existing facilities/ structures, where so required and their relocation at new area shall be indicated by the Purchaser, rerouting of over ground and underground pipes, cables, ducts, supports, structures, trestles, etc. as necessary for erection and commissioning of FGD system.		Tender condition prevails

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Name of the Bidder: BGR

Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
1.	Vol-IIA, Sec-II, Cl 7.01.00, Page 2/2	Meterological data	For the HVAC system the data from ISHRAE will be adopted based on nearest station data.	For design of HVAC system bidder shall consider data from tender specification Vol-IIA, Sec-II, Cl 7.01.00, Page 2/2
2.	Vol-IIA, Sec-III, Cl 1.00.00, page 1/14	Chemicals	Chemicals in the nature of consumables will not be supplied for one year as they have limited shelf life and cannot be stored for longer period of time. We will provide the chemicals upto the completion of trial operation.	Tender specification prevails
3.	Vol-IIA, Sec-III, Cl 1.03.07, page 3/14	Handling of equipment for maintenance	For these equipment monorail will be provided if it is inside bldg. In outdoor areas separate monorail or hoist is not provided as these can be accessed by mobile maintenance equipment.	Tender specification is self explanatory.
4.	Vol-IIA, Sec-III, Cl 1.03.12, page 3/14	Buildings and layout	Bidder has the option to combine or separate buildings meeting the functional requirements and accommodating all the equipment for operation and maintenance.	Tender specification prevails. Bidder to refer Vol-IIA, Sec-IV, Clause 7.00.00
5.	Vol-IIA, Sec-III, Cl 1.03.12 (ii), page 4/14	Air conditioning of electrical and control building	AC is for control room areas only and not for the electrical rooms.	Tender specification prevails. Bidder to refer Vol-II-I, Section-I & II
6.	Vol-IIA, Sec-III, Cl 1.04.00 (q), page 5/14	Interface with third party system	Please clarify the interface with third party systems, Provide details of such system and type of interface required.	The required interface with third party systems are clearly indicated in Vol-IIE, Sec-II, Cl. 2.00.

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
7.	Vol-IIA, Sec-III, Cl 1.05.00 (b), page 5/14	FGD Station transformer (proposed)- Fire protection	The hydrant and spray requirements of this transformer will be tapped from the nearest existing headers of the plant. Please confirm.	Bidder to refer Vol-IIA, Sec-III, Annexure-I (Terminal points)
8.	Vol-IIA, Sec-III, Cl 1.05.00 (d), page 5/14	DC starter	Please clarify purpose of DC starter. If it is applicable it will be provided, otherwise it will not be provided.	Noted.
9.	Vol-IIA, Sec-III, Cl 1.06.00 (b), page 6/14	Rain water harvesting	Please provide the details of the rain water harvesting system required. Please provide details of rain water harvesting adopted in the existing plant.	Cl 3.19.00(r)/Sec IV/Vol II G1/Page 14 of 40 shall be followed
10.	Vol-IIA, Sec-III, Cl 1.06.00 (b), page 6/14	Sewage system connection location	Please provide the location coordinates (approx) for the main sewage system interconnection.	Cl 1.00.00/Sec II/Vol II G2/Part A/Page 1 of 14 shall be followed (civil corrigendum sl no 44)
11.	Vol-IIA, Sec-III, Cl 3.00.00, page 8/14	Exclusions	Please confirm that the stack monitoring instruments, CEMS is excluded from the scope. We also understand that the lining for the wet chimney, wet stack study, wet stack drainage collection and handling system are also excluded from scope of FGD.	CEMS is included in the bidders' scope. Refer Vol-IIE, Sec-II, Cl. 2.04.00 (g). Lining for Wet chimney and wet stack study is excluded from Bidder's scope. Regarding wet stack drainage collection and handling system, bidder to refer S. No. 1 & 2 of Errata-Mechanical
12.	Vol-IIA, Sec-III, Cl 3.00.00, page 8/14	Exclusions	We understand sewage treatment plant is excluded from the scope.	Bidder's understanding is correct.
13.	Vol-IIA, Sec-III, Cl 3.04.00, page 8/14	Additional chimney	Please indicate the height of the proposed additional chimney, type of flue.	RCC Chimney height is 150 m with Steel flue internally lined with borosilicate blocks.
14.	Vol-IIA, Sec-III, Annex-1 Sl No. 1 (ii) page 9/14	Chimney terminal point	Please clarify the terminal point location with respect to the chimney. Who will provide the counterflanges with fasteners at the chimney.	Tender specification is self explanatory.

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
15.	Vol-IIA, Sec-III, Annex-1 Sl No. 2 (i) page 9/14	Process water terminal point	Please clarify the available pressure. Is there a pump to be supplied by FGD vendor for the transfer of the water.	Bidder to refer S. No. 38, 39 & 40 of Errata-Mechanical
16.	Vol-IIA, Sec-III, Annex-1 Sl No. 2 page 9/14	ACW terminal point	Please clarify terminal point for the ACW. (Sea water)	ACW water intake is from Process water tank which is in the scope of bidder. Bidder to refer Vol-IIJ, 17A14-DWG-M-0001A & 17A14-DWG-M-0001E
17.	Vol-IIA, Sec-III, Annex-1 Sl No. 2 (iii) page 9/14	Service water terminal point	Please clarify the pressure of the service water available at terminal point. Please clarify approximate location of the interconnection point.	Service water pressure at terminal point is 3 kg/cm2 in the Piperack near Chimney.
18.	Vol-IIA, Sec-III, Annex-1 Sl No. 2 (vi) page 10/14	Fire water terminal point	Please indicate the pressure of the fire water pump (rated) Please provide tentative location of the interconnection for fire water tap offis (hydrant and spray).	Fire water pressure at terminal point is 8 kg/cm2 behind Chimney.
19.	Vol-IIA, Sec-III, Annex-1 Sl No. 2 (iv) page 10/14	Drinking water terminal point	Please clarify the terminal point pressure and approximate location of the interconnection point.	Will be provided during detail engineering
20.	Vol-IIA, Sec-III, Annex-1 Sl No. 2 (v) page 10/14	Treated waste water TP	Please clarify the pressure of water required at the outfall pipe connection.	Available Pressure of sea water in the outfall pipe is 2.5 kg/cm2. Bidder to decide the Terminal point pressure of Treated waste water at outfall pipe connection accordingly.
21.	Vol-IIA, Sec-III, Annex-1 Sl No. B(1) page 12/14	Electrical TP	Please clarify location of the relay panels. It is understood that the existing building has space provision for these panels. Please provide the layout of the existing building where these panels are to be located.	Bidder to visit site to get the required details
22.	Vol-IIA, Sec-III, Annex-	Electrical TP	We understand that these switchboards are in	These switchboards are in the power house

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
	1 Sl No. B(1) page 12/14		the power house building. Please confirm. For the cabling from the switchgear to the FGD plant, the existing cable trays will be used. Please confirm. We understand that the cable trays are already protected by existing fire protection system and Bidder need not consider fire protection system for the same.	building. Additional trays to be provided wherever required. Fire Protection shall be envisaged for the new trays.
23.	Vol-IIA, Sec-III, Annex-1 Sl No. B(3) page 13/14	Earthing	Please provide the existing plant soil resistivity soil report.	Soil resistivity value may be considered as 1.0 Ohm-m for bidding purpose. Actual resistivity shall be measured by successful bidder as specified in Vol-IIG2-PartA/Sec-1, Clause 6.06.00, Page 17 of 26
24.	Vol-IIA, Sec-III, Annex-1 Sl No. D(4) page 14/14	Sewage system connection location	Please clarify location of the terminal point physical location for the sewage connection	Cl 1.00.00/Sec II/Vol II G2/Part A/Page 1 of 14 shall be followed (civil corrigendum sl no 44)
25.	Vol-IIA, Sec-IV, Cl 2.02.00, Page 2/31	Margins	Please clarify the margin either at Design point or guarantee point	Margins mentioned in this clause are the design margins as specified.
26.	Vol-IIA, Sec-IV, Cl 2.02.00, Page 2/31	Booster fan margin	Margin for booster fan capacity is not required, since these margins are already provided with the ID fan, and the booster fan takes suction from the ID fan. As per clause 1.01.00 the capacity is the same as ID fan. For the pressure margin, please note that the 44% margin is not required. A reasonable number would be 10%.	Tender specification prevails
27.	Vol-IIA, Sec-IV, Cl 7.00.00, Page 6/31	DG set	We understand DG sets are provided with acoustic enclosures and are located outdoor. Please confirm	DG sets shall be outdoor .please refer Vol -II- H regarding DG specifications in detail

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
28.	Vol-IIA, Sec-IV, Cl 7.00.00(g), Page 7/31	Pipe and cable rack	Walkway will be provided in the pipe and cable rack in the top tier where cable trays are routed. For pipe tier walkway is not provided. This is as per normal engineering practice.	Tender specification prevails
29.	Vol-IIA, Sec-IV, Cl 7.00.00(n), Page 8/31	Building height	This requirement is not applicable for non plant buildings. This requirement shall not be applicable to electrical and control rooms, cable vault where there is no specific requirement to maintain such height. Also refer clause 3.0 in Sec-IV of the specification.	Tender specification prevails
30.	Vol-IIA, Sec-IV, Cl 7.00.00(o), Page 8/31	Rolling shutter	The requirement for rolling shutter is not mandatory for all builidngs. For example electrical and control rooms. Non plant buildings. This requirement is applicable for process equipment rooms.	Tender specification prevails Cl 4.00.00(11)/Sec IV/Vol II G1/Page 26 of 40 shall be followed
31.	Vol-IIA, Sec-IV, Cl 7.00.00(o), Page 8/31	Staircase	For multistreyed buildings number of staircases will be decided by the NBC regulations, it is not mandatory to provide 2 staircases for smaller floor areas.	Tender specification prevails
32.	Vol-IIA, Sec-IV, Cl 7.00.00(u), Page 8/31	Fire water pipes in power block area	This clause is not applicable for the FGD package.	Tender specification prevails
33.	Vol-IIA, Sec-IV, Cl 7.00.00(v), Page 8/31	Fire water pipes	Fire water pipes can be routed above such pipes in another tier. Please confirm.	Tender specification prevails

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
34.	Vol-IIA, Sec-IV, Cl 17.01.00, Page 13/31	Effluent water scheme	Please clarify the requirement of zero discharge. The effluents are to be discharged to the outfall pipe as per the specification. Please clarify what is the treatment required for the waste water.	Bidder to refer S. No. 21 of Errata-Mechanical
35.	Vol-IIA, Sec-IV, Cl 17.01.00, Page 13/31	Effluent water scheme	This clause is not clear. Please clarify if the project clearances are awaited. If such new conditions changes the scope of work of the contract, then compliance to such requirement by the Contractor shall be subject to change order for commercial and technical aspects as it will be change in statutory requirement.	Tender specification prevails
36.	Vol-IIA, Sec-IV, Cl 17.02.00 (c), Page 14/31	Noise level	The noise level of 105 dBA shall be applicable for the limestone grinding mills and limestone crusher also. Please accept.	Bidder to refer S. No. 20 of Errata-Mechanical
37.	Vol-IIA, Sec-IV, Cl 17.02.00 (d), Page 14/31	Statutory variations	If there are any future changes in the statutory requriements, it shall be treated as Change in Law and suitable change order or variation order will be required if there is any change to the contract technical conditions.	Tender specification prevails
38.	Vol-IIA, Sec-IV, Annex-II, B 2 (a), Page 21/31	Roads	We under stand that the carriage way width is 7 m and including the shoulders it is 10 m. Please confirm.	Cl 4.03.01/Sec I/Vol II G1/Page 17 of 23 shall be followed and volume II G with subsequent civil corrigendum sl no 6,7&8 shall prevail for all roads
39.	Vol-IIA, Sec-IV, Annex-II, B 2 (b), Page 21/31	Roads	We understand it is 4.5 m carriage way width and including the shoulders it is 7.5. Please confirm.	Cl 4.03.01/Sec I/Vol II G1/Page 17 of 23 shall be followed and volume II G with subsequent civil corrigendum sl no 6,7&8 shall prevail for all

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
				roads
40.	Vol-IIA, Sec-IV, Annex-II, B 2 (c), Page 21/31	Access ways	Please clarify the spec for the access ways. Is this 1600 mm width with 1.2 m shoulders either side.	Cl 4.03.01/Sec I/Vol II G1/Page 17 of 23 shall be followed and volume II G with subsequent civil corrigendum sl no 6,7&8 shall prevail for all roads
41.	Vol-IIA, Sec-IV, Annex-II, 2.19 (2), Page 21/31	Separation distance for transformer	The separating distance and fire protection system will be as per relevant code/standard.	Wherever separation distance is mention in specification, the same to be followed.
42.	Vol-IIA, Sec-IV, Annex-II, 2.19 (4), Page 21/31	Transformer fire protection.	It is proposed to follow the relevant IS standard with respect to the fore protection of transformers. Please confirm.	Tender specification prevails.
43.	Vol-IIA, Sec-IX, Table-3, Sh 3/7	DMCW analysis	Please provide the DMCW analysis.	Bidder to refer Vol-IIA, Sec-IX, Table-III, Page 3 of 7
44.	Vol-IIA, Sec-IX, Table-5 and 6, Sh 5/7, 6/7	DG set fuel	The DG set will utilise HSD (High Speed Diesel) as fuel. Please confirm. LDO or HFO is not used as fuel in the FGD plant.	Tender specification prevails. Bidder to refer Vol. II-H/Section-V, Clause 6.01.08
45.	Vol-IIB, Sec-1, Page 2/57, Cl 3.02.00	Chimney	Please provide the drawing of the proposed wet chimney with height and flue diameter. Please clarify if the proposed chimney is with steel flue or brick flue. Please clarify liner envisaged.	RCC Chimney height is 150 m with Steel flue internally lined with borosilicate blocks. Other details with drawing will be provided during detail engineering.
46.	Vol-IIB, Sec-1, Page 3/57, Cl 3.04.03	Gypsum purity	Gypsum purity will be as per the specification provided in Page 51/57, of Vol IIB, Sec-1. Please confirm.	Bidder's understanding is correct.

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PRE-BID QUERIES

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Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
47.	Vol-IIB, Sec-1, Page 3/57, Cl 3.05.00	Desalinated water tank and pumps	Please clarify location of the desalinated water storage tank. Please clarify the MOC of the storage tank. Please clarify if these pumps are located outdoor. Please clarify if the power supply for these pumps are available at the nearest MCC. Please clarify if the pumps are controlled by local controls or is it envisaged in the desalination plant controls.	Bidder to refer S. No. 38, 39 & 40 of Errata-Mechanical
48.	Vol-IIB, Sec-1, Page 4/57, Cl 4.01.01 a	Existing facilities	Please provide the details, list and approximate quantity of facilities, items to be relocated.	Bidder to visit site to get the required details
49.	Vol-IIB, Sec-1, Page 7/57, Cl 4.03.08	Oxidation air blower	It can be compressors or blowers as per process design.	Tender specification prevails. Bidder to refer Vol-IIB,Sec-1, Clause 5.10.02, Page 26 of 57
50.	Vol-IIB, Sec-1, Page 8/57, Cl 4.05.07c	Self cleaning strainers ACW	Since the makeup is from the process water which is desalinated water, a self cleaning strainer is not required. Basket strainer at suction of the ACW pumps are considered adequate. Please review and confirm.	Tender specification prevails.
51.	Vol-IIB, Sec-1, Page 10/57, Cl 5.01.02	Limestone silos-Liner	Lining thickness of 10 mm is very high. Please review. Typically the lining thickness is 3 or 4 mm. Please provide grade of SS.	Bidder to refer S. No. 22 & 23 of Errata-Mechanical
52.	Vol-IIB, Sec-1, Page 13/57, Cl 5.06.03	Limestone slurry pipes	The 10 mm thickness is very high. Typically 6 mm is provided. Please review and confirm.	Tender specification prevails.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
53.	Vol-IIB, Sec-1, Page 13/57, Cl 5.07.01(i)	Booster fan margin	The fan capacity will be the same as ID fan capacity, separate margin over and above this is not applicable. Please review and confirm. he margin on pressure is not applicable as flow rate margin of 1.2 is not applicable. We request you to consider a reasonable margin of 10% for the pressure.	Tender specification prevails.
54.	Vol-IIB, Sec-1, Page 14/57, Cl 5.07.01(ii)	Chimney	Please clarify if existing chimney will be used or new chimney will be used.	Bidder to refer Vol-IIA, Sec-III, Annexure-I (Terminal points), S. No. 1 & 2
55.	Vol-IIB, Sec-1, Page 16/57, Cl 5.07.03(c)	Ducting	As these ducting are downstream of the dust control equipment like ESP, typically the ducts are designed for 1/10 of duct full of ash. Please review and confirm.	Tender specification prevails.
56.	Vol-IIB, Sec-1, Page 17/57, Cl 5.07.05	Ducting MOC	IS code materials will be used. Please confirm acceptance. Please provide gasket material required, available in India; since the ducting is in the cold side, please clarify type of gasket.	Tender specification prevails.
57.	Vol-IIB, Sec-1, Page 18/57, Cl 5.07.15	Duct design pressure	The design pressure of the ducting is normally +660 mm WC -150 mm WC for the FGD system. Please review.	Tender specification prevails.
58.	Vol-IIB, Sec-1, Page 18/57, Cl 5.07.17	Duct size	Please provide the dimensions of the duct and the drawing.	Bidder to refer attached drawings.
59.	Vol-IIB, Sec-1, Page 24/57, Cl 5.08.03p	Mist eliminator wash	The pressure of washing for mist indicated is very high. Please review.	Bidder to refer S. No. 41 of Errata-Mechanical
60.	Vol-IIB, Sec-1, Page 25/57, Cl 5.08.03s	Mist eliminator spray piping	Please also accept PVC for piping of mist eliminator spray header	Tender specification prevails.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
61.	Vol-IIB, Sec-1, Page 25/57, Cl 5.08.03s	Mist eliminator spray piping	The statement is not clear. Please clarify about the coating mentioned. The mist eliminator spray headers are not exposed to slurry.	Tender specification prevails.
62.	Vol-IIB, Sec-1, Page 29/57, Cl 5.13.10	Hydrocylone lining	The specified lining thickness is very high. Typical thickness is 10-12 mm. Please review.	Bidder to refer S. No. 24 of Errata-Mechanical
63.	Vol-IIB, Sec-1, Page 31/57, Cl 5.17.12	Waste water piping	Please accept CPVC also.	Tender specification prevails.
64.	Vol-IIB, Sec-1, Page 49/57, Annexure-1, 2 (a) (3)	Bulk density	In clause 6.01.00, bulk density of limestone for volume calculation is specified as 900 kg/m3. Please clarify.	Bidder to refer S. No. 11 of Errata-Mechanical
65.	Vol-IIB, Sec-1, Page 50/57, Annexure-1, 3 © (6) (1)	MOC of absorber and oxidation tank	The MOC as per Cl 5.08.03 (e) and (w) are different from those specified here for absorber as well as wet dry interface. Please review and clarify.	Bidder to refer S. No. 26 & 27 of Errata-Mechanical
66.	Vol-IIB, Sec-1, Page 50/57, Annexure-1, 3 d	MOC of outlet duct	The duct material specified in Cl 5.07.12 is in variance with those specified here. Please review and clarify.	Bidder to refer S. No. 25 of Errata-Mechanical
67.	Vol-IIB, Sec-1, Page 52/57, Annexure-1, 5(b)	Gypsum silo	Please clarify requirement of gypsum silo. The gypsum from the dewatering system will be stored in the shed, and no silo is applicable. The scheme enclosed with the tender documents also does not indicate the silo.	Bidder to refer S. No. 28 of Errata-Mechanical
68.	Vol-IIB, Sec-1, Page 53/57, Annexure-1, 8(d)	Flue gas pressure	Please indicate the pressure of flue gas to be considered at the terminal point of the flue gas duct and the new chimney.	Bidder to refer S. No. 42 of Errata-Mechanical
69.	Vol-IIB, Sec-1, Page 53/57, Annexure-1, D (5)(d)	ACW temperature	Since the ACW is flowing through dedicated cooling tower system, the limit on the ACW temperature rise is not applicable. Please confirm.	Tender specification prevails.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
70.	Vol-IIB, Sec-1, Page 54/57, Annexure-1, D (5)(e)	DMCW and ACW	As the DMCW and ACW are both closed circuit dedicated for the FGD the pressure drop limitation is not applicable.	Tender specification prevails.
71.	Vol-IIB, Sec-1, Page 54/57, Annexure-1, D (5)(g)	ACW booster	ACW booster pump is not applicable as separate circuit is provided.	Bidder to refer S. No. 29 of Errata-Mechanical
72.	Vol-IIB, Sec-IV, Page 1/8, Cl 2.02.11	Tank	These tanks are part of the process. They do not handle any saleable product. So certification by Department is not applicable.	Tender specification prevails.
73.	Vol-IIC, Sec-1, Page 3/74, Cl 3.03.06	Dust suppression system	Please clarify location of the dust suppression system. Normally only DE system is provided as it is limestone.	Bidder to refer S. No. 7, 8 & 9 of Errata-Mechanical
74.	Vol-IIC, Sec-1, Page 3/74, Cl 4.01.03	Liner for beams	The liner is normally 12 mm thick. Please review and clarify.	Bidder to refer S. No. 32 of Errata-Mechanical
75.	Vol-IIC, Sec-1, Page 3/74, Cl 4.01.03	Gunniting	The guniting thickness is normally 25 mm. Please review and clarify.	Bidder to refer S. No. 32 of Errata-Mechanical
76.	Vol-IIC, Sec-1, Page 19/74, Cl 5.08.00	Stone picking	Please clarify applicability of the requirement since it is limestone and not ROM coal.	Bidder to refer S. No. 35 of Errata-Mechanical
77.	Vol-IIC, Sec-1, Page 28/74, Cl 6.01.02	Limestone silos	No data available with BMCR design coal. Please provide the data at this condition	Bidder to refer “Design point condition” Vol-IIB, Section-1, Annexure-I, Page 48 of 57
78.	Vol-IID, Sec-1, Page 4/19, Cl 4.01.08	Piping design	This shall not be applicable for non metallic piping such as HDPE, CPVC etc. Please also note that the utility piping such as service water, service air, potable water, instrument air, DMCW, DM water, ACW water which are all part of this FGD package never reaches the temperature of 80 deg C. So we request that the design pressure and temperature as per the process conditions be adopted for each	Tender specification prevails.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
			system.	
79.	Vol-IID, Sec-1, Page 13/19, Annexure-1	Auxiliary steam	Auxiliary steam piping is not applicable for the FGD package. Please clarify.	Bidder's understanding is correct.
80.	Vol-IIH, Sec-1, Annexure-1, Page 23/28	Ammonia compressor building	Please clarify scope, as this ammonia compressor building is not applicable for FGD plant.	Bidder to refer S. No. 36 of Errata-Mechanical
81.	Vol-IIH, Sec-1, Annexure-III, Page 22/22	Elevator electricals	Please note that the elevator manufacturers provide the electrical equipment degree of protection as per their standard practice and it is not possible to obtain vendors who are prepared to modify their standard features for the elevators	Tender specification prevails.
82.	Vol-IIH, Sec-IV, Cl 3.01.02c, Page 3/10	Portable pumps	As this will be a portable pump, the level switches in this case is not applicable.	Bidder to refer S. No. 37 of Errata-Mechanical
83.	Vol-IIH, Sec-IV, Annexure-II, Page 3/10	Submersible pumps	Group B will be submersible pumps and some of the specifications of sump pumps are not applicable here.	Bidder to refer S. No. 37 of Errata-Mechanical
84.	Vol-IIH, Sec-V, 5.07.00, Page 6/30	DG set	Noise enclosure will be provided to meet this noise level.	Tender specification prevails.
85.	Vol-IIH, Sec-VI, 4.01.00 (i), Page 6/30	FPS	Other approvals such as IS TAC, VDS shall also be acceptable. Items like valves in the fire protection system do not carry UL/FM or other such approvals.	Tender specification prevails.
86.	Vol-IIH, Sec-VI, 4.01.00 (vi), Page 2/21	Detector coverage	The coverage of the detectors will be as per the relevant IS standard.	Tender specification prevails.
87.	Vol-IIH, Sec-VI, 4.01.00 (vii), Page 2/21	Fire wall	The provision of the fire wall depends on the layout, and shall be governed by IS/TAC standard.	Tender specification prevails.

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PRE-BID QUERIES

Annexure-III

Sl.NO	Spec Ref & Page No	Subject	Clarification Required Dated 20-05-2019	NLCIL/DCPL /NTPL Reply
88.	Vol-IIH, Sec-VI, 4.01.00 (vii), Page 2/21	Transformer fire protection.	We request that the provision of fire fighting system for the transformers be as per IS 3034 standard.	Tender specification prevails.
89.	Vol-IIH, Sec-VI, 4.01.00 (viii), Page 4/21	Cable vault	Spark detectors for the cable vault/cable cellar is not required. Please review. The zoning of the cable cellar will be through the fire protection system, fire barrier walls are not considered in the cable cellar/cable vault.	Tender specification prevails.
90.	Vol-II(I), Sec -1, page 1/11, Cl 2.01.00	Split AC units	Air cooled non ductable Split AC units are standard units, and will be as per OEM standards. Please accept the same. Some of the features of the machine may not exactly match with those mentioned in the specification.	Tender specification prevails.
91.	Vol-II(I), Sec -1, page 2/11, Cl 2.03.01	Split AC units	Split AC units are standard units, and will be as per OEM standards. Please accept the same. The drive motors are part of the integral unit and will follow the OEM standards.	Tender specification prevails.
92.	Vol-II(I), Sec -1, page 4/11, Cl 4.03.00	Split AC units-RH	The split AC units do not provision for control of RH. Hence this provision shall not be applicable.	Clause 4.03.00, page 4 of 11 of Vol-II-I/ Section-I “ Relative humidity: Not exceeding 65%” stands “Deleted”

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Name of the Bidder: Star Thermal

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
	0009H-Vol-II-A LEAD SPECIFICATION				
1	Section - III VOLUME: II-A	Clause 1.2.4 page 2 of 14	Process Water Storage & Pumping System	Please clarify on the power distribution for this system, since the detail is not clear in Tender SLD.	Bidder to design and connect suitably to required voltage level swichboard.
2	Section - III VOLUME: II-A	Clause 1.2.5 page 2 of 14	Waste Water collection and Treatment Effluent Reuse System	Please clarify on the power distribution for this system, since the detail is not clear in Tender SLD.	Refer reply to Sl.No.1 above
3	Section - III VOLUME: II-A	Clause 1.5.0 - b page 5 of 14	Scope - Complete electrical equipment - 220 / 11.5 / 11.5/ 11KV, 63 / 31.5 / 31.5 MVA FGD Station Transformer	Scope of 220kV Switchyard Bay Equipments for FGD Station Transformer shall be clarified.	Refer Cl:5.06.00 of Vol-II-F/Section-I & Cl:3.12.00 of Section-XIX Station Transformer
4	Section - III VOLUME: II-A	Clause 4.0.0 - B page 12 of 14	Terminal Points - Sl. No. 1 - 11 KV Power and control supply - Scope of - FGD Bidder - Incomer-2: (From 220 / 11.5 / 11.5/ 11KV, 63 / 31.5 / 31.5 MVA FGD Station Transformer).	Scope of 220kV Switchyard Bay Equipments for FGD Station Transformer shall be clarified, with respect to Clause 1.5.0 - b.	Refer Sl.No.3 above

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
	0009H-Vol-II-F - GENERAL ELECTRICAL SPECIFICATION				
1	SECTION-I VOLUME: II-F	Clause 5.06.00 to 5.09.00 page 14 of 45 to page 17 of 45	Source of power supply to FGD plant - The power supply to the auxiliaries of the FGD plant shall be arranged from Owner's existing 220KV switchyard spare Line bay (Bay no. 207) which will be modified for Transformer bay (Fully equipped up to SF6 to Air Bushing)	Scope of 220kV Switchyard Bay Equipments for FGD Station Transformer shall be clarified.	Refer Sl.No.3 of 0009H-Vol-II-A LEAD SPECIFICATION
2	SECTION-I VOLUME: II-F	5.19.07 page 21 of 45	The maximum rating of the transformer shall be limited to 2.5MVA	The fault rating of LV Switchgear is limited to 50kA. If 2.5MVA capacity is utilized, please clarify whether the % impedance of the transformer can be increased suitably or the fault rating can be considered at actuals for the impedance as per standards.	Tender Condition Prevails. Bidder to confirm compliance to the Technical specification.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
3	SECTION-I VOLUME: II-F	5.26.1-b page 26 of 45	For sizing of 11 kV incoming cable to FGD Switchgear from Station Transformer bidder shall consider the full load current of the 32/16/16MVA Station Transformer as current carrying capacity of the cable.	Please clarify on the 32/16/16MVA Station Transformer, since FGD Unit will be fed from 63MVA FGD Station Transformer and exit Unit Switchboard.	Cl:5.26.01, b modified as: "...For sizing of 11 kV incoming cable to FGD Switchgear from Station Transformer bidder shall consider the full load current of the 63 / 31.5 / 31.5 MVA Station Transformer ....
4	Section - I VOLUME: II-A	14.2.1 page 39 of 45	Documents to be submitted with the Bid: -Equipment layouts. -Dimensional general arrangement drawing along with cross-sections for major equipment.	Equipment layouts and Dimensional general arrangement drawing along with cross-sections for major equipment will be submitted during Detail Engineering.	Tender condition prevails
5	SECTION-IV VOLUME: II-F	3.5.7 page 3 of 29	Each 11kV & 3.3kV SWGR Section shall be provided with the followings: (I) 1 no highest motor rating spare feeder. (ii) 1 no lowest motor rating spare feeder (iii) 1 no spare transformer feeder of 2.5MVA rating	In Tender SLD, Spare Transformer Feeders of 1250kVA rating for each transformer is provided. Please clarify on this against this of clause tender specification.	Tender Condition Prevails. Bidder to confirm compliance to the Technical specification.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
	Volume II J - Tender SLD:				
1	- Volume II J	11kV Switchboard Page 15 of 40	2 numbers of Feeder to Desalination Plant indicated is in each Bus Section of 11kV FGD Switchboard.	Power Demand / Load details for Desalination Plant to be furnished.	Each Desalination Plant Feeder - 11/3.45KV, 2.5MVA Tranformer Feeder
2	- Volume II J	11kV Switchboard Page 15 of 40	1 number Feeder to RO Plant is indicated in each Bus Section of 11kV FGD Switchboard.	Power Demand / Load details for RO Plant to be furnished.	Spare Feeder
3	- Volume II J	11kV Switchboard Page 15 of 40	1 number Feeder to existing Station Switchboard is indicated in each Bus Section of 11kV FGD Switchboard.	Power Demand / Load details for each bus section of existing Station Switchboard to be furnished.	Refer Annexure-I Terminal Points, B)Electrical of Vol-II-A/ Section-III
4	- Volume II J	- Page 15 of 40	Waste Water System Feeders	Tender SLD does not indicate Feeders for Waste Water Pumps. Please confirm whether the same is included in existing plant itself or it Shall be fed from Common PCC proposed for FGD system.	Bidder to design and connect suitably to required voltage level swichboard.

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
	Prebid Queries on Mechanical Portion				
	0009H-Vol-II-J DRAWINGS				
1	- Volume II J	Page 11 & 12 of 40		Location or free space available for limestone/Gypsum storage to be informed.	Limestone Storage: Refer Dwg No: 17A14-DWG-M-0002 B Available space for Limestone handling system buildings, Conveyors, Storage shed, FGD control room, Limestone storage silos and Mill building is (129x44)M. Bidder shall optimize the layout accordingly. Bidder shall also refer S. No. 18 of Errata Mechanical Gypsum Storage: Refer Dwg No: 17A14-DWG-M-0002 B Available space for Gypsum dewatering building and Gypsum Storage shed is (44x37) M Bidder shall also refer S. No. 19 of Errata Mechanical

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

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Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
2	- Volume II J	Page 11 & 12 of 40		There is two layout enclosed in the bid. The flue gas connection to the chimney are not followed the same in those two drawings. In one drawing it is connected to old chimney and other drawing it is in new chimney. Please clarify.	Bidder shall refer 17A14-DWG-M-0002B - Proposed Layout for Limestone based FGD plant of Tender specification
3	- Volume II J	Page 11 & 12 of 40		Some of proposed FGD plant equipment's / buildings might be changed and it will be showed in revised FGD plant layout for your approval.	Tender condition prevails
4	- Volume II J	Page 11 & 12 of 40		Please inform the warehouse location	Refer Dwg No: 17A14-DWG-M-0002 B 6A Approx 10000 sq m.
	0009H-Vol-II-C LIME STONE & GYPSUM HAND				
1	Section C Volume II C	Clause 3.01.01 Pg 3 of 105	Limestone of (-) 250 mm size will be received at the Power Station by road trucks from nearby mines and stored in a Limestone storage building.	In general the limestone will be received to site with precrushed due to constraints in transportation and storage perspective. Since the lime stone size to be rechecked and confirmed by NLC. Moreover the belt conveyor not suit for convey (-)250 mm of size lime stone. (As per scheme, up to crusher lime stone to be conveyed by BC-1A).	Tender condition prevails

FGD System Package for 2X500 MW NTPL at Tuticorin

PRE-BID QUERIES

Annexure-III

Sl. No	Section/ Volume	Clause No./ Sheet No.	Specification Requirement	Pre-Bid Clarification	Resolution/ Clarification
	General				
1				Please furnish the below details 1. Soil report 2. Pile cap dimensions at FGD equipments location area 3. Cable tray routing and pipe rack details between station transformer and FGD area to be furnised. 4. Editable copy of Bid documents to be given.	1. Will be furnished seperately 2. DDE based on the design requirements. 3. Bidder to visit site to get the required details 4. Will be provided

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NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
1.			Bidder shall provide one no. common condensate storage tank of capacity 5 m3 complete with associated piping, fittings, valves, pumping system (2x100% of 5 m3/h capacity each), level control, etc for draining of condensate from Chimney and Ducts. Pumped condensate shall be discharged into FGD waste water tanks for further treatment and disposal into the existing ash pond. MOC of Pump Casing and impeller shall be Super duplex Stainless Steel. Shaft and Shaft Sleeves shall be Stainless Steel-410. Material of Piping shall be HDPE.
2.	IIA/Section-III/Ann.-1, Terminal points/S. No. 2 vii)/ 10 of 14	Terminal point	**Items/Description:** Condensate from each Chimney flue (New chimney flue) **Terminal Point:** A single terminal point for each chimney flue at elevation of duct entry into the chimney will be provided by purchaser. **Scope of FGD bidder:** Further piping from terminal point shall be in the scope of bidder.
3.	IIA/1.4/ 31 of 146	The crushers will receive the lumped limestone from the underground reclaim hopper through an arrangement of limestone feed conveyor & bucket elevator. The limestone crushed to proper size will be fed to the limestone day silos by crushed limestone fixed tripper. The day silos in turn will feed the limestone wet ball mill through a volumetric feeder.	The crushers will receive the lumped limestone from the **Surface feeders** through an arrangement of limestone feed conveyor. The limestone crushed to proper size will be fed to the limestone day silos by belt conveyor & bucket elevators. The day silos in turn will feed the limestone wet ball mill through a gravimetric feeder. (Bidder to refer the attached specification for Surface feeder)
4.	Vol II C, Section-I, Page 4 of 105, Clause	Uncrushed limestone will be dozed to the unloading hoppers UH-1,2,3,4 and fed to Conveyor BC-1A	Bidder to consider 3 nos. payloader of minimum bucket capacity of 2.5 cu.m and 3 nos. dozer of minimum blade capacity of 2.5 cu.m (Bidder to refer the attached specification for Payloader and Dozer)

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NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
	3.01.02		
5.	Vol II C, Section-I, Page 6 of 105, Clause 4.02.02	Reversible conveyor in Crusher House	2 nos. Reversible conveyor 2A & 2B (1W+1S)
6.	Vol-IIJ, 17A14-DWG-M-0001A		
7.	Vol II C, Section-I, Page 27 of 74, Clause 5.17.00	**DS & Ventilation System** Suitable Dust Suppression & Ventilation System shall be provided as per details enclosed elsewhere in this specification.	**DE & Ventilation System** Suitable Dust Extraction & Ventilation System shall be provided as per details enclosed elsewhere in this specification.
8.	Vol IIC, Section-I, Page 35 of 74, Clause 7.09.00	**Dust Suppression System** Conveyors / Equipment a. It shall be possible to operate the dust extraction/ dry fog system on to Limestone/ Gypsum stream only when corresponding conveyors/equipment are running with material at spray application points. b. If a running pump/fan trips stand-by pump/fan shall start automatically. It shall be possible to select any of the pumps/fans as auto standby from main FGD control room. c. Pumps/fans shall trip with a time delay, if	**Dust Extraction System** Conveyors / Equipment a. It shall be possible to operate the dust extraction system on to Limestone/ Gypsum stream only when corresponding conveyors/equipment are running with material at spray application points. b. If a running fan trips stand-by fan shall start automatically. It shall be possible to select any of the fans as auto standby from main FGD control room. c. Fans shall trip with a time delay, if discharge valves fail to open. Suitable pressure/flow switch shall be provided to sense this condition.

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NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
		discharge valves fail to open. Suitable pressure/flow switch shall be provided to sense this condition. d. Pumps shall trip in case of low level of water in tank. e. All feeding pumps to tank shall trip in case of high pressure & no flow by pressure switch. f. Motorized inlet valve to Dust Suppression tanks shall close in case of High-High level & open in case of low level. g. Pumps/fans shall be started manually or from PLC. If any of the pumps/fans trip, stand-by pump/fan shall start automatically. It shall be possible to select any of the pumps/fans as auto stand - by. h. Following annunciations shall be provided at local control panel. i. Motor electrical protection operated (Group) ii. Discharge water pressure low (Group) iii. Water level low in tank (Individual) i. Following individual indications shall be provided at local control panel. i. Motor ON/OFF/TRIP ii. Discharge pressure healthy iii. Water level high in tank.	d. Fans shall be started manually or from PLC. If any of the fans trip, stand-by fan shall start automatically. It shall be possible to select any of the fans as auto stand - by. e. Following annunciations shall be provided at local control panel. i. Motor electrical protection operated (Group) f. Following individual indications shall be provided at local control panel. i. Motor ON/OFF/TRIP
9.	Vol IIC, Section-II	**Dust extraction, Dust suppression and service water Systems**	Bidder to refer Revised Vol-IIC, Section-II attached.

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NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

<table>
<tr><th>S. No</th><th>Vol/Chapter/ Clause/ Page</th><th>Existing TS Requirement</th><th>Revised TS Requirement</th></tr>
<tr><td>10.</td><td>Vol-IIA, Sec-II, Clause-6.00.00</td><td>Ash Disposal Area</td><td>This clause stands “Deleted”</td></tr>
<tr><td>11.</td><td>Vol-IIB, Sec-I, Clause-6.01.00</td><td>The bulk density of limestone shall be taken as 950 kg/m3 for all volumetric calculations and for load calculations the same should be considered as 1500 kg/m3.</td><td>The bulk density of limestone shall be taken as 1400 kg/m3 for all volumetric calculations and for load calculations the same should be considered as 1700 kg/m3.</td></tr>
<tr><td>12.</td><td>Vol-IIB, Sec-I, Clause-4.05.07</td><td>2x100 % capacity self-cleaning strainers on the secondary (ACW) side</td><td>2x100 % capacity self-cleaning strainers on the secondary (ACW) side. Size of strainer shall be 1000 micron and Strainer Body shall be constructed of mild steel as per IS: 2062 (tested quality). Strainer wires shall be of stainless steel AISI: 316, 18 BWG, 30 mesh.</td></tr>
<tr><td>13.</td><td>Vol-IIB, Sec-I, S.no.9D, Page 53 of 57</td><td>Roof top mounted cooling tower</td><td>The following items are included in the table<table><tr><td>4) Material of Cooling tower</td><td>FRP construction</td></tr><tr><td>5) Fan & Motor</td><td>Aluminium/FRP bladed Fan with Cast Iron hub with SS hardware</td></tr></table></td></tr>
<tr><td>14.</td><td>Vol-IIB, Sec-III, Annexure-I</td><td>Data specification sheet- Horizontal centrifugal pumps
20 d) Impeller for Pumps handling Clear Water – SS 304</td><td>Data specification sheet- Horizontal centrifugal pumps
20 d) Impeller for Pumps handling Clear Water – CF8M</td></tr>
<tr><td>15.</td><td>Vol-IIB, Sec-I, Clause 5.07.01, xiii)</td><td>Overhang type impeller designs shall not be accepted. Shaft shall be carried in bearings on either side of impeller and shall be independent of casing.</td><td>This clause stands “Deleted”</td></tr>
</table>

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NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
16.	Vol II C, Section-I, Page 4 of 74, Clause 4.04.00	Two (2) Nos. Fixed trippers over the Silos	Two (2) Nos. Reversible conveyors (1W +1S) over the Silos
17.	Vol II C, Section-I, Page 28 of 74, Clause 6.04.01	**Limestone handling system:** The capacity of limestone conveying system shall be sized such that the maximum daily requirement of the plant (2x500MW at BMCR) can be conveyed from unloading hoppers to limestone crushers within twelve (12) hrs.	**Limestone handling system:** The capacity of limestone conveying system shall be sized such that the maximum daily requirement of the plant (2x500MW at BMCR) can be conveyed from unloading hoppers to limestone crushers within twelve (12) hrs. **Rated capacity of all the limestone handling system equipment from Limestone stockyard to Limestone silo shall be minimum 26 TPH or as calculated by the bidder, whichever is higher, taking in to account all the factors mentioned in the Tender specification. Design capacity shall be arrived at considering 10% margin over the rated capacity as per Tender specification.**
18.	Vol II C, Section-I, Page 28 of 74, Clause 6.01.01	The limestone storage shed will be sized for 15 days limestone consumption of both units operating at BMCR with design Coal.	The limestone storage shed will be sized for 15 days limestone consumption of both units operating at BMCR with design Coal. **Maximum Limestone stockpile height shall be 6 m and repose angle shall be 40 degree**
19.	Vol II C, Section-I, Page 28 of 74, Clause 6.01.03	The gypsum storage shed will be sized for 15 days gypsum production of both units operating at BMCR with design Coal.	The gypsum storage shed will be sized for **7 days** gypsum production of both units operating at BMCR with design Coal. **Maximum Gypsum stockpile height shall be 6 m and repose angle shall be 50 degree.**

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FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
20.	Vol-IIB, Section-I, Page 15 of 57, Clause 5.07.01 (xv)	Noise shall be limited to maximum 85 dbA for all equipment (except of 90 dBA for wet balls mill and 95 dBA for limestone crushers) as measured at a distance of 1m and at a height of 1.5 meter	Noise shall be limited to maximum 85 dbA for all equipment (except of **<95 dBA** for wet balls mill and **<102 dBA** for limestone crushers) as measured at a distance of 1m and at a height of 1.5 meter
21.	Vol-IIA, Sec-IV, Cl 17.01.00, Page 13/31	The FGD Plant Equipment & auxiliaries area shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to ensure zero discharge from liquid effluents and other effluents within the limits specified in Environment (Protection) Rules 1986 as amended till date.	The FGD Plant Equipment & auxiliaries area shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to ensure ~~**zero**~~ discharge from liquid effluents and other effluents within the limits specified in Environment (Protection) Rules 1986 as amended till date.
22.	Vol-IIB, Sec-1, Page 10/57, Cl 5.01.02	The storage hopper cones shall be fabricated of carbon steel with a SS lining (10 mm minimum) in the complete cones to ensure reliable discharge of material.	The storage hopper cones shall be fabricated of carbon steel with a **SS304 lining (4 mm minimum)** in the complete cones to ensure reliable discharge of material.
23.	Vol-IIB, Sec-1, Annexure-1 Page 49/57, S. No. 2a) (5 ii)	Complete cone - Carbon steel with SS lining (10 mm thick)	Complete cone - Carbon steel with **SS304 lining (4 mm thick)**
24.	Vol-IIB, Sec-1, Page 29/57, Cl 5.13.10	The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber shall be provided with a minimum lining thickness of 25mm. The liners shall have a minimum wear life of not less than 7000 hrs.	The hydro-cyclone shall be of proven design and shall be provided with replaceable rubber lining. The feed chamber shall be provided with a minimum lining thickness of **12mm**. The liners shall have a minimum wear life of not less than **8000 hrs**.
25.	Vol. – IIB, Section –I,	MOC of outlet duct SS 317 LMN/ Alloy 31, min. 8 mm thick	MOC of outlet duct - Cladded sheet of minimum 2 mm thickness of either Titanium (Grade 2 as per ASME SB265) or C-276 over 8 mm

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Errata - Mechanical

<table>
<tr><th>S. No</th><th>Vol/Chapter/ Clause/ Page</th><th>Existing TS Requirement</th><th>Revised TS Requirement</th></tr>
<tr><td></td><td>Annexure – 1, Page 51 of 57</td><td></td><td>thick (minimum) mild steel base metal.</td></tr>
<tr><td>26.</td><td>Vol. – IIB, Section –I, Annexure – 1, Page 50 of 57</td><td>i) Absorber and oxidation tank - Minimum 7 mm thick carbon steel with 2 mm thick lining / cladding / wall paper of SS 317 LMN / Alloy 31 or 5 mm thick rubber lining.</td><td>Absorber and oxidation tank – Minimum 7 mm thick Carbon steel with minimum 2 mm thick lining/cladding of Alloy 59/ C276.</td></tr>
<tr><td>27.</td><td>Vol. – IIB, Section –I, Annexure – 1, Page 50 of 57</td><td>ii) Wet-dry interface - STEN-1 lined with 4 mm thick Alloy C276 / Alloy 59.</td><td>Wet-dry interface - Solid Alloy 59 or C276 of minimum 6 mm thickness.</td></tr>
<tr><td>28.</td><td>Vol. – IIB, Section –I, Annexure – 1, Page 52 of 57, S. No. 5 b)</td><td><table><tr><td colspan="2">Gypsum Silo</td></tr><tr><td>(1) Numbers</td><td>Two (2) total</td></tr><tr><td>(2) Net capacity, each</td><td>7 days gypsum production of both units operating at BMCR with design Coal</td></tr><tr><td>(3) Bulk density for volume calculation</td><td>950 kg/m^3</td></tr><tr><td>(4) Design code</td><td>IS 9178</td></tr><tr><td>(5) Material</td><td></td></tr></table></td><td><table><tr><td colspan="2">Gypsum Storage Shed</td></tr><tr><td>(1) Numbers</td><td>One (1) total</td></tr><tr><td>(2) Net capacity, each</td><td>7 days gypsum production of both units operating at BMCR with design Coal</td></tr><tr><td>(3) Bulk density for volume calculation</td><td>950 kg/m^3</td></tr><tr><td>(4) “Deleted”</td><td></td></tr><tr><td>(5) “Deleted”</td><td></td></tr></table></td></tr>
</table>

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FLUE GAS DESULPHURIZATION SYSTEM

Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
		i) Shell: Carbon steel, 10 mm thick min. ii) Complete cone: Carbon steel with SS lining (10 mm thick)	
29.	Vol. – IIB, Section –I, Annexure – 1, Page 54 of 57		Wherever “ACW Booster Pump” is specified in the Table, same shall be read as “ACW Pump”
30.	Vol. – IIC, Section –I, Clause 4.01.01	Limestone Storage Building	2 x100% Surface feeders of effective capacity to receive the limestone either from trucks or from front end loaders and convey it further to the downstream belt conveyor system. (Bidder to refer to Specification for Surface feeders attached)
31.	Vol. – IIC, Section –I, Clause 4.01.02	Four (4) nos. RCC Unloading hoppers along with shed and maintenance bays at both ends including erection hatch, staircase, Dust Suppression System, hoists, etc.	This clause stands “Deleted”
32.	Vol. – IIC, Section –I, Clause 4.01.03	50 mm thick guniting on all RCC hopper internal walls. All projection/beam inside unloading hopper shall be provided with 16 thick TISCRAL/SAILMA liners.	This clause stands “Deleted”

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Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
33.	Vol. – IIC, Section –I, Clause 4.01.04	Steel gratings over the unloading hopper of 300mm square openings (Inside-Inside) are to be provided to pass limestone of size below 250 mm.	This clause stands “Deleted”
34.	Vol. – IIC, Section –I, Clause 4.01.05	Four nos. (4) Vibrating feeders, one under each unloading hopper complete with all accessories and Dust Suppression System.	This clause stands “Deleted”
35.	Vol. – IIC, Section –I, Clause 5.08.00	**Stone Picking**	This clause stands “Deleted”
36.	Vol-IIH, Sec-1, Annexure-1, Page 23/28	Ammonia compressor building	This building stands “Deleted”
37.	Vol. II-H/Section-IV, Annexure-I, S. No.5	Limestone unloading area – Group B	Limestone unloading area - Group A
38.	Vol-IIB, Sec-I, Clause 3.05.00, Page 3 of 57	Process water requirement for FGD plant will be drawn from the de-saline water storage tank of the new desalination plant through 2x100% capacity desaline water transfer pumps for FGD Plant and shall be stored in a Process water tank.	Process water requirement for FGD plant will be supplied by Desalination package vendor by desaline water transfer pumps & piping and shall be stored in a Process water tank.
39.	Vol-IIA/Sec-III/Ann.-1, Terminal	**Process water:** **Terminal point:** New Desalination plant storage	**Process water:**

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Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
	points/S. No. 3 vii)/ 10 of 14	area **Scope of FGD Bidder:** From the terminal point to the Process water tank for further distribution within FGD plant. **Remarks:** Isolation valve and counter flange is in bidder's scope. Necessary Welding is also under the bidder's scope. Upstream system of the terminal point shall be in Desalination Package Vendor scope.	**Terminal point:** Near Process water storage tank in FGD area **Scope of FGD Bidder:** From the terminal point to the Process water tank for further distribution within FGD plant. **Remarks:** Isolation valve and counter flange is in bidder's scope. Necessary Welding is also under the bidder's scope. Upstream system of the terminal point including pumps and piping shall be in Desalination Package Vendor scope.
40.	Vol-IIJ, 17A14-DWG-M-0001A	Scope demarcation between Desalination plant package vendor and FGD plant package vendor near Desalination water storage tank	Scope demarcation between Desalination plant package vendor and FGD plant package vendor shifted near Process water storage tank after pumps (Bidder to refer revised drawing)
41.	Vol-IIB, Sec-I, Clause 5.08.03, Page 24 of 57	They shall also be capable of being periodically washed with manual high pressure wash systems (210 kg/cm^2) without damage or failure.	They shall also be capable of being periodically washed with manual high pressure wash systems (3 kg/cm^2) without damage or failure.
42.	Vol-IIB, Sec-I, Ann.1, S. No. 8, Page 53 of 57	Flue gas booster fans	g) Pressure at new Chimney inlet – (+) 25 mmWC
43.	Vol. – IIA, Section –IX, TABLE-VII / Page 7 of 7	Properties of Limestone	Following Notes are included below Vol. – IIA, Section –IX, TABLE-VII / Page 7 of 7 1. Guaranteed parameters (guarantee on limestone consumption, auxiliary power consumption & gypsum purity) shall be based on available (reactive) CaCO3 content of 89% i.e Limestone purity is

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Errata - Mechanical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement
			considered as 89%. The design of flue Gas Desulphurization (FGD) system & auxiliaries shall be based on available (reactive) CaCO3 content of 79% i.e Limestone purity is considered as 79%. 2. For the purpose of volumetric computations of limestone handling & storage system the bulk density of lime stone shall be taken as 1400 kg/m3. However for torque, drive & structural load requirements the density of lime stone shall be taken as 1700 kg/m3.

VOLUME: II-C

SECTION - II

DUST EXTRACTION, AND SERVICE WATER SYSTEMS

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VOLUME – II-C

SECTION - II

DUST EXTRACTION AND SERVICE WATER SYSTEMS

1.00.00 INTRODUCTION

This section presents the system description, design criteria, construction details, performance requirements and scope of supply for the Dust Extraction (DE) and Service Water (SW) systems for limestone and gypsum handling system, which shall cater the need of existing 2 x 500 MW Tuticorin Thermal Power Station at Tuticorin, Tamil Nadu of NLC Tamil Nadu Power Limited (NTPL).

2.00.00 CODES AND STANDARDS

2.01.00 The design, construction and testing of the equipment under Dust Extraction (DE) Suppression and Service Water (SW) systems for Limestone and gypsum Handling Plant shall generally conform to the latest revision of the following Codes / Standards, but not be limited to:

2.01.01 IS-6595 Part-2/: Horizontal Centrifugal pumps for clear, cold and fresh water.

2.01.02 IS-5120/1977: Technical requirements for Rotodynamic special Purpose pumps.

2.01.03 IS-9137/1978: Code for acceptance tests for centrifugal, mixed flow and axial flow pumps - Class 'C'.

2.01.04 Standards of the Hydraulic Institute of USA (1983).

2.01.05 PTC 8.2/1965: Power Test Codes - Centrifugal pumps.

2.01.06 IS-1239 [Part-I & II]: Mild steel tubes, tubular and other wrought steel fittings.

2.01.07 American National Standards (ANSI) on

a) Steel Pipe Flanges and Flanged Fittings (B 16.5)
b) Wrought steel Butt welding fittings (B-16.9).
c) Face to face & end to end dimensions of valves (B-16.10).
d) Steel Fittings S.W. and Threaded (B 16.11).
e) Butt welding ends-Pipe, valves, & fittings (B16.25).
f) Valves – Flanged, Threaded and Welding End (B 16.34).

2.01.08 American Society for Mech. Engineers (ASME)

2.01.09. American Society for Testing & Materials (ASTM)

2.01.10. Bureau of Indian Standards (BIS)

2.01.11. All codes & standards specified elsewhere in this document.

In the event of conflict between Indian and International codes and standards specified above and this specification, the latter shall govern.

3.00.00 **SYSTEM DESCRIPTION**

3.01.00 The equipment for Dust Extraction (DE) and Service Water (SW) systems are required for providing :-

i) Dust extraction system of limestone dust from the dust generation points, such as uncrushed Limestone Stock-pile area, limestone Unloading Hoppers, limestone transfer at Transfer Points, and
ii) Supplying service water to entire Limestone Handling Plant as detailed elsewhere.

3.02.00 Dry type Dust Extraction Systems shall be provided to extract limestone dust-laden air from Crusher House, Limestone silos and Gypsum storage area.

3.03.00 Compressed air required for all DE: Vendor shall arrange the service air requirement for the entire limestone handling plant at required pressure by providing 2x100% compressors, air driers, air receiver, piping with valves etc.

3.04.00 Water supply for Cooling Water for Fluid Coupling, Compressor Cooling and Service water (for floor cleaning of entire FGD plant area) shall be provided by Owner at a single terminal point. A RCC Surge-Cum-Storage tank to be constructed by the Vendor. The Vendor shall lay the make up piping from the Service Water Header. All downstream equipment and piping with valves etc., with RCC on ground or underground/PVC overhead storage tanks, pumps, valves, support, etc. shall be furnished by the Vendor. The Vendor shall clearly indicate in his proposal the normal and maximum quantity of water required by him.

3.05.00 Electric and manual hoists of adequate capacity shall be provided for maintenances of different equipment.

3.06.00 Local control panels are to be provided by Vendor to allow for local operation of the plant. Equipment located in the Power Block area shall operate under all operating conditions from FGD control panel.

4.00.00 **SCOPE OF SUPPLY AND SERVICES**

The scope of the entire Dust Extraction (DE)and Service Water (SW) systems for limestone and gypsum handling system to be supplied, constructed / erected and commissioned shall be as per this Specification. The equipment, detailed in all the sections of the bid documents including Bid drawings, shall be in the scope of the Vendor. The scope of work shall include, but not limited to the following:

4.01.00 Dry type dust extraction unit including:

4.01.01 Centrifugal fan units, each complete with electric drive motor, impeller with straight backward inclined flat blades with casing, supporting structure, pair of slide rails for motor and common base frame, Drive pulley, V-belts, belt guard, vibration isolators, outlet damper and flexible connection with matching flanges.

4.01.02 Sheet metal canopy over motor, damper at all dust extraction points, fan discharge side ducting, 3.15 mm thick stack with drain and bird screen.

4.01.03 Dust outlet with motorized rotary air lock feeder arrangement. Screw conveyor, wherever required, shall be provided.

4.01.04 Dust disposal chute with outlet duct. Mist spray system for feeding the dust back to operating conveyor.

4.01.05 Suitable CO_2 detectors for fire protection in the dust collection hoppers.

4.01.06 Air drier, oil cooler, solenoid valves, timers,etc.

4.01.07 All duct work for DE system consisting of the following as applicable and as required.

i) MS duct work

ii) Suction hoods with rubber apron and manual damper wherever required.

iii) Sealing compound and jointing gaskets

iv) Supply air grilles with volume control dampers.

v) Splitters, manually controlled dampers, guide vanes etc. wherever necessary.

vi) Rain protection cowl with bird screen

4.02.00 Service Water System including:

4.02.01 RCC Surge-Cum-Storage tank

4.02.02 Two (2) Horizontal centrifugal Pumps (one Working and one standby) complete with drive motor, and other accessories like coupling and guard, valves, base frame, starters, pressure gauges at suction & discharge end, foundation bolts etc.

4.02.03 Interconnecting piping work including discharge nozzles, valves, hose pipe, , fittings etc.

4.03.00 Coating and wrapping for buried piping

4.04.00 Supports, structures, hangers etc.

4.05.00 Suitable manual and electrically operated hoists shall be provided at suitable locations to facilitate erection and maintenance. The numbers of hoists shall be so decided that the offset of hoist from CG of any equipment is limited within 500 mm.

4.06.00 Local Control Panels complete with all accessories. There should be selector switches to provide local and auto mode of operation of each system with displaying mimic board.

4.07.00 Supply and installation of all safety guards, platforms, anchor bolts, foundation bolts / plates, sleeves, nuts and inserts to be embedded.

4.08.00 First fill of lubricants till the plant is taken over by Owner.

4.09.00 All tests at works and site as described elsewhere including supply of all equipment and accessories required for the same.

4.10.00 All erection and commissioning work as described elsewhere.

4.11.00 All commissioning and mandatory spare parts required for the plant & equipment under this specification..

4.12.00 All tools and tackle required for the plant & equipment under this specification.

4.13.00 All drawings, documents, manuals etc. as described in various sections of this specification.

4.14.00 All civil and structural and architectural works as specified in relevant volume of this specification.

4.15.00 All electrical, instrumentation & control, civil, structural & architectural works as specified in relevant Volumes.

4.16.00 All items which are not mentioned specifically but are required for safe, reliable and trouble-free operation of the plant and equipments.

5.00.00 **DESIGN AND CONSTRUCTION**

5.01.00 Dry Type Dust Extraction Unit

5.01.01 Dry type dust extraction units consist of bag filters, rotary feeder arrangement, screw conveyor (wherever applicable), discharge chute with flexible duct up to nearest conveyor and bunker, as applicable, supports and supporting structures.

5.01.02 The whole unit shall be constructed with proper supports and supporting structure with maintenance platform, cage ladder and rain protection hood / canopy.

5.01.03 Bag dust collector shall consist of bag filters of hose like structure, contained within a sheet metal chamber, dust collecting hopper, discharge chute with rotary air lock feeder / screw conveyor as specified. Each unit shall include suitably stiffened filter housing of sheet steel, gas inlet gas distribution arrangement, filter bags secured to the housing by clamps, exhaust chamber, supports to provide a minimum clearance of 2 M from floor level (unless otherwise specified), differential pressure gauge / DF switches to measure the pressure drop across the units, etc.

5.01.04 It is preferred to have directly driven rotary feeder.

5.01.05 The casing of bag dust collector shall be fabricated from 8 mm thick MS plate.

5.01.06 Bag filters shall be high ratio type with pulse jet bag cleaning arrangement. Pulse jet cleaning arrangement shall consist of a header for compressed air supply and distribution piping and electrically operated diaphragm type solenoid valve with timer.

5.01.07 Each row of bags will be served by a solenoid valve and each bag shall have a well designed venture. Filter bags secured to the housing by clamps.

5.01.08 An air receiver shall be provided before each filter unit, suitable moisture trap with automatic draining facilities shall be provided in the receiver.

5.01.09 Moreover one air drier, oil separator, carbon filter, pressure regulator shall be provided in the header of compressed air line downstream of the compressed air supply.

5.01.10 The bags shall be manufactured of suitable material, e.g. synthetic fabric of type / trade names such as pole propylene, polyester nylon, teryline, nomex, teflon, glass fibre etc., fire retardant with antistatic properties. The bags shall ensure longer working life for the specified application of the particular filter. The Vendor shall indicate the types of bag materials offered for different application of the bag filters in the plant. The air to cloth ratio of bags filters shall not exceed 90 m^3 per hour per m^2. The bag housing shall have central walkway to have access for attending the bags and solenoid valve for maintenance purpose.

5.01.11 The bags shall preferably be grouped in separate compartment to facilitate bag cleaning. The collector shall have air tight access doors into each bag compartment and each hopper.

5.01.12 Dust feeding arrangement back to conveyor belt should be through a rotary dustless unloader with regulated water mist spray so that dust should be uniformly mixed with water and the mixture would be discharged to the conveyer.

5.01.13 No water spray system shall be adopted where limestone is directly fed to the crusher and silo.

5.02.00 Centrifugal Fan and Axial Flow Fan

5.02.01 The fans shall be capable of withstanding the stresses which may be experienced during normal operation and during over speed testing. All fans shall be suitable for outdoor installation.

5.02.02 All fans shall preferably be designed to operate between 9% and 25% of system throttling line.

5.02.03 All the fan units shall be reasonably noise and vibration free in operation and hence of reasonably low speed. The noise level shall be limited to 85 db at 1 M radius.

5.02.04 Casing for centrifugal fans shall be reasonably leak proof. Casing drains with valves shall be provided where-ever required.

5.02.05 The fan and the drive motor shall be rated for continuous operation.

5.02.06 The fans shall be designed to permit interchangeability of parts and ease of access during inspection, maintenance and repair.

5.02.07 All bearings shall be heavy duty ball and/or roller type capable of withstanding axial and/or radial thrust as the case may be. Self-aligning bearings should be used wherever required. The bearings should have a minimum life of 40,000 hours.

5.02.08 All centrifugal fans shall have adequate arrangement for vibration isolation of minimum 95% efficiency.

5.02.09 The first critical speed of all the fans shall be at least 25% above the rated speed.

5.02.10 The construction features of fans used in dust extraction systemsshallhave following features over and above mentioned.

5.02.11 The centrifugal fans shall have flat backward inclined blades. They shall have single inlet and shall be of single width type. As the dust concentration at the outlet of bag filters will be low, Vendors may also consider offering backward curved bladed fans with high efficiency if blade erosion is not anticipated.

5.02.12 The fans shall be of robust construction. The casing and impeller shall be manufactured of sheets thicker than the thickness used for normal ventilation fans, so that the fans may handle limestone dust laden air.

5.02.13 Fan should be designed for adequate duty keeping a margin in approximately 15% on pressure ratings. Operating speed of the centrifugal fan shall not be more than 1500RPM and velocity at outlet shall not be exceeding 20 M /second.

5.02.14 Material of Construction

The following materials shall be used for the construction of various parts:

a) Centrifugal fan impeller : MS Sheet (IS: 2062)

b)	Axial flow fan impeller	:	Cast Aluminium Alloy (LM-6)
c)	Fan shaft	:	C-45, IS: 1570 or Class-IV, IS: 1875.
d)	Fan scrawl	:	Heavy gauge M.S. (IS: 2062)
e)	Supports, frames & structures	:	M.S. of adequate thickness (IS: 2062)
f)	Dampers: louver type and butterfly type	:	MSof heavy gauge (IS: 2062)
g)	Flexible connections for fan inlet and outlet	:	Rubber impregnated canvas with MS Flanges & Cleats.
h)	`V' Pulleys	:	C.I. Multigrooves (IS: 210, Gr. 20)
i)	`V' Belts	:	Reinforced Rubber of Appropriate Section. Belts should be inmatched set.
j)	Slide rails	:	CI or MS
k)	Connection pieces	:	Galvanized iron according to supplier's design.
l)	Bolts and Nuts	:	As per IS: 1367.
m)	Rain protection cowls andhoods	:	Casing and exhaust hoodsto be hot dip galvanized afterfabrication from M.S. IS:2062
n)	Vibration isolating pad, washers& bushes, if any	:	Hard synthetic rubber of hardness 40 degree shore.

5.03.00 Motor Drives

5.03.01 Centrifugal fans shall be provided with V-belts and sheaves. All belts shall be sized with minimum 1.5 service factor. All V-belt drives shall be equipped with removable guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive. Motor shall conform to separate motor specification enclosed with this specification.

5.03.02 The BHP rating of the motor shall be selected to provide at least 20% margin over the driven equipment BHP including the drive loss. The fan motor shall have 20% margin over limit load and pump motors shall have 20% margin over BHP.

5.03.03 The starting torque characteristic of the motor shall be suitable for the duty desired.

5.03.04 For other details of Motor, refer Electrical Specification, Volume-II F1 & F2.

5.04.00 Ducting

5.04.01 The ducts for conveying dusty air shall be of round shape and of streamline appearance.

5.04.02 The velocity of air in the duct shall be high enough (in the range of 18 to 21 m/second) to transport the suspended dust in the air without deposition in the ducts.

5.04.03 The ducting shall be made of M.S. Sheet of 3.15mm thickness. The duct shall be properly painted.

5.04.04 Duct support shall be provided as per stipulations hereunder:

	Diameter of duct	Spacing of support
i.	Less than 200 mm	Maximum 2.50m
ii.	More than 200 mm	Maximum 3.00m

5.04.05 The duct work shall be properly reinforced to prevent sagging, buckling and vibration. Interior of ducts shall be smooth and free from obstruction.

5.04.06 Flexible connections shall be provided at the duct connections to inlet and discharge of the fans. All flexible connections shall be non-collapsible type and their length shall be kept to a minimum.

5.04.07 Duct supports, wherever required, shall be provided. Hangers and support positions shall be made as per good engineering practices.

5.04.08 Medium pressure ducts for dust extraction shall be welded and shall have flanged joints. Thickness of the flanges shall be minimum 5mm for duct sizes upto and including 500mm. diameter. For duct sizes above 500mm. diameter, the flange thickness shall be minimum 6mm.

5.04.09 All hangers and supports shall have to be approved by the Consultant. Vertical ducts passing through floor slab shall be supported by means of collars constructed of structural steel angles securely fastened about the girth of the duct and resting on the floor slab. The supporting angle shall be fastened to the floor slab with a filler or bitumastic compound inserted in between the horizontal leg of the supporting angle and the floor.

5.04.10 All ducts running on the floor/roof shall be adequately fixed in position by MS Angles. The supporting and fixing arrangement shall be approved by the Owner/Consultant.

5.04.11 All extraction points should have manual dampers for flow balancing. Motorized damper shall be used for isolation of non-operating extraction points. Interlocking of motorized damper with drive motor of main equipment of the stream as approved during detail engineering stage shall be provided.

5.05.00 Supply Air Grilles and Intake Louvers

5.05.01 The supply air grilles shall be provided with two sets of adjustable louvers for desired spread and throw requirement for supply and one set of fixed louvers for exhaust system. The louvers shall be fitted such as to remain in position by friction grip. The grilles shall also have one set of opposed multiple louver damper at the inlet. The material of construction will be 16G MS sheets for frame and 20G MS sheets for louvers. All grilles will be primer coated and finish painted as per specifications.

5.05.02 Intake louvers shall be made of 14G MS sheet constructed with closely spaced vertical spacer members (made out of 6 mm MS plates) to give rigidity. The outer-framework will be of 6mm MS plate or suitable angle iron structure. The whole construction should be galvanised and must give neat appearance.

5.06.00 Dry Filter

5.06.01 The filter media shall be of GI, and shall have an efficiency not less than 85% down to particle size of 10 microns.

5.06.02 The filter media shall be sandwiched in between two galvanised wire netting arrangement in a uniformly corrugated form to increase the surface area.

5.06.03 The filter shall have GI frames of adequate thickness suitable for long use in an industrial plant.

5.06.04 The filters may be in panels of size about 600 x 600 for easy handling them. The filters panels shall be mounted on ladder type angle iron holding frames.

5.06.05 The frames shall be designed strong enough to take the load of double the pressure drop in dirty condition of the filters.

5.06.06 The face velocity across the filter media shall not exceed 2.5m/second. Pressure drop across the filter shall be limited to 12mm WG during clean and 15 mm WG during dirty condition.

5.07.00 Dust Collecting Hood

5.07.01 Centre line of the hoods shall be located at the point of generation of maximum pressure during formation of dust.

5.07.02 The hoods shall be adequately sized to collect all dusty air generated at the point. Velocity in the hood must not be so high as to draw larger size particles unnecessarily and shall be limited to 1.25 - 1.8 m/sec.

5.07.03 The hoods shall be made of MS Plate of adequate thickness not less than 2mm.

5.08.00 Centrifugal Pumps

5.08.01 The Vendor shall supply required numbers of pumps as mentioned and as required for service water system. Capacity and head of pumps shall be selected to take care of service water water requirement of all System of the FGD Plant area.

5.08.02 Each service water distribution pump shall be of horizontally split casing centrifugal type, directly coupled to electric drive motor and mounted on a common base plate.

5.08.03 The design of the shaft shall take into consideration the critical speed which shall be at least 25% above the operating speed.

5.08.04 Pump head capacity characteristic shall be gradually rising from operating to shut off point without any zone of instability.

5.08.05 The pump BHP flow characteristics shall preferably be non-overloading type beyond rated capacity point.

5.08.06 Pump shall be rated for continuous operation.

5.08.07 Operating speed of the pump shall preferably be not more than 1500 RPM.

5.08.08 Material of the pump shall preferably be as follows (all materials shall be of tested quality).

a)	Casing	:	Cast iron, FG-260 as per IS: 210
b)	Impeller & wear rings	:	Bronze conforming to Grade II of IS: 318.
c)	Shaft	:	Carbon steel C-45 as per IS: 1570 or Class-IV, IS: 1875.
d)	Shaft sleeve	:	Bronze

5.08.09 Pumps shall be provided with suitable bearings sized adequately to take the maximum possible unbalance. The bearings should have a minimum life of 40,000 hours.

5.08.10 Pump and drives shall be directly coupled through a flexible coupling. Suitable coupling guard shall be provided for each pump.

5.08.11 Each pump shall be complete with pressure gauge at the suction and discharge end with isolating valves, all integral piping required for sealing, cooling etc.

5.08.12 The rated BHP of the motor shall provide 20% margin over the rated BHP of the pump. For other electrical particulars of the motor the Specification of the Motor (Data Sheet for Motor) attached with the specification shall be referred to.

5.08.13 The design of the pumps shall conform to the relevant IS Codes, Standards of Hydraulic Institute of USA or approved equivalent.

5.09.00 Piping

5.09.01 All water piping shall be conforming to IS: 1239 Part-I (GI) heavy grade or IS: 3589, Class-3 (MS) depending upon pipe size. Up to and including 65 mm diameter pipes will be of GI and higher sizes will be of MS - ERW quality.

5.09.02 The pipes shall be plain end (i.e. suitable for welded connection as far as possible).

5.09.03 Counter-flanges, for connecting to flanges on valves or equipment shall be made up of IS: 2062 or superior and shall preferably be slip-on-type, suitable for welding on the piping.

5.09.04 All bolts and nuts shall be of black hexagonal carbon steel type as per IS: 1363 and with the material and other requirements as per IS: 1367 or equivalent.

5.09.05 For piping of size 80mm. or above bends and fittings, fabricated at site from straight length of piping, would be acceptable. If instead, the Vendor uses the regular type fittings/bends, that shall be as per IS: 1239, Part-II or equivalent.

5.09.06 Spacing and location of hanger shall conform to preferred Engineering Practice. Hangers and supports shall be made of structural steel sections. The design of the hangers and supports shall provide for suitable protection to insulation on the pipes where applicable. All materials for anchoring the hangers with reinforced concrete work or building structural beams and columns shall be furnished by the Vendor.

5.10.00 Valves and Specialties

5.10.01 All valves shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.

5.10.02 Gate/Sluice valves shall be used for isolation of flow in pipe lines and Globe valves shall be used for regulating the flow.

5.10.03 All gate and globe valves of size 80NB and large shall be bolted bonnet, outside screw, rising type with flanged ends and of Cast Iron Body. Valves of size 65NB or less shall be union bonnet, with screwed ends and of SS/CS/FS body.

5.10.04 Gate valves shall be provided with the following as necessary:

i. Hand Wheel

ii. Position indicator

iii. By-pass valve and spur gear reduction unit for larger valves

iv. Draining arrangement

5.10.05 Globe valves shall be provided with contoured plug to have good controllability.

5.10.06 Non-return valves shall be swing check type. These valves will have permanent `arrow' inscription on its body to indicate direction of motion of the fluid. Lift check type will be applicable for 40NB and below sizes.

5.10.07 All valves shall be provided with hand wheels, chain operated, extension spindle and floor stand wherever required so that they can be easily operated either at a lower or higher elevation as the case may be.

5.10.08 Strainer shall be of duplex type and strainers with sizes 40 NB and below shall be Y-type designed with suitable isolation valves so that one filter can be cleaned while the other is in operation. Suitable vent and drain valves shall also be provided. Screen opening area shall be at least four times the pipe cross sectional area. Pressure drop in clean condition shall not exceed 1.5 MWC at full flow.

5.10.09 Material of construction for valves and specialties:

a) Cast Iron Valves:

i) Body and bonnet	:	Cast Iron to IS: 210, Gr. FG-260
ii) Disc for non-return valves	:	Cast Iron to IS: 210, Gr. FG-260
iii) Seating surfaces and rings	:	13% chromium steel.
iv) Hinge pin for non-return valves	:	Stainless steel type AISI-31
v) Stem for gate and globe valves	:	13% chromium steel
vi) Back seat bush	:	13% chromium steel.

b) Steel Valves : below 65 NB

i) Body and bonnet	:	SS/CS/FS
ii) Trim	:	Gun metal to IS: 318, GR.-2

c) Duplex Strainer:

i) Body	:	MS fabricated
ii) Strainer element	:	Stainless steel type AISI-316.
iii) Backwash facility	:	Required

5.11.00 Deleted

6.00.00 **SPECIFIC DESIGN CRITERIA**

6.01.00 Dust Extraction System

6.01.01 The Vendor shall calculate the total air quantity, sizing of the ducting and fans, pressure drop in the ducting, equipment and air outlet etc. based on conveyor

belt speed, width, size of various equipment as per respective specifications enclosed and actual physical parameters of equipment involved. The extraction quantity of various dust extraction points shall be as per recommendation of statutory health organisations.

6.01.02 Dust concentration at Clean Air Discharge should be restricted to 50 mg/Nm^3.

6.01.03 Dust extraction system at Limestone Transfer Houses, Silo and Gypsum storage area shall have motorized line dampers so that it can be connected to either of the feeding conveyors and further conveying systems depending upon which one of the stream is operating. This is also to be achieved by motorized damper. The motorized dampers should have provision for manual operation also.

6.01.04 The stack height should be at least 3.0 m above from the nearest building height. The stack bottom should be provided with an access door for periodical cleaning of collected dust.

6.02.00 Deleted

6.03.00 Deleted

6.04.00 Service water system

6.04.01 Service water network throughout the entire FGD Plant area shall be fed by Service water pumps. 2x100% Capacity Service Water Pumps shall be considered for this purpose separately. The service water will be used for mainly floor washing. One (1) service water tapping point shall be provided to every RCC floor.

6.04.02 Each tapping point for floor washing (Service Water) shall also be provided with one gate valve, hose with suitable length and quick fix connection. Each system shall have gate valve for closing water flow, if necessary, and same shall not be located in the valve pit even if the pipe runs underground. Suitable arrangement is to be made for covering the over ground valves.

6.04.03 Make-up water will be provided by the Owner at one (1) terminal point at 1.0kg/cm^2 in Surge-Cum-Storage tank.

6.04.04 The Vendor shall calculate independently the water requirement and furnish the size of the tanks for review by Owner/Consultant. Tanks shall be complete with float valve, man-hole, vent connection, make-up connection, pump suction connection, over flow connection etc.

6.05.00 All equipment like pumps, motors, PVC water tanks, local control panel and local push button stations etc. installed outdoor shall be provided with rain protection canopy.

6.06.00 The schedule of Dust Extraction are attached as Annexures A.

6.07.00 Performance Guarantee

6.07.01 The Vendor shall guarantee that the equipment / system offered shall meet the ratings and performance requirements to fulfill the stipulated parameters.

6.07.02 Final Acceptance Test of the plant / equipment shall be as per the Contract document.

6.07.03 The guarantees shall be furnished and demonstrated as specified in Section IX of Volume 1B.

7.00.00 **PLANT CONTROL PHILOSOPHY**

7.01.00 The Control system of Dust Extraction systems shall be capable of monitoring, control and operation of the respective system through PLC/DCS.

7.02.00 Process trends, reports, historical data logging shall be achieved in the PLC/DCS with interface of key parameters with main DCS.

7.03.00 Local Control Panels (LCP) shall be provided as applicable for the control and monitoring purpose.

7.04.00 Motorized line dampers in Dust extraction systems at Limestone Transfer Houses, Silo and Gypsum storage area shall be connected to either of the feeding conveyors and further conveying systems depending upon which one of the stream is operating.

7.05.00 The rotary feeders at the outlet of the Bag Filter units shall be interlocked with the drive of the respective fans in such a way that the fan motor cannot be started until and unless rotary feeder is started and it will automatically stop if the DE fan stops.

8.00.00 **INSPECTION AND TESTING**

8.01.00 Dynamic balancing of rotating parts shall be conducted for all centrifugal fans and pumps. The residual unbalance shall be restricted to Grade 6.3, ISO 1940.

8.02.00 Performance testing of fans is an essential requirement. Routine test certificates in case of all equipment except big size centrifugal fan units (consuming more than 15 HP) may be acceptable. For big size fan units, performance testing of at least one fan of each type is to be shown in presence of Owner's representative. This testing may be carried out at reduced speed for minimizing power consumption during testing. All instruments used shall be supplied by the Vendor and shall be calibrated by an acceptable authority.

8.03.00 The manufacturer shall conduct all tests required to ensure that the equipment shall conform to the requirements of the specifications and in compliance with the requirements of applicable codes and standards.

8.04.00 The particulars of the proposed tests and procedures for the tests shall be submitted to the Owner for approval before conducting the tests, as described elsewhere.

8.05.00 All materials castings and forgings shall be of tested quality and certified. All critical forgings/castings shall be examined by suitable non-destructive testing to ensure freedom from harmful internal flaws. Material test certificates shall be furnished.

8.06.00 The Vendor shall prepare a detailed welding procedure as applicable for each combination of joint and welding procedures shall be submitted to the Owner. Procedure review and welding procedure tests, welder and welding operator qualification shall be completed prior to the start of fabrication.

8.07.00 The sub-vendors for castings, forging and fabrication work as applicable shall be subject to prior approval of the Owner.

8.08.00 Centrifugal pumps and fans shall be tested for dynamic balancing, noise and vibration.

8.09.00 Hydraulic leak test as per applicable standard and set air leakage test at 95% of set pressure for valves.

8.10.00 Performance test on fans for capacity, head, efficiency and power consumption as routine test

8.11.00 Performance test on pumps for capacity, head, efficiency and power consumption as routine test

8.12.00 Performance test on Bag filter as routine and type test including inlet/outlet dust concentration and efficiency

8.13.00 Test certificates and reports shall be made available to the Owner for approval. The material shall be dispatched to site only after such approval.

8.14.00 The Vendor shall inform the Owner prior to all shop tests with sufficient notice so that if the Owner so desires, he can witness the tests.

8.15.00 All pipes and fittings shall be tested hydrostatically to test pressure as per applicable codes and piping material specification.

8.16.00 Hydrostatic test on the pump casing at one and a half times of the shut-off head value or two times the rated head, whichever is higher. This test shall be conducted for a minimum duration of 30 minutes.

8.17.00 Routine tests and type tests as per IS: 3588 for all axial flow fans shall be carried out.

8.18.00 Shop test to establish the pressure drop value in the water flooded nylon filter shall be conducted.

8.19.00 All equipment/system shall be subject to site testing also to Owner's satisfaction. Any defective part shall be repaired/replaced till the desired performance is obtained without any extra price.

8.20.00 Field Test and Performance Test

8.20.01 For inspection procedure and all other details like guarantee etc. please refer the relevant part of the specification.

8.20.02 Capacity test of one fan of each type shall be made at site. In case any fan does not meet the desired performance requirement, all fans of that type shall be tested.

8.20.03 Also the Vendor shall arrange for any modification/ replacement of the defective equipment or systems which fall short of the performance requirement at site. Additional testing required to show the effectiveness of such modifications shall be performed by the Vendor.

8.20.04 All tests and inspection shall have to be carried out upto full satisfaction of the Owner.

8.20.05 After erection at site, the equipment shall be operated at site to show satisfactory performance, as required by the applicable clause of this specification.

8.20.06 Field test shall be performed to indicate freedom from vibration, noise, unbalance, leakage, satisfactory operation of all interlocks for each individual equipment for complete systems and to establish the design performance of equipment and systems, viz. guaranteed air flow rate of each supply air grille, guaranteed air-extraction rate at each DE hood, guaranteed dust concentration at each stack of DE systems, guaranteed water flow rate and throw for each nozzle etc. The Vendor shall also carry out the balancing of air flow/water flow in all branches to obtain the desired flow rate at all points. Vendor shall submit the procedure of field test for various systems, for Owner's approval.

8.20.07 All instruments used for the field test shall be supplied by the Vendor.

8.21.00 Test Records

The certificates and records of these tests shall be submitted for Owner's approval. The Vendor shall maintain records of all tests conducted as per specification requirement for at least five (5) years. A list of records shall be submitted to the Owner on completion of the job. The Owner shall be able to obtain certified copies of such records at any time, within the five year period.

9.00.00 DRAWING, DATA AND INFORMATION REQUIRED

9.01.00 Technical Data & Information to be submitted by Bidder with Proposal

9.01.01 Preliminary Schematic flow diagrams for all the systems indicating clearly the scope and limits of supply

9.01.02 Preliminary Layout drawings showing the route of water piping

9.01.03 Utility requirements (normal and peak)

9.01.04 Manufacturer's catalogue

9.01.05 Proposal Data sheets duly filled-up

9.02.00 Technical Data & Information to be submitted by Vendor during Contract Stage:

The Vendor shall submit various drawings and data strictly as per agreed Master Drawing Submission schedule, for review & approval of Owner/Consultant and afterwards for final distribution. The various drawings and data to be furnished shall include but be not limited to the following:

9.02.01 Final version of Proposal Data sheets.

9.02.02 Design basis calculations to establish the equipment selection and duct/pipe size for various DE systems. Pressure drops calculation for the ducting and piping layout.

9.02.03 General arrangement, cross sectional view and technical particulars with performance curve for the following equipment:

a. Dry type bag filter.
b. Centrifugal fan.
c. Axial flow fan.
d. Unitary air filtration unit with internal details.
e. Centrifugal pump.
f. Electric motor
g. Supply air grilles
h. Nozzles
i. Local control panels for DE systems.
j. Any other equipment/accessories as required by the Consultant.

9.02.04 Foundation plan with load data for all equipment

9.02.05 Schematic flow diagram for the complete systems indicating clearly the scope and limits of supply

9.02.06 Layout drawings showing the route of water piping

9.02.07 Ducting and piping layout drawings including details of dimensions, joints, supports, DE hoods, supply air grilles, valve details, nozzles etc

9.02.08 Write-up on control and interlock scheme with schematic wiring diagram for the control panel and systems as applicable.

9.02.09 Shop test certificates and test reports.

9.02.10 Material test certificates

9.02.11 List of recommended spare parts for three years trouble free operation.

9.02.12 Instruction sheets for calibration and checking balancing alignment adjustments.

9.02.13 Write-up on performance test arrangement for various systems

9.02.14 Performance test certificates and test records.

9.02.15 Operation, maintenance and installation manuals for all equipment as mentioned elsewhere.

`ANNEXURE-C

SCHEDULE OF DUST EXTRACTION SYSTEM

SL. NO.	EQUIPMENT / SYSTEM TAG	FUNCTION / LOCATION	CAPACITY (m^3/Hour) EACH	FAN STATIC PRESSURE mm of WG	TYPE	NO. REQD.	ACCESSORIES
1	DE-1	All Limestone Feed Points in Crusher House for Conveyor 1A/ 2B.	To be decided by Vendor	To meet the System requirement	Dry	1	Bag filter with accessories, dust collecting hopper, supporting structure, solenoid valves, timers, ventures, air drier, oil separator etc. and Centrifugal fan unit with drive motor, manually operated volume control damper, DE duct, split draw band type flexible connection at fan inlet and outlet, suction hood, with volume control damper, motorized damper for stream selection, dust fed back system with drive rotary feeder & screw conveyor as required, stack with support and supporting structure, vibration isolator, hangers and grouting bolts etc.
2	DE-2	All Limestone Discharge Points of Silos.	To be decided by Vendor	To meet the System requirement	Dry	1	-Do-
2	DE-3	Gypsum storage area	To be decided by Vendor	To meet the System requirement	Dry	1	-Do-

NOTE:

1. Design Parameters of the respective Systems shall be as per calculation done by the Vendor during detail engineering, which is subject to Owner's approval.

TECHNICAL SPECIFICATION
FOR
PAY LOADER

1.00.00 Machine shall be suitable for removal of oversize pieces of hale/sandstone/other extraneous material from bar grid at tippler hopper. These M/c shall also be for housekeeping/limestone/ gypsum dosing etc.

Two (2) self-propelled Pay loader (Tyre Mounted) shall be provided with a minimum power 113 kw (152hp) (SAE-GROSS) / (Min.) 2.5 m^3 bucket capacity, SAE Rated (nominal heaped). Each Pay loader shall be equipped with all the necessary components and controls to provide a complete and independent unit as specified herein and as delivered to the project. Each Pay loader shall be fully assembled and ready for production when delivered, bucket mounted; fuel tank full of fuel; coolant system filled with heater/engine coolant; and crankcase, transmission, differential and final drives (each), hydraulic system, and windshield washer reservoirs filled.

Each Pay loader shall have a rollover protective structure (ROPS) which meets SAE / ISO standards.

Each cab shall meet requirements for operator sound exposure limits when tested according to ANSI / SAE J732. Each cab shall be sound suppressed and have an air conditioner. Each cab shall include an adjustable suspension seat, seat cover, and seat belt; tilt steering wheel; air filter; rear view mirrors; and front and rear windshield washer and wiper.

Each Pay loader shall have the following or equivalent equipment:

Lighted instrument panel: Monitoring systems for alternator charging and voltmeter; fuel level and pressure; transmission oil temperature and filter service; coolant flow and temperature; pilot system filter service; hydraulic oil level, temperature, and filter system service; engine oil level, temperature, and pressure, air cleaner service; brake oil pressure and parking brake application; and clock hour meter. Monitoring systems can include lighted gauges and/or electronic monitoring system with warning horn.
Vandalism protection group, cap locks, and key start.
Muffler
Safety glass in windshield
Backup alarm
Warning horn
50 amp alternator and heavy-duty batteries
Lighting system, six forward lights, two rear mounted lights, and rear mounted stop lights. Electrical diagnostic connector and diagnostic tool.
Fast oil change system
Fast fuel system
Fire suppression
Draw bar
Front counterweight
Power shift transmission
Supplemental steering
Guards on power train
Heavy-duty crankcase guard.

Tool kit
Multiple row module radiator
All other standard equipment

2.00.00 TECHNICAL DATA SHEET OF PAY LOADER

Engine	:	Diesel Engine
Quantity	:	Two (2) Nos.
Type	:	Self-propelled Pay loader (Tyre Mounted)
FHP (Min.)	:	152
Bucket capacity (Minimum)	:	2.5 m^3
Operating capacity	:	To suit the requirement
Turning radius	:	To suit the requirement
Operating weight	:	As per manufacturer standard
Dumping height	:	To suit the requirement
Total cycle time	:	As per manufacturer standard

All tests as per manufacturer's standards.

Note :

Pay loader shall be complete with all accessories. Bidder to indicate the accessories considered by him in the offer.

3.00.00 PAINTS AND PROTECTION

a) All machinery, equipment, piping etc. shall receive surface preparation and painting according to the following general guideline. This specification does not relieve the Contractor from supplying any other special paints or coatings where special local conditions require such.

b) All steel surfaces shall be free from all mill scales, rusts, oil, grease or any foreign matters.

c) Dry sand blasting procedure shall be preferred. The abrasive shall be chroride free siliceous sand (marine sand excluded). The compressed air used for blasting shall be free from detrimental amount of water and oil. Suitable separator and traps shall be provided for the purpose.

d) Surface preparation by cleaning of rust or mill scale by using wire brush, carborandum tips etc. shall only be allowed with prior approval from the purchaser.

e) All welded areas shall be given special attention for removal or welding flux in crevices.

f) The paint manufacturer's recommendation, if any, shall be strictly followed during surface preparation.

g) The paint manufacturer's instructions regarding thinning, mixing, method of application, handling and drying time shall be strictly followed and considered a part of this specification.

h) The Brand, application procedure, etc. shall be subject to the Purchaser's / Owner's approval.

The colour scheme for the entire plant equipment and piping shall be got approved by the Contractor from the Purchaser / Owner before application of paint.

General compatibility between primer and finishing paint shall be certified by the paint manufacturers supplying these paints.

i) Two (2) coats of epoxy resin based zinc rich primer compatible with subsequent finish coats shall be applied.

j) Two (2) coats of epoxy glossy enamel paint of colour, to be mutually determined, shall be applied.

k) The dry film thickness per coat of applied paints shall not be less than the following limits:

Primers : 35 microns

Finish Paints : 40 microns

Structures / equipment shall receive one coat of primer paint immediately after fabrication at shop after appropriate surface preparation followed by spot priming.

l) The paints shall be applied as per recommendation of the paint manufacturer and as may be approved by the Purchaser / Owner. The brand, application procedure and compatibility between primer and finishing paint shall be certified by the paint manufacturer.

m) It is preferable to use peel able paints, adhesive tapes, punched metal sheets on the equipment for identification.

n) All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against insect and corrosion, fungus. Screens shall be furnished on all ventilating louvers to prevent entrance of insect.

o) The following inspection and testing shall be performed during and on completion of painting at the discretion of the Purchaser / Owner:

i) Checking of Dry Film thickness by suitable non-destructive thickness Gauge. The painting will be rejected if any of the spot measurement shows thickness to be less than 80% of the specified thickness.

ii) Visual inspection of appearance and uniformity of the surface painted.

If during inspection, defects are observed, the Contractor shall carryout rectification, at his own cost, to bring the faulty surface to the acceptable degree.

TECHNICAL SPECIFICATION
FOR
BULLDOZER

1.00.00 Three (3) self - propelled crawler dozers shall be provided with a minimum of Net Power 242 kW (324HP) (ISO: 9249). Each dozer shall be equipped with all the necessary components and controls to provide a complete and independent unit as specified herein and as delivered to the Project. Each dozer shall be fully assembled and ready for production when delivered, blade mounted; fuel tank full of fuel; coolant system filled with heater/ engine coolant; and crankcase, transmission, differential and final drives (each), hydraulic system and windshield washer reservoirs filled.

Each dozer shall have a rollover protective structure (ROPS) which meets SAE / ISO standards. Each cab shall meet requirements for operator sound exposure limits when tested according to ANSI/ SAE J116. Each cab shall be sound suppressed and have an air conditioner. Each cab shall include an adjustable suspension seat, seat cover, and seat belt; tilt steering wheel; air filter; rear view mirrors; and front and rear windshield washer and wiper.

Each Machine shall be provided with matching Limestone Blade for stockpile management. Further one earth blade shall also be supplied for each machine.

Each dozer shall have the following or equivalent equipment:

Lighted instrument panel: Monitoring systems for alternator charging and voltmeter; fuel level and pressure; transmission oil temperature and filter service; coolant flow and temperature; pilot system filter service; hydraulic oil level, temperature, and filter system service; engine oil level, temperature and pressure, air cleaner service; brake oil pressure and parking brake application; and clock hour meter. Monitoring systems can include lighted gauges and/ or electronic monitoring system with warning horn.

Vandalism protection group, cap locks, and key start.
Muffler & Safety glass in windshield
Backup alarm & Warning horn
50 amp alternator and heavy-duty batteries
Lighting system, six forward lights, two rear mounted lights and rear mounted stop lights Electrical diagnostic connector and diagnostic tool
Fast oil change system & Fast fuel system
Fire suppression, Draw bar & Front counterweight & Power shift transmission
Supplemental steering & Guards on power train & Heavy-duty crankcase guard Tool kit
Multiple row module radiator
All other standard equipment

2.00.00 TECHNICAL DATA SHEET OF BULL DOZER

Nos. Required	:	Three (3)
Type	:	Diesel Engine Driven Self-propelled crawler type
Handling Material	:	Limestone/ Gypsum
Condition of Grade	:	Generally levelled
Theoretical Capacity of blade	:	2.5 m^3
No. of speed steps	:	Forward : not less than three (3) Reverse : not less than three (3)
Engine rating (BHP)	:	Not less than 242 KW (324 H.P.)
Transmission type	:	"Torque flow"
Driver/operator's cabin	:	ROPS which meets SAE/ISO standards
All Standard Control & monitoring features	:	As per manufacturer's recommendation
Dust Seal	:	To be provided.
Pilot operated hydraulic system for fine blade control	:	Through joystick
All Standard accessories	:	As per manufacturer's recommendation
All special accessories	:	As per manufacturer's recommendation

All tests as per manufacturer's standards.

Note :

Bull dozer shall be complete with all accessories. Bidder to indicate the accessories considered by him in the offer.

3.00.00 **PAINTS AND PROTECTION**

a) All machinery, equipment, piping etc. shall receive surface preparation and painting according to the following general guideline. This specification does not relieve the Contractor from supplying any other special paints or coatings where special local conditions require such.

b) All steel surfaces shall be free from all mill scales, rusts, oil, grease or any foreign matters.

c) Dry sand blasting procedure shall be preferred. The abrasive shall be chroride free siliceous sand (marine sand excluded). The compressed air used for blasting shall be free from detrimental amount of water and oil. Suitable separator and traps shall be provided for the purpose.

d) Surface preparation by cleaning of rust or mill scale by using wire brush, carborandum tips etc. shall only be allowed with prior approval from the purchaser.

e) All welded areas shall be given special attention for removal or welding flux in crevices.

f) The paint manufacturer's recommendation, if any, shall be strictly followed during surface preparation.

g) The paint manufacturer's instructions regarding thinning, mixing, method of application, handling and drying time shall be strictly followed and considered a part of this specification.

h) The Brand, application procedure, etc. shall be subject to the Purchaser's / Owner's approval.

The colour scheme for the entire plant equipment and piping shall be got approved by the Contractor from the Purchaser / Owner before application of paint.

General compatibility between primer and finishing paint shall be certified by the paint manufacturers supplying these paints.

i) Two (2) coats of epoxy resin based zinc rich primer compatible with subsequent finish coats shall be applied.

j) Two (2) coats of epoxy glossy enamel paint of colour, to be mutually determined, shall be applied.

k) The dry film thickness per coat of applied paints shall not be less than the following limits:

Primers : 35 microns

Finish Paints : 40 microns

Structures / equipment shall receive one coat of primer paint immediately after fabrication at shop after appropriate surface preparation followed by spot priming.

l) The paints shall be applied as per recommendation of the paint manufacturer and as may be approved by the Purchaser / Owner. The brand, application procedure and compatibility between primer and finishing paint shall be certified by the paint manufacturer.

m) It is preferable to use peel able paints, adhesive tapes, punched metal sheets on the equipment for identification.

n) All electrical equipment, accessories and wiring shall have fungus protection involving special treatment of insulation and metal against insect and corrosion, fungus. Screens shall be furnished on all ventilating louvers to prevent entrance of insect.

o) The following inspection and testing shall be performed during and on completion of painting at the discretion of the Purchaser / Owner:

   i) Checking of Dry Film thickness by suitable non-destructive thickness Gauge. The painting will be rejected if any of the spot measurement shows thickness to be less than 80% of the specified thickness.

   ii) Visual inspection of appearance and uniformity of the surface painted.

   If during inspection, defects are observed, the Contractor shall carryout rectification, at his own cost, to bring the faulty surface to the acceptable degree.

DWG. NO. 17A14-DWG-M-0001A REV 1

SL. No.	ABBREVIATION
UH	UNDERGROUND HOPPER
VF	VIBRATING FEEDER
BS	BELT SCALE
SM	SUSPENDED MAGNET
ILMS	INLINE MAGNETIC SEPERATOR
MD	METAL DITECTOR
BC	BELT CONVEYOR
PH	PENT HOUSE
RG	ROD GATE
RPG	RACK & PINION GATE
CR	CRUSHER
CH	CRUSHER HOUSE
BF	BELT FEEDER
BE	BUCKET ELEVATOR

LIMESTONE STORAGE BUILDING
UH-1
UH-2
UH-3
UH-4
VF-1
VF-2
VF-3
VF-4
UNLOADING HOPPER (4 NOS.)
BS-1A
SM-1A
ILMS-1A
MD-1A
BC-1A
BS-1B
SM-1B
ILMS-1B
MD-1B
BC-1B
PENT HOUSE PH-1
RG-1
RPG-1
CR-1
RG-2
RPG-2
CR-2
LIME CRUSHER HOUSE (CH-1)
ILMS-2A
ILMS-2B
BF-1
BF-2
BE-1A
BE-1B
BUCKET ELEVATOR (2 NOS.)
BELT WEIGH FEEDER-2
BELT WEIGH FEEDER-1
REVERSIBLE BELT CONVEYOR
REVERSIBLE BELT CONVEYOR
LIMESTONE SILO 1
LIMESTONE SILO 2
WEIGHT BELT FEEDER - A
WEIGHT BELT FEEDER - B
REVERSIBLE BELT CONVEYOR 2
EXISTING NEW SERVICE WATER
TO NEAREST SETTLING PIT
FGD PACKAGE
CHIMNEY PACKAGE
FGD PACKAGE
NEW WET STACK
SUMP PUMP (1W+1S)
SUMP PIT
DESALINE WATER STORAGE TANK
DESALINE WATER TRANSFER PUMP (1W+1S)
FGD PLANT PACKAGE VENDOR
DESALINATION PLANT PACKAGE VENDOR
PROCESS WATER TANK
FLUE GAS QUENCHING PUMP (1W+1S)
FOR FLUE GAS QUENCHING SYSTEM
MIST ELIMINTOR WATER PUMP (1W+1S)
PROCESS WATER PUMP (1W+1S)
MAKE-UP WATER FOR FDG PLANT EQUIPMENT COOLING SYSTEM (AT ROOF TOP COOLING TOWER BASIN)
FOR FLUSHING SYSTEM HEADER & OTHER PROCESS NEEDS
EMERGENCY MAKE-UP TANK
FROM PROCESS WATER SYSTEM
MIST ELIMINATOR
EMERGENCY COOLING
ABSORBER-I
EXISTING STACK
BYPASS GAS DAMPER
EXISTING NEW
NEW EXISTING
EXISTING NEW
UNIT#1
ID FAN B
ID FAN A
BOOSTER FAN B
BOOSTER FAN A
OXIDATION AIR COMPRESSORS (1W+1S)
EMERGENCY COOLING
OXIDATION TANK
AGITATOR (2W+1S)
ABSORBER RECIRCULATION PUMP (1W+1S) FOR EACH LEVEL
GYPSUM BLEED PUMP (1W+1S)
ABSORBER DRAIN PIT
ABSORBER DRAIN PIT PUMP (1W+1S)
LIMESTONE SLURRY STORAGE TANK-1 (12 HRS. STORAGE)
LIMESTONE SLURRY DISTRIBUTION PUMP (1W+1S)
LIMESTONE SLURRY DISTRIBUTION PUMP (1W+1S)
LIMESTONE SLURRY STORAGE TANK-2 (12 HRS. STORAGE)
WASTE WATER TREATMENT
WASTE WATER BUFFER TANK
WASTE WATER DISPOSAL PUMP
NEW EXISTING TO OUTFALL PIPE
WASTE WATER COLLECTION TANK (8 HRS. HOLDING CAPACITY)
GYPSUM HYDROCYCLONE
SECONDARY HYDRO-CYCLONE FEED TANK
WASTE WATER HYDROCYCLONE
WASTE WATER HYDROCYCLONE FEEDING PUMP (1W+1S)
GYPSUM HYDROCYCLONE
LIMESTONE SLURRY CYCLONE 1
WET BALL MILL 1
LIMESTONE SLURRY CIRCULATION PUMP (1W+1S)
LIMESTONE SLURRY CIRCULATION TANK 1
LIMESTONE SLURRY CYCLONE 2
WET BALL MILL 2
LIMESTONE SLURRY CIRCULATION TANK 2
LIMESTONE SLURRY CIRCULATION PUMP (1W+1S)
LIMESTONE PREPARATION DRAIN PIT PUMP (1W+1S)
LIMESTONE SLURRY PREPARATION AREA DRAIN PIT
LIMESTONE PREPARATION SYSTEM
VACUUM BELT FILTER 1
CAKE WASH PUMP 1 (1W+1S)
WATER SEPARATOR 1
VACUUM RECEIVER 1
VACUUM PUMP 1
CLOTH WASH PUMP 1 (1W+1S)
FILTRATE PUMP 1 (1W+1S)
VACUUM BELT FILTER 2
CAKE WASH PUMP 2 (1W+1S)
WATER SEPARATOR 2
VACUUM RECEIVER 2
VACUUM PUMP 2
FILTRATE PUMP 2 (1W+1S)
CLOTH WASH PUMP 2 (1W+1S)
CONV-3A
CONV-3B
GYPSUM STORAGE AREA
FILTRATE WATER PUMP (2W+1S)
FILTRATE TANK
GYPSUM DEWATERING DRAIN PIT
GYPSUM DEWATERING PUMP (1W+1S)
GYPSUM DEWATERING SYSTEM
SEAL AIR DISTRIBUTION FOR GUILLOTINE TYPE GATES AT ABSORBER OUTLET & MULTI LOUVER TYPE BY-PASS DAMPER
SEAL AIR FAN (1W+1S)
SEAL AIR DISTRIBUTION FOR GUILLOTINE TYPE GATES AT INLET OF BOOSTER FANS
SEAL AIR FAN (1W+1S)
SEAL AIR DISTRIBUTION FOR GUILLOTINE TYPE GATES AT OUTLET OF BOOSTER FANS
SEAL AIR FAN (1W+1S)
TYPICAL SEAL AIR DISTRIBUTION SYSTEM FOR EACH UNIT
EXISTING NEW SERVICE WATER
DRINKING WATER
INSTRUMENT AIR
SERVICE AIR
DMCW IN
DMCW OUT
AUXILIARY STEAM
DISTRIBUTION POINTS
EMERGENCY SLURRY PUMP (1W+1S)
AGITATOR (2W+1S)
EMERGENCY ABSORBER TANK

NOTES:-

1. FOR LEGEND REFER DWG. NO. 17A14-DWG-M-001Z, 2 SHEETS.
2. THE WASTE WATER TREATMENT SCHEME AS SHOWN IN THIS DRAWING IS TYPICAL ONLY. BIDDER SHALL FURNISH ALL REQUIRED EQUIPMENT TO MEET THE QUALITY MENTIONED IN THE TECHNICAL SPECIFICATION.

FOR TENDER PURPOSE ONLY

APPROV.	MECH.	INST.	ELEC.	STRL.	ARCH.	NATURE OF REVISION & DESCRIPTION	CHECKED	DRAWN	REV.	DATE
	REVIEWED					REVISED AS PER OWNER's COMMENTS	M.R	S.K.D	1	01.04.19

RELEASE STATUS	DATE	SIGNATURE
PRELIMINARY		
FOR TENDER ONLY		
FOR CONSTRUCTION		
REVIEWED: ARCHITECTURAL		
REVIEWED: CIVIL & STRUCTURAL		
REVIEWED: ELECTRICAL		
REVIEWED: INSTRUMENTATION		
REVIEWED: MECHANICAL		
REVIEWED: *		

OWNER: NLC TAMILNADU POWER LIMITED

PROJECT: 2x500 MW THERMAL POWER PLANT AT TUTICORIN

TITLE: FLOW SCHEME OF LSFO FGD SYSTEM

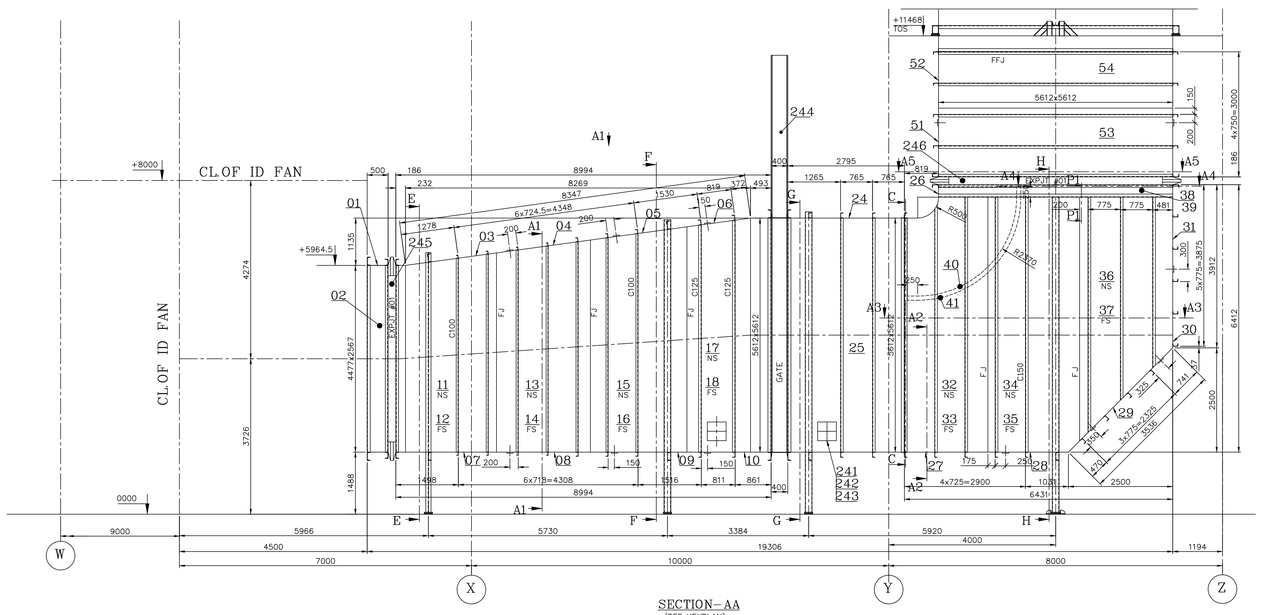
DEVELOPMENT CONSULTANTS PVT LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

PREPARED	Sandip Kumar Das	JOB NO.	17A14
CHECKED	M.Roy	SCALE	N.T.S
APPROVED	A.Sen	DATE	01/06/18
DWG. NO.	17A14-DWG-M-0001A		REV 1
			SHEET 1 OF 1

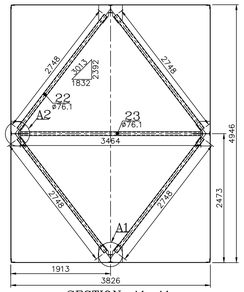
CORPORATE DRG IDYY
TP-DG-0-00-273-88098ZZ

DRAWING NO. 0-00-273-88098

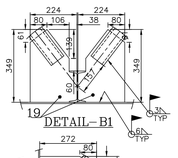
FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299



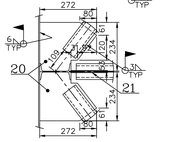
SECTION–AA
(REF KEYPLAN)



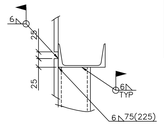
SECTION–A1–A1
(2 PLACES)



DETAIL–B1



DETAIL–B2

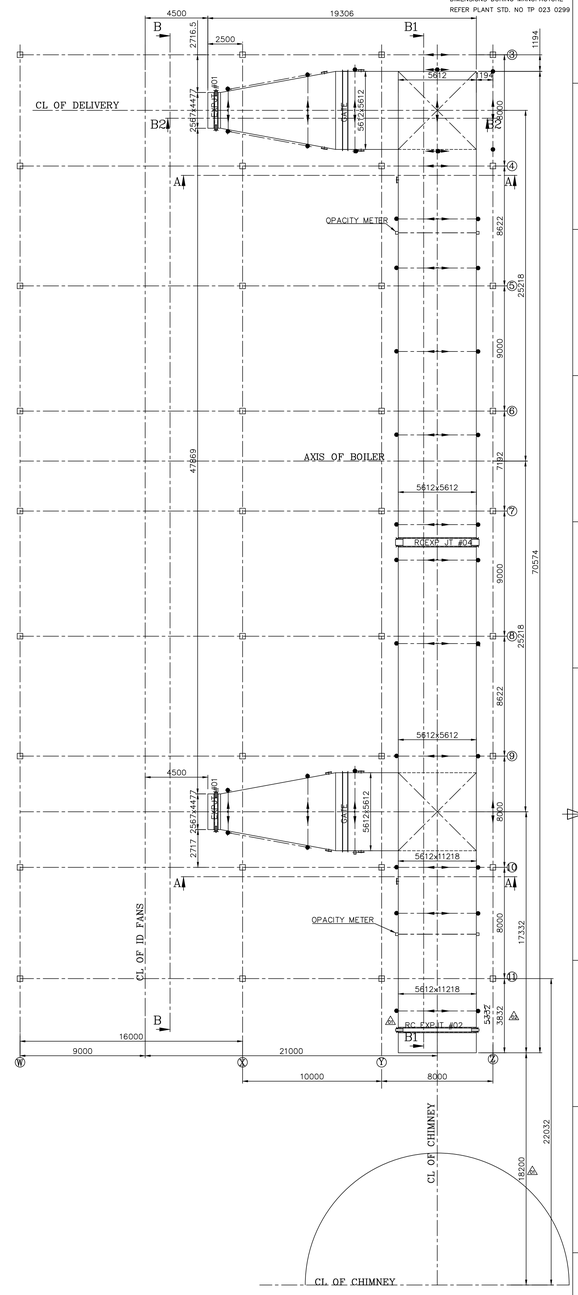


SECTION–P1–P1

SYMBOL	DESCRIPTION
MOVEMENT RESTRICTED IN THIS DIRECTION MARKED BY ARROWS	VIEW–F (BOTTOM PLATE)
MOVEMENT RESTRICTED IN THIS DIRECTION MARKED BY ARROWS	VIEW–N
FREE SUPPORT	VIEW–A
MOVEMENT RESTRICTED IN THIS DIRECTION MARKED BY ARROWS	VIEW–G

NOTES
01. SUPPORT LOCATION AND DIRECTION SHOWN IN THE SKETCH IS VALID FOR ALL POINTS.
02. THE ARRANGEMENT OF BOTTOM PLATE, BEARING PLATE AND TOP PLATE SHOULD BE INLINE AT COLD CONDITION AS SHOWN IN DETAIL–S*.
03. THE GAP BETWEEN STOPPER AND TOPLATE SHOULD BE 2mm GAP ONLY.
04. THE ELEVATION OF SUPPORT POINTS TO BE MAINTAINED AT SITE.

DETAIL–S*

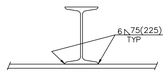


KEY PLAN
(SCALE 1:150)

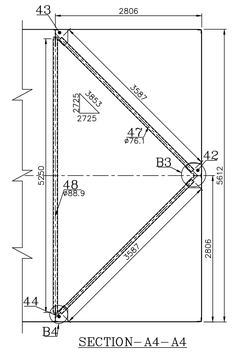
VIEW–A1

ERECTOR NOTES

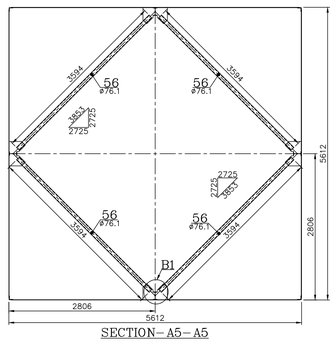
1. THE DUCT SYSTEM IS DESIGNED WITHOUT REGARD TO THE LOCATION OF BLANKING OFF PLATES WHICH MAY BE REQUIRED FOR TESTING. REACTIONS WHICH MAY BE INTRODUCED BY THESE PLATES MUST BE TAKEN CARE OF BY THE ERECTOR BY PROVIDING ADEQUATE STOPS AND BRACINGS.
2. EXTERNALLY SEAL WELD AROUND ALL EXPOSED BOLTS HEADS OR NUTS WITH A SPACING GREATER THAN 100mm.
3. PATCH ALL HOLES PLACED IN STIFFENER FOR LIFTING PURPOSES AFTER DUCT IS IN PLACE.
4. FOR ADDITIONAL WELDING AND ERECTION NOTES NOT SHOWN. SEE REFERENCE NOS.
   OF REFERENCE DRG. NO.
   0-00-260-87609
   0-00-260-87610
   0-00-260-87611
   0-00-260-87612
5. WASHERS TO BE USED ON SLOTTED CONNECTIONS ONLY AND MUST BE LOCATED ON SLOTTED SIDE.NUT TO BE FINGER TIGHTNED.BACKED OF 1/2 TURN AND TACK WELDED TO BOLT WITH 3 .6mm LONG.
6. FIXED SUPPORTS SHOULD BE IN PLACE AND SPRING SUPPORTS AT PROPER COLD SETTING WITH STOPS AND BLOCKS REMOVED BEFORE CUTTING LOOSE.
7. ALL PIPE STRUTS OR OTHER STRUCTURAL SHAPES PAINTED WITH A YELLOW BAND ARE TO BE REMOVED AFTER DUCT ERECTION IS COMPLETE.



TYP.TRUSS BEAM/
DUCT PL WELDING



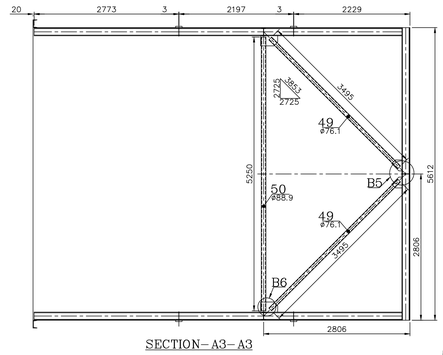
SECTION–A4–A4
(2 PLACES)



SECTION–A5–A5

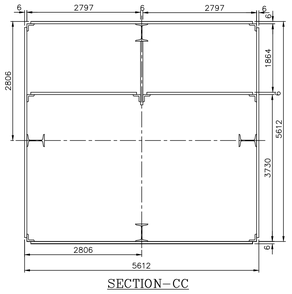
GENERAL NOTES

1. ONE COMPLETE DUCT ARRANGEMENT REQUIRED PER UNIT.
2. QUANTITIES INDICATED ARE FOR ONE (1)_ COMPLETE UNIT.
3. DUCTS ARE TO BE OF WELDED CONSTRUCTION PER REFERENCE NOS. IN DRG. No. 0–
4. ALL MATERIAL TO BE _CARBON_ STEEL UNLESS NOTED.
5. ALL PLATES TO BE _6mm_ UNLESS NOTED.
6. ALL DIMENSIONS ARE TO OUTSIDE OF PLATES UNLESS NOTED.
7. "F.F.J" INDICATES FLANGED FIELD JOINT.
8. "F.J" INDICATES SPLICED FIELD JOINT.
9. EXPANSION JOINTS(S) ARE TO BE FABRICATED AT A NEUTRAL POSITION PER EXPANSION JOINT ASSY. DRAWING.
   AT ERECTION EXPANSION JOINTS ARE TO BE INSTALLED AT THE DIMENSIONS INDICATED IN THE DUCT ARRANGEMENT DRGS.
10. ALL PIPE STRUTS OR OTHER STRUCTURAL MEMBERS THAT ARE ADDED BY THE SHOP TO DUCT SECTIONS SOLELY FOR THE PURPOSE OF SHIPPING WILL BE PAINTED WITH A YELLOW BAND.
11. CORNER CONSTRUCTION D.S TYPE.
12. ALL STIFFENERS ARE TO BE FL ISMC 200 UNLESS NOTED.
13. THIS DRAWING IS READ ALONG WITH DRG. NO. 0-00-273-88099/01
    0-00-273-88100/01
    1-00-273-05866
    1-00-273-05865
    1-00-273-05867

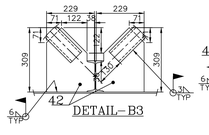


SECTION–A2–A2
(2 PLACES)

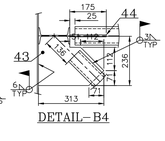
SECTION–A3–A3



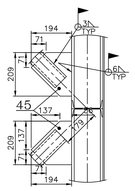
SECTION–CC



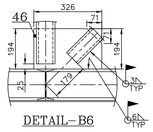
DETAIL–B3



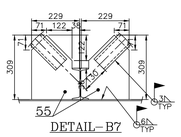
DETAIL–B4



DETAIL–B5



DETAIL–B6



DETAIL–B7

CUSTOMER NO: 0673 & 0674

CUSTOMER: NLC TAMILNADU POWER LIMITED
CONSULTANT: MECON LIMITED
PACKAGE NO. TA1 – MAIN PLANT PACKAGE (SG & TG)
NLC TAMILNADU POWER LIMITED
2X500 MW POWER PLANT AT TUTICORIN
355-029
BHARAT HEAVY ELECTRICALS LIMITED.,
BOILER PLANT UNIT; TIRUCHIRAPALLI–620014
EQUIPMENT : STEAM GENERATOR

	NAME	SIGNATURE	DATE
DRN	EOL/KUMAR		03.12.10
CHD	VIVEK		03..12.10
APPD	SHANMUGAM		03.02.10

ALL DIMENSIONS IN MILLIMETRE
PROJECTION
SCALE:

TITLE: ID TO CHIMNEY DUCTING
DRG. NO. 0-00-273-88098 (SH01/06)
REV 02

REV	DATE	ALTERED : KULA
02	09.03.13	CHD & APPD : RAMANA
ZONE		DUCT LENGTH FROM COLUMN 11 TO T.P CHANGED

REV	DATE	ALTERED : VIVEK
01	15.03.11	CHD & APPD : SHAN
ZONE		1.T.P DETAILS CHANGED 2.SUPPORT DETAILS CHANGED SUITABLY.

CAUTION: THE INFORMATION ON THIS DOCUMENT IS THE PROPERTY OF BHARAT HEAVY ELECTRICALS LIMITED. IT IS LOANED SUBJECT TO AGREEMENT AND UNDERTAKING THAT IT WILL NOT BE USED IN ANY WAY DETRIMENTAL TO THE INTEREST OF THE COMPANY.

DRAWING NO. 0-00-273-88099

FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299

NOTE:AS PER BHEL REPLY VIA EMAIL,SUPPORTS TO BE PROVIDED BY CHIMNEY VENDOR WITHIN 2500MM FROM EXPANSION JOINT.

FLANGE (ISMC 125) (RELEASED BY BHEL)
MATING FLANGE (ISMC 125) DU NO: 208,209 (RELEASED BY BHEL)
DUCT WALL DU NO: 201,202,203 (RELEASED BY BHEL)
CHIMNEY DUCT WALL (BY CUSTOMER)

DETAIL-A

C/L OF DELIVERY

AXIS OF BOILER

SECTION-BB (REF KEYPLAN)

SECTION-A6-A6

SECTION-A7-A7

SECTION-A8-A8

SECTION-A10-A10 (SECTION-A11-A11)

SECTION-A12-A12 (SECTION-A13-A13)

SECTION-A14-A14 (2 PLACES) (SECTION-A15-A15)

SECTION-P2P2

SECTION-A9-A9

SECTION-A16-A16

SECTION-A17-A17

DETAIL-B8

DETAIL-B9

DETAIL-B10

DETAIL-B11

DETAIL-B12

DETAIL-B13

DETAIL-B14

DETAIL-B18

DETAIL-B19

DETAIL-B20

NOTE

THIS DRAWING IS READ ALONG WITH DRG. NO. 0-00-273-88098/01
0-00-273-88100
1-00-273-05866
1-00-273-05865
1-00-273-05867

CUSTOMER NO: 0673 & 0674

REV	DATE	ALTERED : RAVI
02	30.03.13	CHD & APPD : RAMANA
ZONE		DETAIL A ADDED
REV	DATE	ALTERED : VIVEK
01	15.03.11	CHD & APPD : SHAN
ZONE		1.T.P DETAILS CHANGED. 2.DUCT DIMENSIONS AND SUPPORT LOCATIONS SUITABLY CHANGED. 3.NOTES ADDED

CAUTION:- THE INFORMATION IN THIS DOCUMENT IS THE PROPRIETARY PROPERTY OF BHEL AND IT MUST NOT BE USED DIRECTLY OR INDIRECTLY FOR ANY PURPOSE OTHER THAN THAT FOR WHICH IT IS FURNISHED.

CUSTOMER: NLC TAMILNADU POWER LIMITED
CONSULTANT: MECON LIMITED
PACKAGE NO. TA1 – MAIN PLANT PACKAGE (SG & TG)
NLC TAMILNADU POWER LIMITED
2X500 MW POWER PLANT AT TUTICORIN
BHARAT HEAVY ELECTRICALS LIMITED.,
BOILER PLANT UNIT; TIRUCHIRAPALLI-620014
EQUIPMENT : STEAM GENERATOR
355-029

	NAME	SIGNATURE	DATE
DRN	EOL/KUMAR		03.12.10
CHD	VIVEK		03.12.10
APPD	SHANMUGAM		03.12.10

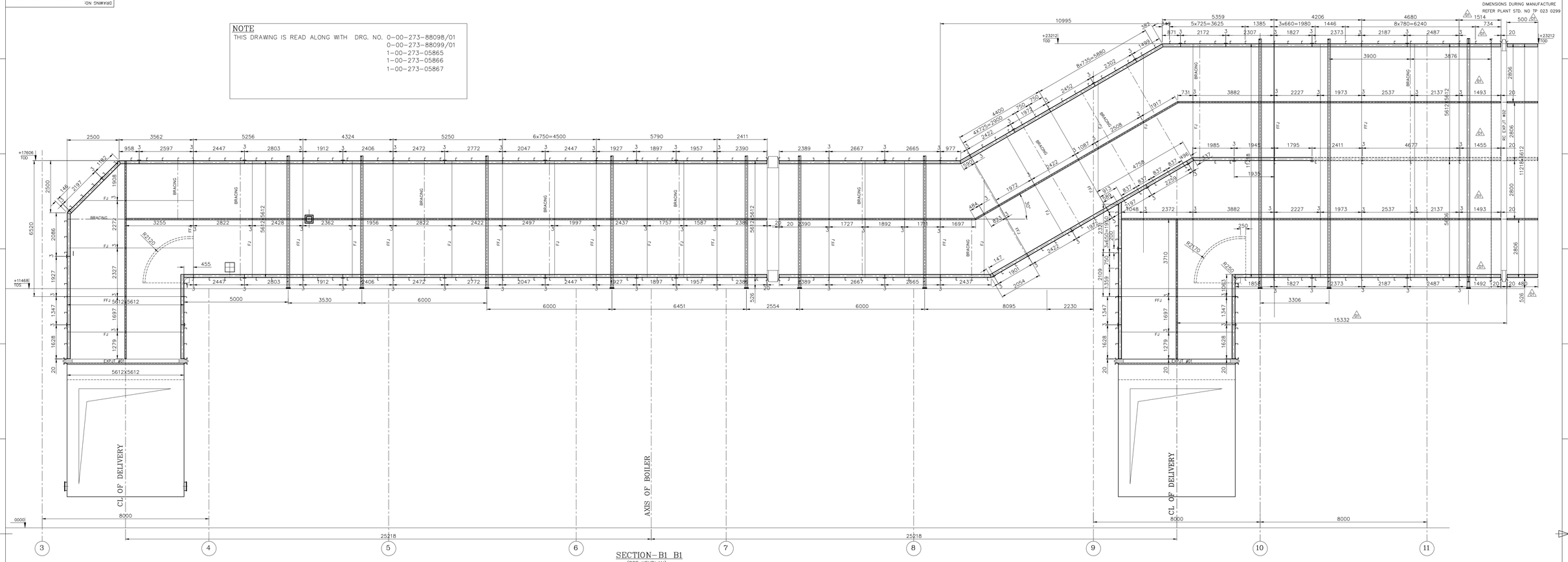
TITLE: ID TO CHIMNEY DUCTING
ALL DIMENSIONS IN MILLIMETRE
PROJECTION
SCALE:
DRG. NO. 0-00-273-88099 (SH02/06)
REV 02

CORPORATE DRG IDVY
TP-DG-0-00-273-88100Z
35720/2020/SHOP/MS

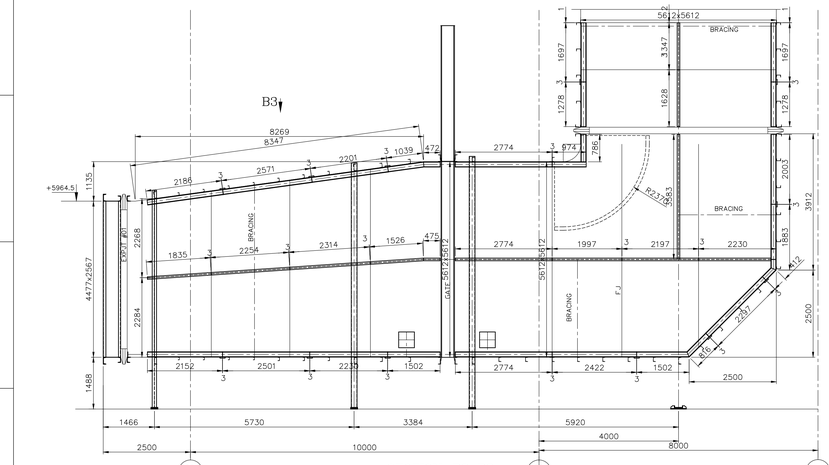
DRAWING NO: 0-00-273-88100

FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299

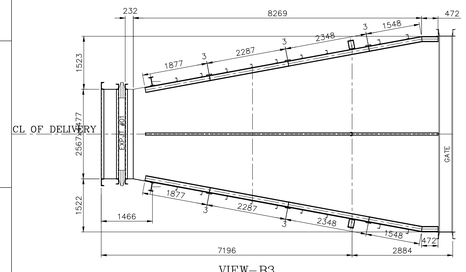
NOTE
THIS DRAWING IS READ ALONG WITH DRG. NO. 0-00-273-88098/01
0-00-273-88099/01
1-00-273-05865
1-00-273-05866
1-00-273-05867



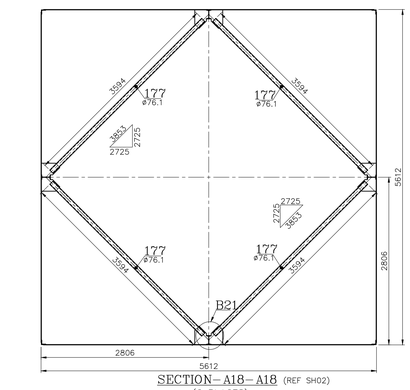
SECTION–B1 B1
(REF KEYPLAN)



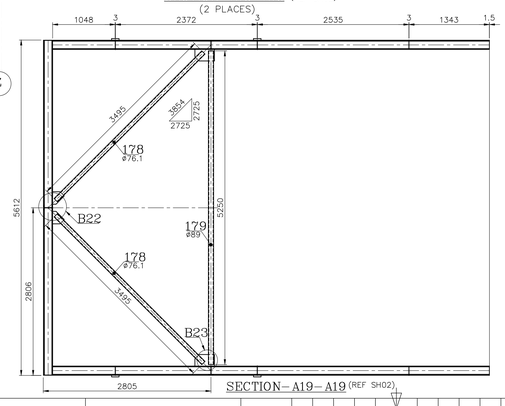
SECTION–B2 B2
(REF KEYPLAN)



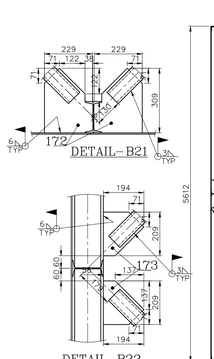
VIEW–B3

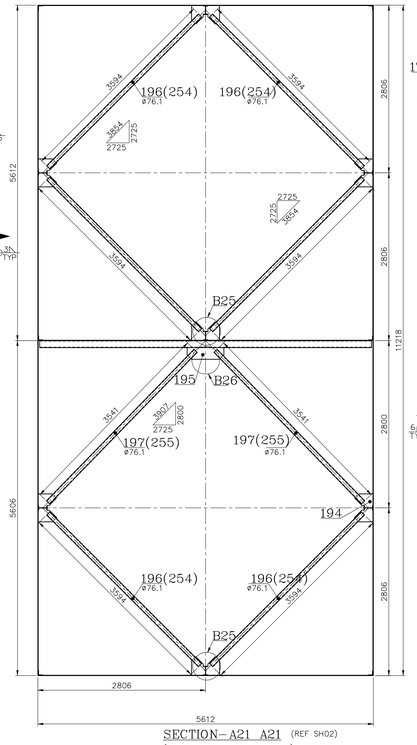


SECTION–A18–A18 (REF SH02)
(2 PLACES)

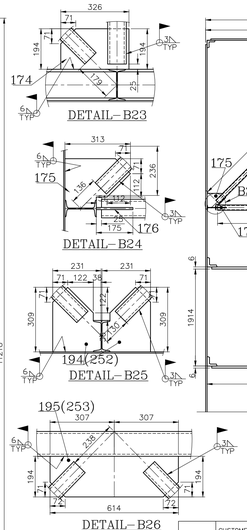


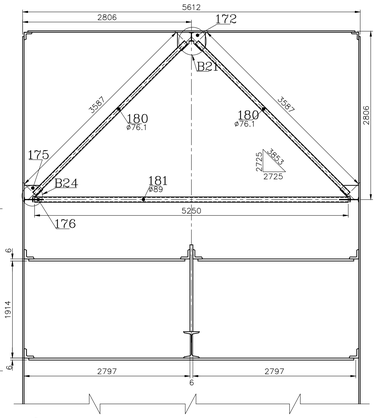
SECTION–A19–A19 (REF SH02)





SECTION–A21 A21 (REF SH02)
(SECTION–A22 A22) (REF SH02)





SECTION–A20–A20
(REF SH02)

REV	DATE	ALTERED :	VIVEK
01	15.03.11	CHD & APPD :	SHAN
ZONE	1.DUCT DIMENSIONS CHANGED. 2.SUPPORT DETAILS CHANGED		

CUSTOMER NO: 0673 & 0674

CUSTOMER: NLC TAMILNADU POWER LIMITED
CONSULTANT: MECON LIMITED
PACKAGE NO. TA1 – MAIN PLANT PACKAGE (SG & TG)
NLC TAMILNADU POWER LIMITED
2X500 MW POWER PLANT AT TUTICORIN
BHARAT HEAVY ELECTRICALS LIMITED.,
BOILER PLANT UNIT; TIRUCHIRAPALLI–620014
EQUIPMENT : STEAM GENERATOR
355–029

	NAME	SIGNATURE	DATE
DRN	EOL/KUMAR		03.12.10
CHD	VIVEK		03.12.10
APPD	SHANMUGAM		03.12.10

ALL DIMENSIONS IN MILLIMETRE
PROJECTION
SCALE:

TITLE: ID TO CHIMNEY DUCTING
DRG. NO. 0–00–273–88100 (SH03/06)
REV 01

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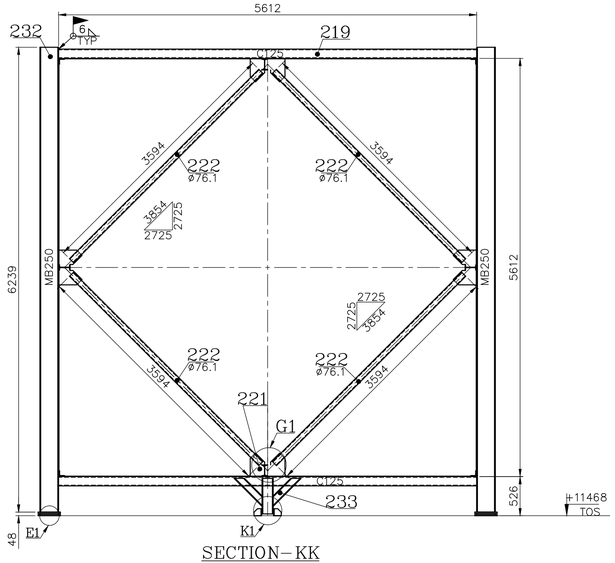
CORPORATE DRG IDVY
TP-DG-XX0-00-273-88100

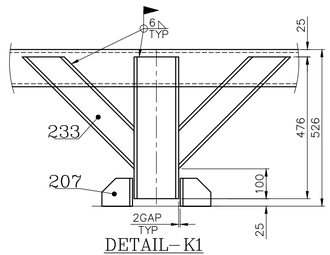
CORPORATE DRG IDYYY
TP-DG-1-00-273-05865Z
BM
35720/2020/PS-SR

DRAWING NO: 1-00-273-05865

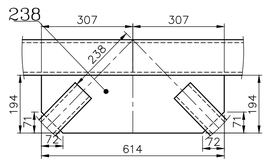
FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299



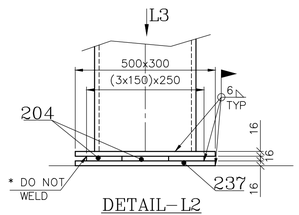
SECTION–KK
(7 PLACES)
(REF SH 02)



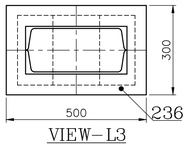
DETAIL–K1



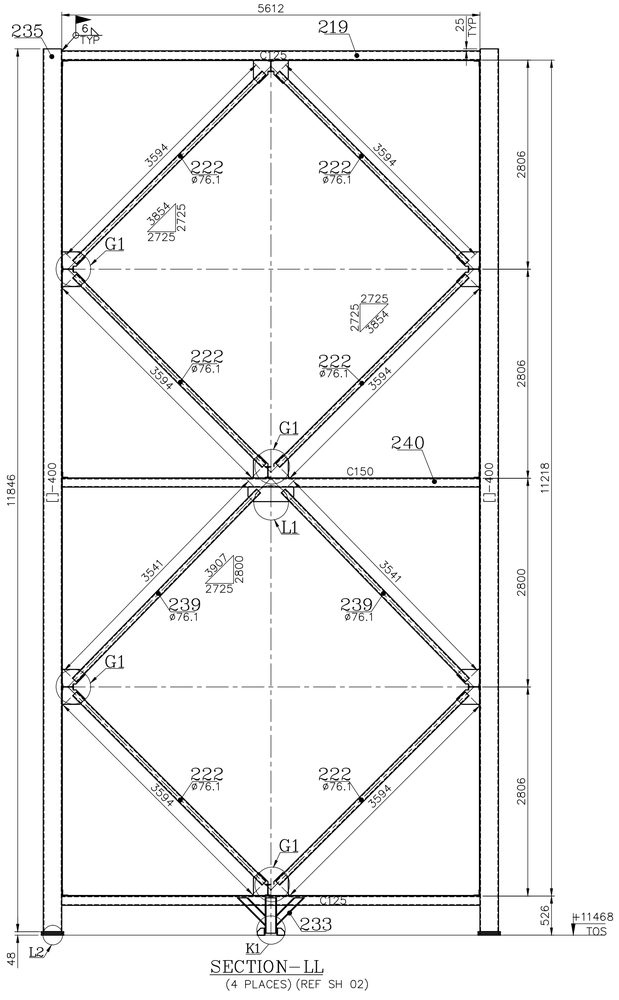
DETAIL–L1



DETAIL–L2



VIEW–L3



SECTION–LL
(4 PLACES) (REF SH 02)

NOTES

THIS DRAWING IS TO BE READ ALONG WITH DRG. NO. 0-00-273-88098
0-00-273-88099
0-00-273-88100
1-00-273-05866
1-00-273-05867

100	48-492	DUCT WALL	100	2	C-6 SH 02
99	48-492	DUCT WALL	099	2	C-6 SH 02
98	48-492	DUCT WALL	098	2	C-6 SH 02
97	48-492	DUCT WALL	097	2	C-6 SH 02
96	48-492	STRUT PIPE	096	4	H-8 SH 02
95	48-492	GUSSET PLATE	095	8	M-4 SH 02
94	48-492	DUCT WALL	094	2	C-5 SH 02
93	48-492	DUCT WALL	093	2	C-5 SH 02
92	48-492	DUCT WALL	092	2	C-5 SH 02
91	48-492	DUCT WALL	091	2	C-5 SH 02
90	48-492	DUCT WALL	090	2	C-4 SH 02
89	48-492	DUCT WALL	089	2	C-4 SH 02
88	48-492	DUCT WALL	088	2	C-4 SH 02
87	48-492	DUCT WALL	087	2	C-4 SH 02
86	48-492	STRUT PIPE	086	4	H-8 SH 02
85	48-492	GUSSET PLATE	085	8	M-4 SH 02
84	48-492	DUCT WALL	084	2	C-3 SH 02
83	48-492	DUCT WALL	083	2	C-3 SH 02
82	48-492	DUCT WALL	082	2	C-3 SH 02
81	48-492	DUCT WALL	081	2	C-3 SH 02
80	48-492	STRUT PIPE	080	1	H-7 SH 02
79	48-492	STRUT PIPE	079	2	H-6 SH 02
78	48-492	STRUT PIPE	078	3	H-2 SH 02
77	48-492	STRUT PIPE	077	6	H-2 SH 02
76	48-492	GUSSET PLATE	076	2	L-7 SH 02
75	48-492	GUSSET PLATE	075	2	K-5 SH 02
74	48-492	GUSSET PLATE	074	6	K-4 SH 02
73	48-492	GUSSET PLATE	073	6	K-4 SH 02
72	48-492	GUSSET PLATE	072	6	L-3 SH 02
71	48-492	COLLECTOR FLANGE	071	2	C-2 SH 02
70	48-492	DIVIDER PLATE	070	1	D-2 SH 02
69	48-492	GUIDE VANE	069	2	D-2 SH 02
68	48-492	ELBOW WALL	068	1	C-2 SH 02
67	48-492	ELBOW WALL	067	1	C-2 SH 02
66	48-492	ELBOW WALL	066	1	C-2 SH 02
65	48-492	ELBOW WALL	065	1	C-2 SH 02
64	48-492	ELBOW WALL	064	1	C-2 SH 02
63	48-492	ELBOW WALL	063	1	D-2 SH 02
62	48-492	ELBOW WALL	062	1	C-2 SH 02
61	48-492	ELBOW WALL	061	1	C-2 SH 02
60	48-492	ELBOW WALL	060	1	C-1 SH 02
59	48-492	ELBOW WALL	059	1	C-1 SH 02
58	48-492	ELBOW WALL	058	1	D-1 SH 02
57	48-492	ELBOW WALL	057	1	D-3 SH 02
56	48-492	STRUT PIPE	056	8	K-11 SH 01
55	48-492	GUSSET PLATE	055	16	M-8 SH 01
54	48-492	DUCT WALL	054	4	B-8 SH 01
53	48-492	DUCT WALL	053	4	B-8 SH 01
52	48-492	DUCT WALL	052	4	B-7 SH 01
51	48-492	DUCT WALL	051	4	B-7 SH 01
50	48-492	STRUT PIPE	050	2	K-6 SH 01
49	48-492	STRUT PIPE	049	4	J-6 SH 01
48	48-492	STRUT PIPE	048	4	J-2 SH 01
47	48-492	STRUT PIPE	047	8	J-2 SH 01
46	48-492	GUSSET PLATE	046	4	L-7 SH 01
45	48-492	GUSSET PLATE	045	4	L-6 SH 01
44	48-492	GUSSET PLATE	044	8	L-6 SH 01
43	48-492	GUSSET PLATE	043	8	L-5 SH 01
42	48-492	GUSSET PLATE	042	8	M-4 SH 01
41	48-492	DIVIDER PLATE	041	2	C-7 SH 01
40	48-492	GUIDE VANE	040	4	C-7 SH 01

39	48-492	ELBOW WALL	039	2	B-9 SH 01
38	48-492	ELBOW WALL	038	2	B-9 SH 01
37	48-492	ELBOW WALL	037	2	C-8 SH 01
36	48-492	ELBOW WALL	036	2	C-8 SH 01
35	48-492	ELBOW WALL	035	2	D-7 SH 01
34	48-492	ELBOW WALL	034	2	D-7 SH 01
33	48-492	ELBOW WALL	033	2	D-7 SH 01
32	48-492	ELBOW WALL	032	2	D-7 SH 01
31	48-492	ELBOW WALL	031	2	C-8 SH 01
30	48-492	ELBOW WALL	030	2	C-8 SH 01
29	48-492	ELBOW WALL	029	2	D-8 SH 01
28	48-492	ELBOW WALL	028	2	D-8 SH 01
27	48-492	ELBOW WALL	027	2	D-7 SH 01
26	48-492	ELBOW WALL	026	2	B-7 SH 01
25	48-492	DUCT WALL	025	4	C-6 SH 01
24	48-492	DUCT WALL	024	4	B-6 SH 01
23	48-492	STRUT PIPE	023	2	B-10 SH 01
22	48-492	STRUT PIPE	022	8	B-9 SH 01
21	48-492	GUSSET PLATE	021	4	E-10 SH 01
20	48-492	GUSSET PLATE	020	8	E-9 SH 01
19	48-492	GUSSET PLATE	019	8	D-10 SH 01
18	48-492	TRANSITION WALL	018	2	D-5 SH 01
17	48-492	TRANSITION WALL	017	2	C-5 SH 01
16	48-492	TRANSITION WALL	016	2	D-5 SH 01
15	48-492	TRANSITION WALL	015	2	D-5 SH 01
14	48-492	TRANSITION WALL	014	2	D-4 SH 01
13	48-492	TRANSITION WALL	013	2	D-4 SH 01
12	48-492	TRANSITION WALL	012	2	D-4 SH 01
11	48-492	TRANSITION WALL	011	2	D-4 SH 01
10	48-492	TRANSITION WALL	010	2	D-6 SH 01
09	48-492	TRANSITION WALL	009	2	D-5 SH 01
08	48-492	TRANSITION WALL	008	2	E-4 SH 01
07	48-492	TRANSITION WALL	007	2	D-4 SH 01
06	48-492	TRANSITION WALL	006	2	B-5 SH 01
05	48-492	TRANSITION WALL	005	2	C-5 SH 01
04	48-492	TRANSITION WALL	004	2	C-4 SH 01
03	48-492	TRANSITION WALL	003	2	C-4 SH 01
02	48-492	DUCT WALL	002	4	C-3 SH 01
01	48-492	DUCT WALL	001	4	B-3 SH 01
SL.No	PG.MA	DESCRIPTION	DU.No	QTY	ZONE

CUSTOMER NO: 0673 & 0674

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CUSTOMER: NLC TAMILNADU POWER LIMITED
CONSULTANT: MECON LIMITED
PACKAGE NO. TA1 – MAIN PLANT PACKAGE (SG & TG)
NLC TAMILNADU POWER LIMITED
2X500 MW POWER PLANT AT TUTICORIN
BHARAT HEAVY ELECTRICALS LIMITED.,
BOILER PLANT UNIT; TIRUCHIRAPALLI–620014
EQUIPMENT : STEAM GENERATOR
355-029

	NAME	SIGNATURE	DATE
DRN	EOL/KUMAR		25.02.10
CHD	–		25.02.10
APPD	SHANMUGAM		25.02.10

ALL DIMENSIONS IN MILLIMETRE
PROJECTION
SCALE:

TITLE: ID TO CHIMNEY DUCTING
DRG. NO. 1-00-273-05865 (SH05/06)
REV 00

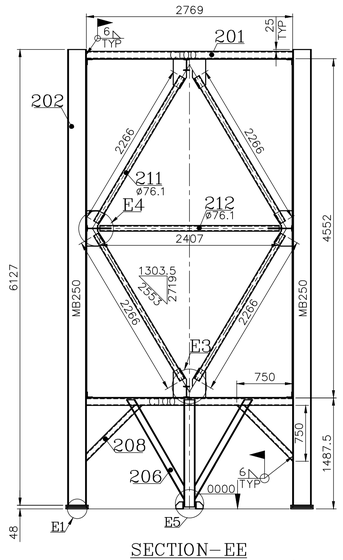
REV	DATE	ALTERED :
ZONE		CHD & APPD :

CORPORATE DRG IDYY
TP-DG-XX1-00-273-05865

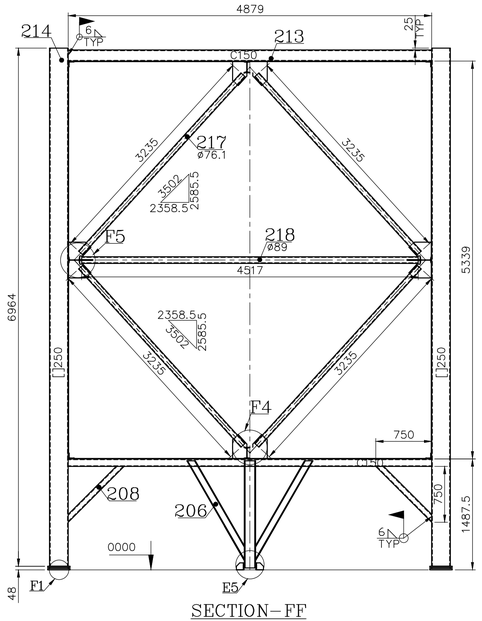
CORPORATE DRG IDYW
TP-DG-1-00-273-05866Z
35720/2020/PS-BB-BM

DRAWING NO: 1-00-273-05866

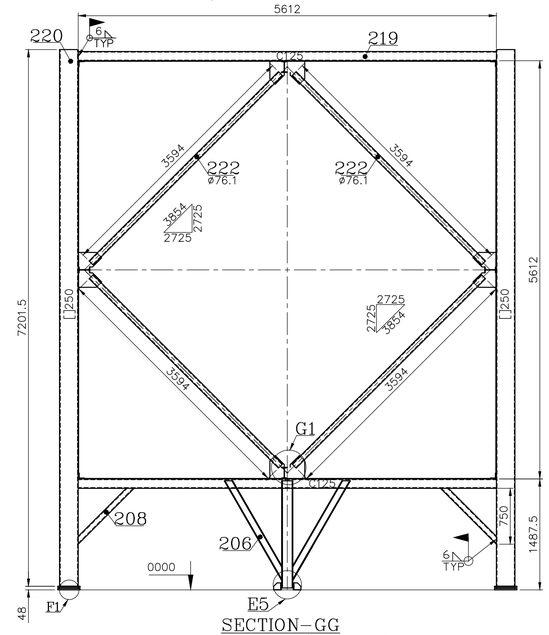
FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299



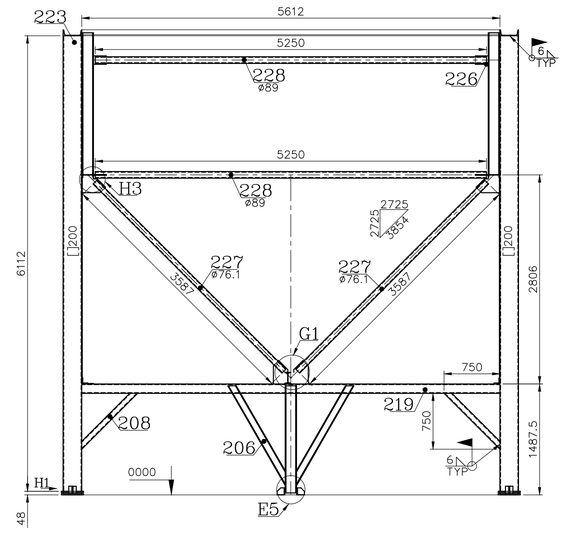
SECTION–EE
(2 PLACES) (REF SH 01)



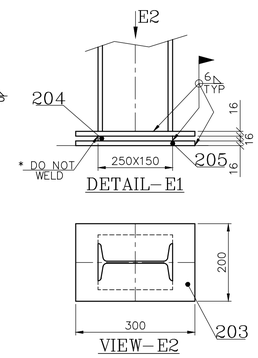
SECTION–FF
(2 PLACES) (REF SH 01)

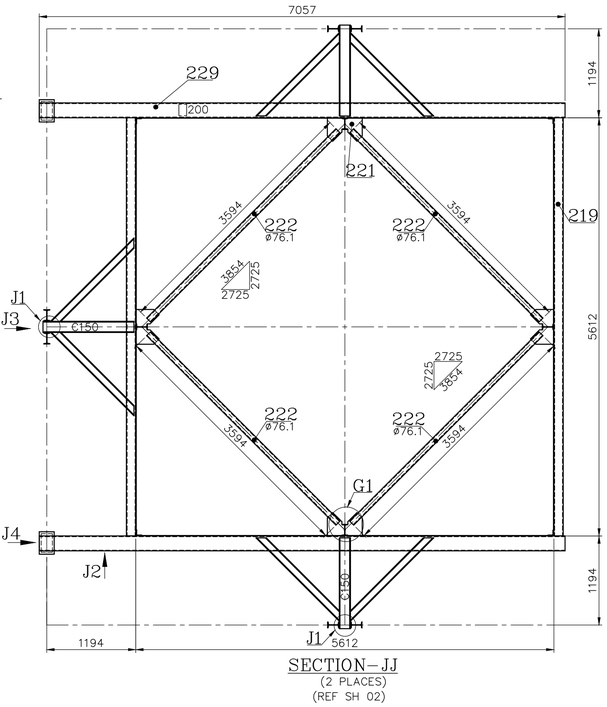


SECTION–GG
(2 PLACES) (REF SH 01)

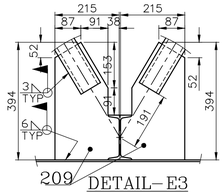


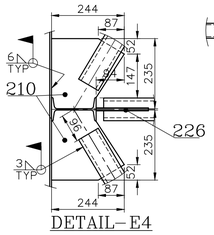
SECTION–HH
(2 PLACES) (REF SH 01)

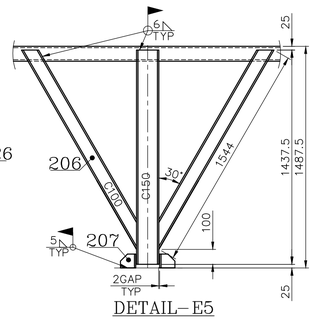


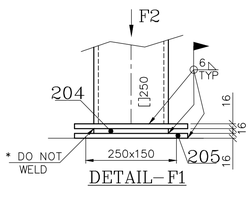


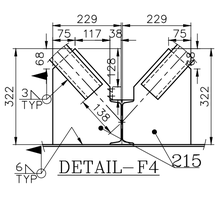
SECTION–JJ
(2 PLACES)
(REF SH 02)

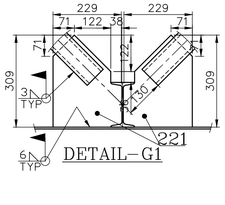


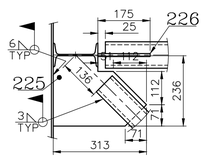


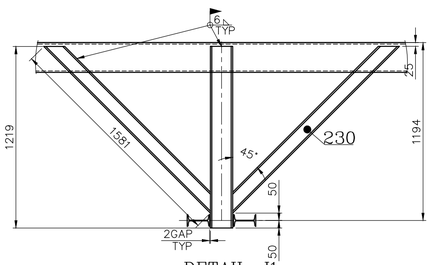


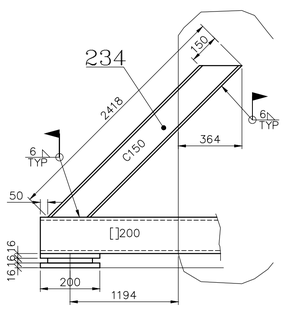


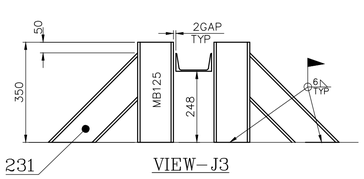


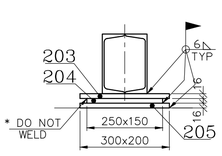


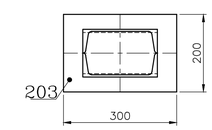




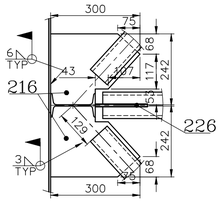


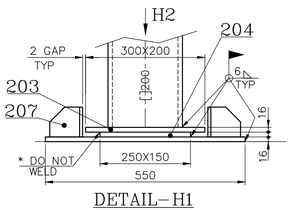


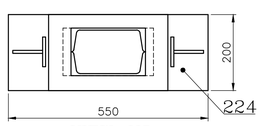




VIEW–F2







NOTES

THIS DRAWING IS TO BE READ ALONG WITH DRG. NO. 0-00-273-88098
0-00-273-88099
0-00-273-88100
1-00-273-05867
1-00-273-05865

CUSTOMER NO: 0673 & 0674

CUSTOMER: NLC TAMILNADU POWER LIMITED

CONSULTANT: MECON LIMITED

PACKAGE NO. TA1 – MAIN PLANT PACKAGE (SG & TG)

NLC TAMILNADU POWER LIMITED
2X500 MW POWER PLANT AT TUTICORIN

BHARAT HEAVY ELECTRICALS LIMITED.,
BOILER PLANT UNIT; TIRUCHIRAPALLI–620014
EGUIPMENT : STEAM GENERATOR
355–029

	NAME	SIGNATURE	DATE
DRN	EOL/KUMAR		03.12.10
CHD	VIVEK		03.12.10
APPD	SHANMUGAM		03.12.10

TITLE: ID TO CHIMNEY DUCTING

ALL DIMENSIONS IN MILLIMETRE

PROJECTION

SCALE:

DRG. NO. 1-00-273-05866 (SH04/06)

REV 00

REV	DATE	ALTERED :
ZONE		CHD & APPD :

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CORPORATE DRG IDYY
TP-DG-XX1-00-273-05866

CORPORATE DRG IDYYY
TP-DG-1-00-273-05867ZZ
35720/2020/PS-SR-BM

DRAWING NO: 1-00-273-05867

FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER PLANT STD. NO TP 023 0299

NOTES

THIS DRAWING IS TO BE READ ALONG WITH DRG. NO. 0-00-273-88098
0-00-273-88099
0-00-273-88100
1-00-273-05865
1-00-273-05866

257	48-492	FLANGE	209	2	B-16 SH-02
256	48-492	FLANGE	208	2	D-16 SH-02
255	48-492	STRUT PIPE	207	2	K-11 SH-03
254	48-492	STRUT PIPE	206	6	H-11 SH-03
253	48-492	GUSSET PLATE	205	1	K-13 SH-03
252	48-492	GUSSET PLATE	204	14	J-13 SH-03
251	48-492	DUCT WALL	203	1	B-16 SH-02
250	48-492	DUCT WALL	202	2	B-16 SH-02
249	48-492	DUCT WALL	201	2	B-16 SH-02
248	48-494	RC EXP.JT #02 11218x5612	005	1	B-16 SH-02
247	48-494	RC EXP.JT #04 5612x5612	004	1	B-8 SH-02
246	48-494	RC EXP.JT #01 5612x5612	003	2	B-7 SH-01
245	48-494	RC EXP.JT #01 4477x2567	002	2	C-3 SH-01
244	48-494	GATE (RANIPET) 5612x5612	001	2	B-6 SH-01
243	48-495	GRAB BAR-2	043	10	D-6 SH-01
242	48-495	GRAB BAR-1	042	10	D-6 SH-01
241	48-495	MAN HOLE DOOR	041	10	D-6 SH-01
240	48-495	ISMC 125;5600	040	3	F-3 SH-05
239	48-495	STRUT PIPE	039	8	F-3 SH-05
238	48-495	GUSSET PLATE	038	4	C-5 SH-05
237	48-495	PL16x300x500	037	6	D-5 SH-05
236	48-495	TOP PLATE-2	036	6	F-5 SH-05
235	48-495	CHANNEL BOX-5	035	8	D-1 SH-05
234	48-495	STIFFENER-2	034	4	F-8 SH-04
233	48-495	RESTRAINT-3	033	11	A-4 SH-05
232	48-495	ISMB 200;6240	032	14	A-1 SH-05
231	48-495	STOPPER-2	031	12	G-5 SH-04
230	48-495	RESTRAINT-2	030	6	F-7 SH-04
229	48-495	CHANNEL BOX-4	029	4	D-1 SH-04
228	48-495	STRUT PIPE	028	4	B-10 SH-04
227	48-495	STRUT PIPE	027	4	C-9 SH-04
226	48-495	PL10x114x175	026	16	E-4 SH-04
225	48-495	GUSSET PLATE	025	4	E-4 SH-04
224	48-495	PL16x200x550	024	4	F-12 SH-04
223	48-495	CHANNEL BOX-3	023	4	A-9 SH-04
222	48-495	STRUT PIPE	022	68	A-6 SH-04
221	48-495	GUSSET PLATE	021	148	D-12 SH-04
220	48-495	CHANNEL BOX-2	020	4	A-6 SH-04
219	48-495	ISMC 125;5612	019	32	A-7 SH-04
218	48-495	STRUT PIPE	018	2	B-4 SH-04
217	48-495	STRUT PIPE	017	8	A-4 SH-04
216	48-495	GUSSET PLATE	016	8	E-10 SH-04
215	48-495	GUSSET PLATE	015	8	D-10 SH-04
214	48-495	CHANNEL BOX-1	014	4	A-3 SH-04
213	48-495	ISMC 150;4879	013	4	A-4 SH-04
212	48-495	STRUT PIPE	012	2	B-2 SH-04
211	48-495	STRUT PIPE	011	8	B-1 SH-04
210	48-495	GUSSET PLATE	010	8	D-5 SH-04
209	48-495	GUSSET PLATE	009	8	D-4 SH-04
208	48-495	STIFFENER-1	008	16	C-1 SH-04
207	48-495	STOPPER	007	46	E-7 SH-04
206	48-495	RESTRAINT-1	006	8	D-7 SH-04
205	48-495	PL16x200x300	005	30	B-12 SH-04
204	48-495	BEARING PLATE	004	52	A-11 SH-04
203	48-495	TOP PLATE	003	34	B-12 SH-04
202	48-495	ISMB 250;6127	002	4	B-1 SH-04
201	48-495	ISMC 100;2769	001	4	A-2 SH-04
200	48-492	DUCT WALL	200	1	C-15 SH-02
199	48-492	DUCT WALL	199	2	B-15 SH-02
198	48-492	DUCT WALL	198	2	A-15 SH-02
197	48-492	STRUT PIPE	197	2	K-11 SH-03
196	48-492	STRUT PIPE	196	6	H-11 SH-03
195	48-492	GUSSET PLATE	195	1	K-13 SH-03
194	48-492	GUSSET PLATE	194	14	J-13 SH-03
193	48-492	DUCT WALL	193	1	C-15 SH-02
192	48-492	DUCT WALL	192	1	C-15 SH-02
191	48-492	DUCT WALL	191	2	B-15 SH-02
190	48-492	DUCT WALL	190	2	B-15 SH-02
189	48-492	DUCT WALL	189	2	A-15 SH-02
188	48-492	DUCT WALL	188	2	A-15 SH-02
187	48-492	DUCT WALL	187	1	C-14 SH-02
186	48-492	DUCT WALL	186	1	C-14 SH-02
185	48-492	DUCT WALL	185	2	B-14 SH-02
184	48-492	DUCT WALL	184	2	B-13 SH-02
183	48-492	DUCT WALL	183	2	A-14 SH-02
182	48-492	DUCT WALL	182	2	A-14 SH-02
181	48-492	STRUT PIPE	181	1	H-15 SH-03
180	48-492	STRUT PIPE	180	2	H-15 SH-03
179	48-492	STRUT PIPE	179	1	L-7 SH-03
178	48-492	STRUT PIPE	178	2	K-7 SH-03
177	48-492	STRUT PIPE	177	8	H-7 SH-03
176	48-492	GUSSET PLATE	176	2	H-13 SH-03
175	48-492	GUSSET PLATE	175	2	H-13 SH-03
174	48-492	GUSSET PLATE	174	2	G-13 SH-03
173	48-492	GUSSET PLATE	173	2	J-10 SH-03
172	48-492	GUSSET PLATE	172	18	H-9 SH-03
171	48-492	COLLECTOR FLANGE	171	2	B-11 SH-02
170	48-492	DIVIDER PLATE	170	1	D-13 SH-02
169	48-492	DIVIDER PLATE	169	1	B-13 SH-02
168	48-492	GUIDE VANE	168	2	D-13 SH-02
167	48-492	GUIDE VANE	167	2	B-13 SH-02
166	48-492	T DUCT WALL	166	1	D-12 SH-02
165	48-492	T DUCT WALL	165	1	D-12 SH-02
164	48-492	T DUCT WALL	164	1	B-13 SH-02
163	48-492	T DUCT WALL	163	1	B-13 SH-02
162	48-492	T DUCT WALL	162	1	B-13 SH-02
161	48-492	T DUCT WALL	161	1	B-13 SH-02
160	48-492	T DUCT WALL	160	1	B-12 SH-02
159	48-492	T DUCT WALL	159	1	B-12 SH-02
158	48-492	T DUCT WALL	158	1	B-12 SH-02
157	48-492	T DUCT WALL	157	1	B-12 SH-02
156	48-492	T DUCT WALL	156	1	B-12 SH-02
155	48-492	T DUCT WALL	155	1	B-12 SH-02
154	48-492	T DUCT WALL	154	1	C-13 SH-02
153	48-492	T DUCT WALL	153	1	C-13 SH-02
152	48-492	T DUCT WALL	152	1	C-12 SH-02
151	48-492	T DUCT WALL	151	1	C-12 SH-02
150	48-492	T DUCT WALL	150	1	A-13 SH-02
149	48-492	T DUCT WALL	149	1	A-13 SH-02
148	48-492	T DUCT WALL	148	1	B-12 SH-02
147	48-492	T DUCT WALL	147	1	B-12 SH-02
146	48-492	T DUCT WALL	146	1	B-11 SH-02
145	48-492	T DUCT WALL	145	1	D-12 SH-02
144	48-492	T DUCT WALL	144	1	D-12 SH-02
143	48-492	T DUCT WALL	143	1	D-13 SH-02
142	48-492	STRUT PIPE	142	4	L-11 SH-02
141	48-492	GUSSET PLATE	141	8	L-13 SH-02
140	48-492	DUCT WALL	140	2	C-10 SH-02
139	48-492	DUCT WALL	139	2	C-11 SH-02
138	48-492	DUCT WALL	138	2	B-11 SH-02
137	48-492	DUCT WALL	137	2	B-11 SH-02
136	48-492	STRUT PIPE	136	2	K-8 SH-02
135	48-492	STRUT PIPE	135	4	L-8 SH-02
134	48-492	GUSSET PLATE	134	4	M-9 SH-02
133	48-492	GUSSET PLATE	133	4	M-9 SH-02
132	48-492	GUSSET PLATE	132	4	M-8 SH-02
131	48-492	COLLECTOR FLANGE	131	2	D-11 SH-02
130	48-492	DIVIDER PLATE	130	1	C-10 SH-02
129	48-492	GUIDE VANE	129	2	C-10 SH-02
128	48-492	BEND DUCT WALL	128	1	D-11 SH-02
127	48-492	BEND DUCT WALL	127	1	D-11 SH-02
126	48-492	BEND DUCT WALL	126	1	D-10 SH-02
125	48-492	BEND DUCT WALL	125	1	D-10 SH-02
124	48-492	BEND DUCT WALL	124	1	D-11 SH-02
123	48-492	BEND DUCT WALL	123	1	D-10 SH-02
122	48-492	BEND DUCT WALL	122	1	C-10 SH-02
121	48-492	STRUT PIPE	121	4	H-13 SH-02
120	48-492	GUSSET PLATE	120	8	H-15 SH-02
119	48-492	DUCT WALL	119	2	C-10 SH-02
118	48-492	DUCT WALL	118	2	C-10 SH-02
117	48-492	DUCT WALL	117	2	C-9 SH-02
116	48-492	DUCT WALL	116	2	C-10 SH-02
115	48-492	DUCT WALL	115	2	C-9 SH-02
114	48-492	STRUT PIPE	114	8	H-13 SH-02
113	48-492	GUSSET PLATE	113	16	H-15 SH-02
112	48-492	DUCT WALL	112	4	C-9 SH-02
111	48-492	DUCT WALL	111	4	C-9 SH-02
110	48-492	STRUT PIPE	110	4	H-10 SH-02
109	48-492	GUSSET PLATE	109	8	M-5 SH-02
108	48-492	DUCT WALL	108	2	C-8 SH-02
107	48-492	DUCT WALL	107	2	C-7 SH-02
106	48-492	DUCT WALL	106	2	C-7 SH-02
105	48-492	DUCT WALL	105	2	C-8 SH-02
104	48-492	DUCT WALL	104	2	C-7 SH-02
103	48-492	DUCT WALL	103	2	C-7 SH-02
102	48-492	STRUT PIPE	102	4	H-10 SH-02
101	48-492	GUSSET PLATE	101	8	M-5 SH-02
SL.No	PG.MA	DESCRIPTION	DU.No	QTY	ZONE

CUSTOMER NO: 0673 & 0674

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CUSTOMER: NLC TAMILNADU POWER LIMITED

CONSULTANT: MECON LIMITED

PACKAGE NO. TA1 – MAIN PLANT PACKAGE (SG & TG)

NLC TAMILNADU POWER LIMITED
2X500 MW POWER PLANT AT TUTICORIN

BHARAT HEAVY ELECTRICALS LIMITED.,
BOILER PLANT UNIT; TIRUCHIRAPALLI-620014
EQUIPMENT : STEAM GENERATOR

355-029

REV	DATE	ALTERED :
ZONE		CHD & APPD :

	NAME	SIGNATURE	DATE
DRN	EOL/KUMAR		25.02.10
CHD	–		25.02.10
APPD	SHANMUGAM		25.02.10

ALL DIMENSIONS IN MILLIMETRE

PROJECTION | SCALE:

TITLE: ID TO CHIMNEY DUCTING

DRG. NO. 1-00-273-05867 (SH06/06) REV 00

CORPORATE DRG IDYY
TP-DG-XX1-00-273-05867

35720/2020/PS-SR-PM

NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Electrical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply
1.	IIF/Section-I/ 5.26.01/ 26 of 45	For sizing of 11 kV incoming cable to FGD Switchgear from Station Transformer bidder shall consider the full load current of the 32/16/16MVA Station Transformer as current carrying capacity of the cable.	For sizing of 11 kV incoming cable to FGD Switchgear from Station Transformer bidder shall consider the full load current of the 63/31.5/31.5MVA Station Transformer as current carrying capacity of the cable.	
2.	IIF/ Section-I/ 2.11.14/ 6 of 30	On build-up of the rated voltage and frequency, the DG incomer breaker to DG PCC shall be closed automatically and the DG PCC outgoing breakers are normally kept closed. After the automatic closing of DG incomer breaker, the respective feeder of Emergency switchboard to DG PCC shall be closed automatically.	On build-up of the rated voltage and frequency, the D.G. incomer breaker to Emergency PMCC will be closed automatically.	
3.	IIF/ Section-I/ 5.12.00/ 18 of 45	DG shall be connected to DG PCC through cable.	DG shall be connected to Emergency PMCC through cable.	
4.	IIH/ Section-V/ 3.04.00/ 3 of 30	The essential loads of the FGD plant shall be fed from one Emergency FGD Switchboard with no bus-sections. The emergency FGD Switchboard shall normally be fed from FGD PMCC. On sustained loss of the normal A.C. supply to Emergency FGD Switchboard, the normal breaker shall be tripped automatically. The starting	The essential loads of the FGD plant shall be fed from one Emergency FGD Switchboard having incoming power supply from FGD PMCC of Units # 1 & 2, with a bus coupler. The emergency FGD Switchboard shall normally be fed from FGD PMCC of respective units, bus coupler being kept open. Refer Dwg. No. 17A14-DWG-E-001, Rev-8. On sustained loss of the normal A.C. supply to any section of the Emergency FGD Switchboard, the	

NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Electrical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply
		impulse to the D.G. Sets shall be derived from the voltage-monitoring relay connected to the Emergency FGD Switchboard. ……. ……. …….. The Emergency Switchboard shall have provisions for future expansion.	normal breaker of that section shall be tripped automatically and the bus coupler breaker shall be closed so that the normal supply incomer from the other unit will cater to the emergency loads. In case of failure of normal supply from both the units, the Main DG shall start. The starting impulse to the D.G. Sets shall be derived from the voltage-monitoring relay connected to the Emergency FGD Switchboard. On build-up of the rated voltage and frequency, the D.G. incomer breaker to Emergency PMCC will be closed automatically. As and when the A.C. Power from D.G. is made available to the emergency Switchboard as explained above the emergency auxiliaries will be started manually in staggered manner, except for Flue Gas Quenching water pump, which shall be started automatically. The standby DG set will also start automatically whenever main DG Starts up i.e. starting signal will go to main as well as standby DG set whenever an emergency arises. This will ensure quicker availability of emergency power in the event of failure of main D.G. set to start. However, the incomer from the standby DG set will be closed	

35720/2020/PS-SR-PM

NLC TAMILNADU POWER LIMITED (NTPL 2 X 500MW)
FLUE GAS DESULPHURIZATION SYSTEM

Errata - Electrical

S. No	Vol/Chapter/ Clause/ Page	Existing TS Requirement	Revised TS Requirement	Bidder's Reply
			automatically only when the main DG fails to start. The Emergency Switchboard shall have provisions for future expansion.	
5.	IIH/ Section-V/ 6.09.01-a./ 8 of 30	Two (2) sets of Battery and Battery Charger for each of the Diesel Generator sets.	One (1) set of Battery and Battery Charger for each of the Diesel Generator sets.	
6.	IIH/ Section-V/ 6.09.02-a xiii./ 9 of 30	Rated life of each battery shall be at least ten (10) years.	This clause is deleted.	
7.	IIH/ Section-V/ 6.10.08/ 13 of 30	The generator stator and rotor windings core insulation and all connections including main and neutral leads shall have Class-F insulation meeting the temperature rise limitations with Class-B insulation set forth for air cooled machines in IS : 4722.	The generator stator and rotor ..... and neutral leads shall have Class-H insulation meeting the temperature rise limitations with Class-F insulation ..... in IS: 4722."	

DWG. NO. 17A14-DWG-E-001 REV 8

FROM EXISTING UNIT SWBD#1BA
PANEL NO : 10

TO 220kv SWITCH YARD

STATION TRANSFORMER
63/31.5/31.5 MVA,
220/11.5/11.5/11kV

NGR
300A FOR 10SEC.

NGR
300A FOR 10SEC.

CABLE

CABLE

FROM EXISTING UNIT SWBD#2BB
PANEL NO : 14

UNIT#1

CABLE

LINE PT

11kV FGD SWGR., 1250A, 3ø, 3W, 50Hz, 40kA FOR 3 Sec.

BOOSTER ID FAN-1, 2000kW

SPARE MOTOR FEEDER (2000kW)

SPARE TRANSFORMER FEEDER (1250kVA)

TO DESALINATION PLANT

TO DESALINATION PLANT

BUS PT

FGDTR03
11/0.433kV
1250kVA
(TRAFO.)

FGDTR01
11/3.45kV
6MVA
(TRAFO.)

NGR

FGDTR02
11/3.45kV
6MVA
(TRAFO.)

NGR

FGDTR04
11/0.433kV
1250kVA
(TRAFO.)

BUS PT

MOTOR FEEDER (RO)

FGDTR05
11/0.433kV
1250kVA
(TRAFO.)

BOOSTER ID FAN-2, 2000kW

SPARE MOTOR FEEDER (2000kW)

SPARE TRANSFORMER FEEDER (1250kVA)

3.3kV FGD AUXILIARY SWGR., 1000A, 3ø, 3W, 50Hz, 40kA FOR 3 Sec.

TYPICAL MOTOR FEEDER

BUS PT

TYPICAL MOTOR FEEDER

BUS PT

11kV STATION SWGR., (OBA) EXISTING

11kV STATION SWGR., (OBC) EXISTING

415V FGD PMCC-1, 1600A, 3ø, 4W, 50Hz, 50kA FOR 1 Sec.

OAB-A 160kW

TYP. MOTOR FEEDER

TO MLDB

TO MLDB

TO ELEVATOR

TYP. MOTOR FEEDER

OAB-B 160kW

TO EMSWBD UNIT#1

UNIT#2

CABLE

LINE PT

11kV FGD SWGR.,1250A, 3ø, 3W, 50Hz, 40kA FOR 3 Sec.

BOOSTER ID FAN-3, 2000kW

FGDTR10
11/0.433kV
1250kVA
(TRAFO.)

MOTOR FEEDER (RO)

BUS PT

SPARE MOTOR FEEDER (2000kW)

SPARE TRANSFORMER FEEDER (1250kVA)

FGDTR08
11/0.433kV
1250kVA
(TRAFO.)

FGDTR06
11/3.45kV
6MVA
(TRAFO.)

NGR

FGDTR07
11/3.45kV
6MVA
(TRAFO.)

NGR

FGDTR09
11/0.433kV
1250kVA
(TRAFO.)

3.3kV FGD AUXILIARY SWGR., 1000A, 3ø, 3W, 50Hz, 40kA FOR 3 Sec.

TYPICAL MOTOR FEEDER

BUS PT

TYPICAL MOTOR FEEDER

BUS PT

BUS PT

TO DESALINATION PLANT

TO DESALINATION PLANT

BOOSTER ID FAN-4, 2000kW

SPARE MOTOR FEEDER (2000kW)

SPARE TRANSFORMER FEEDER (1250kVA)

11kV STATION SWGR., (OBB) EXISTING

11kV STATION SWGR., (OBD) EXISTING

415V FGD PMCC-2, 1600A, 3ø, 4W, 50Hz, 50kA FOR 1 Sec.

OAB-C 160kW

TYP. MOTOR FEEDER

TO MLDB

TO MLDB

TO ELEVATOR

TYP. MOTOR FEEDER

OAB-D 160kW

TO EMSWBD UNIT#2

MAIN D.G

STANDBY D.G

DG

DG

CABLE

CABLE

415V FGD EMERGENCY SWBD., UNIT#1, 3ø, 125A, 4W, 50Hz, 50kA FOR 1 Sec.

415V FGD EMERGENCY SWBD., UNIT#2, 3ø, 125A, 4W, 50Hz, 50kA FOR 1 Sec.

ELDB

(TYP)

(TYP)

(TYP)

(TYP)

(TYP)

ELDB

(TYP)

(TYP)

(TYP)

(TYP)

(TYP)

415V COMMON PMCC, 1600A, 3ø, 4W, 50Hz, 50kA FOR 1 Sec.

TYP. MOTOR FEEDER

TO ELEVATOR

TO AC VENTILATION

TO WELDING RECEPTICLE (L/S AREA)

TO WELDING RECEPTICLE (G/S AREA)

TO AC VENTILATION

TO ELEVATOR

TYP. MOTOR FEEDER

LIME STONE SYSTEM

GYPSUM SYSTEM

220V DC SYSTEM FOR FGD SYSTEM

FLOAT CHGR

FLOAT-CUM-BOOST CHARGER (TYP.)

220V DC. BATTERY#01

FLOAT CHGR

FLOAT-CUM-BOOST CHARGER (TYP.)

220V DC. BATTERY#02

220V DCDB, 2W, 50Hz, 25 kA* FOR 1 Sec.

EMG. LIGHTING PANEL

(TYP)

(TYP)

(TYP)

(TYP)

EMG. LIGHTING PANEL

(TYP)

(TYP)

(TYP)

(TYP)

UPS FOR FGD SYSTEM

FROM NEAREST ACDB

UPS STATIC INVERTER

STATIC INVERTER

PARALLELING UNIT

STATIC INVERTER

ISOLATION TRF.

SCVS

415V SCVS

240V OUTPUT

SSW-A

STATIC SWITCH ISOLATOR

MAINTENANCE BYPASS SWITCH

SSW-B

STATIC SWITCH ISOLATOR

MAINTENANCE BYPASS SWITCH

UPS ACDB

240V AC FEEDERS

LEGENDS:

- HT CIRCUIT BREAKER (SF6, VCB, ACB)
- LT CIRCUIT BREAKER
- TWO WINDING TRANSFORMER
- DG
- MCB
- MCCB
- DRAWOUT
- NSPBD/SPBD
- BATTERY
- BATTERY CHARGER
- SFU

NOTES:

1. RATING AND QUANTITY OF VARIOUS ELECTRICAL EQUIPMENT AND THEIR CONNECTION SHOWN IN THIS DRAWING ARE MINIMUM REQUIREMENT ONLY. ACTUAL RATING SHALL BE FINALISED BY THE VENDOR DURING DETAIL ENGINEERING.
2. 11KV SUPPLY TO DESALINATION PLANT SHALL BE ARRANGED BY DESALINATION PLANT CONTRACTOR.

* SHALL BE FINALIZED DURING DETAIL ENGINEERING.

FOR TENDER PURPOSE ONLY

REVIEWED							APPVD	NATURE OF REVISION & DESCRIPTION	REV	DATE	PREPD	CHECKED
				SM			DS	REVISED AS CLIENT'S COMMENTS	8	21.05.2019	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	7	25.01.2019	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	6	18.12.2018	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	5	14.12.2018	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	4	10.12.2018	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	3	10.08.2018	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	2	05.07.2018	BG	SM
				SM			DS	REVISED AS CLIENT'S COMMENTS	1	05.07.2018	BG	SM
				SM			DS	PRELIMINARY	0	19.04.2018	GD	SM
PROCESS	MECH	C&S	ARCH	ELEC	INST	OTHERS						

RELEASE STATUS	DATE	SIGNATURE
PRELIMINARY		
TENDER PURPOSE ONLY	19.04.18	SM
FOR APPROVAL		
FOR CONSTRUCTION		
REVIEWED: PROCESS		
REVIEWED: MECHANICAL		
REVIEWED: CIVIL & STRUCTURAL		
REVIEWED: ARCHITECTURAL		
REVIEWED: ELECTRICAL	19.04.18	SM
REVIEWED: INSTRUMENTATION		
REVIEWED: OTHERS		

OWNER: NTPL
NLC TAMILNADU POWER LIMITED

PROJECT:
2x500 MW THERMAL POWER PLANT AT TUTICORIN

TYPICAL POWER DISTRIBUTION ARRANGEMENT FOR FGD SYSTEM

DEVELOPMENT CONSULTANTS PVT LTD.
CONSULTING ENGINEERS
KOLKATA • MUMBAI • CHENNAI • NEW DELHI

PREPARED	GD	JOB NO.	17A14
CHECKED	SM	SCALE	NTS
APPROVED	DS	DATE	19.04.2018
DWG. NO.	17A14-DWG-E-001		REV 8
			SHEET 1 OF 1

FILE LOCATION: D:\DCPL\17A14\17A14-DWG-E-001_R8.dwg
PLOT DATE: 21 May 2019, 2:39 PM

A1 [841 x 594]

Control & Instrumentation(Mandatory Spares for FGD C&I)			
Sl. No.	**Equipment/Package Name**	**Quantity Required per each Unit**	**Remarks**
1	**NOT USED**		
2	**Large Video Screen**		
2.1	Lamp for Large Video Screen Display (DLP type)	10 (Ten) nos.	
2.2	Video Input Card	1No.	
2.3	Video output Card	1No.	
2.4	Interfacing Module/componets with DCS	1No.	
3	**PLC System**		
3.1	CPU Card	1No.	
3.2	Comunication Processor Module	1No. for each type	
3.3	Binary Input Card	10% of total nos. used in the system or minimum 4(four) nos. whichever is more.	
3.4	Pulse Input Card	10% of total nos. used in the system or minimum 2(two) nos. whichever is more.	
3.5	Analog Input Card (4 to 20 mA type)	10% of total nos. used in the system or minimum 2(two) nos. whichever is more.	
3.6	Analog Input Card (TC input type)	10% of total nos. used in the system or minimum 2(two) nos. whichever is more.	
3.7	Analog Input Card (RTD input type)	10% of total nos. used in the system or minimum 2(two) nos. whichever is more.	
3.8	Binary Output Card for contact	10% of total nos. used in the system or minimum 4(four) nos. whichever is more.	
3.9	Binary Output Card for Voltage (24VDC)	10% of total nos. used in the system or minimum 4(four) nos. whichever is more.	
3.10	Pulse output Card	1No.	
3.11	Analog Output Card (4 to 20 mA type)	10% of total nos. used in the system or minimum 2(two) nos. whichever is more.	
3.12	Interposing Realy	10% of total nos. used in the system or minimum 4(four) nos. whichever is more.	
3.13	Output Relay modules/ Relay Board & Auxiliary Relay	10% of total nos. used in the system or minimum 4(four) nos. whichever is more.	
3.14	Communication Modules	1No. for each type	
3.15	Prefab-cable with connector for CPU, Communication Card and I/O racks	1No. for each type	
3.16	Networking Modules/Components/Switch	1No. for each type	
3.17	Power Supply Unit for CPU, Communication Card and I/O racks	10% of total nos. used in the system or minimum 2(two) nos. whichever is more for each type and rating.	
3.18	RAM Backup Battery	2 (two) nos.	
3.19	MCB	1No. for each type and rating	
3.20	Special Fuse for the Cards	Each type/rating of fuse, 25% of total nos. used in the system or minimum 25 nos. whichever is more.	
3.21	HMI Unit		
3.21.1	Monitor	1No.	
3.21.2	Key Board	1No.	
3.21.3	Mouse	1No.	
3.22	Not used		
3.23	Micro PLC system (i.e. inegrated CPU & I/O system, where above mentioned components are not applicable)	One Complete Set	
4	**Field Instrument**		
4.1	Electronic Transmitters (Pressure, Differential Pressure, Level,Speed etc.) all types	10% or minimum 1 no. (whichever is higher) of each type and model/range used in the system	
4.2	Switch (Pressure, Differential Pressure, Level, Flow, Temperature etc.)	10% or minimum 1 no. (whichever is higher) of each type and model/range used in the system	

4.3	Thermocouple	10% of each type and length of the total nos. used in the system or minimum 2(two) nos. whichever is more.		
4.4	RTD	10% of each type and length of the total nos. used in the system or minimum 2(two) nos. whichever is more.		
4.5	Thermo-well for both TC and RTD	One no. for each type and rating/length used in the system		
4.6	Solenoid Valve			
4.6.1	Complete Solenoid Valve Assembly	2Nos. for each type and rating used in the system		
4.6.2	Coil (single or double coil type)	10% of total nos. used in the system or minimum 5(five) Nos. whichever is more for each type and rating.		
4.7	Gauge (Pressure, Differential Pressure, Temperature, Level)	10% of total nos. used in the system or minimum 1(one) no. whichever is more for each type and range.		
4.8	Air Filter Regulator complete set with pressure gauges	5 Nos.		
4.9	Rotameter	10% of total nos. used in the system or minimum 2(Two) nos. whichever is more for each type, rating,/model and size used in the system.		
4.10.	Gauge Glass / Level Indicator	1No. for each type and size		
4.11	Erection Hardware			
4.11.1	Transmitter's Manifold	10% of total nos. used in the system or minimum 2(Two) nos. whichever is more for each type, rating,/model and size used in the system.		
4.11.2	Impulse Line Root valve	10% of total nos. used in the system or minimum 4(four) nos. whichever is more for each type, rating,/model and size used in the system.		
4.11.3	Impulse Line fittings	Each type/size 25 Nos.		
4.11.4	Impuse Pipe	Each type/size 25 Mtrs.		
4.11.5	SS Tube	Each type/size 25 Mtrs.		
4.11.6	Fittings for SS Tube	Each type/size 25 Nos.		
4.12	Cable			
4.12.1	Thermocouple Cable	250 Mtrs. of each type, size & rating of Cables		
4.12.2	Control & Instrumentation Cable	250 Mtrs. of each type, size & rating of Cables		
5	**NOT USED**			
6	**CEMS / Flue Gas Analysis**			
6.1	Smoke density / Opacity monitoring			
6.1.1	IR source / Transmitter unit	1 (one) no.		
6.1.2	Sink/Receiver unit	1 (one) no.		
6.2	CO, NO_X, SO_X Analyser			
6.2.1	Filter element of Air dryer	1 no.each type		
6.2.2	IR Source unit	1 no.		
6.2.3	Reflector Unit	1 no.		
6.2.4	Gas difuser window unit	1 no.		
6.3	Oxygen Analyser			
6.3.1	Field Sensor	2(two) nos. complete unit		
6.3.2	Field Transmitter/complete Electronic unit	1(one) no. complete unit		
6.3.3	Power supply Card	1 no.		
6.3.4	Instrumentation Hardware (viz, isolation valve, solenoid valve etc.)	1 no. each items/type		
6.4	Co-Analyser			
6.4.1	Field sensor	2 (two) nos. complete unit		
6.4.2	Field Transmitter/Complete Electronic unit	1 (one) no. complete unit		
6.4.3	Power supply Card	1 no.		
6.4.4	Instrumentation Hardware	1 no each item/type		
6.5	Mercury Analyzer			
6.5.1	Field Sensor	2(two) nos. complete unit		
6.5.2	Field Transmitter/complete Electronic unit	1(one) no. complete unit		

6.6	Ultrasonic Gas flow measurement			
6.6.1	Field Sensor	2(two) nos. complete unit		
6.6.2	Field Transmitter/complete Electronic unit	1(one) no. complete unit		
7	**Pneumatic Control Valve & Power Cylinder (for Modulating Type & On-Off/Isolating Type)**			
7.1	Control Valve			
7.1.1	Pneumatic Diaghragm for Diaghragm actuated valve	2(two) nos. for each type of Actuator		
7.1.2	Actuator Seal Kit for Pneumatic Cylinder actuated valve	2(two) nos. for each type of Actuator		
7.1.3	Gland Packing	1(one) set for each type of Control Valve		
7.1.4	Plug, Seat, Cage, Stem etc.	1(one) set for each type of Control Valve		
7.1.5	Retainer Ring, Seal Ring etc.	1(one) set for each type of Control Valve		
7.1.6	Gasket	2(two) Sets. for each type of Control Valve		
7.2	Power Cylinder			
7.2.1	Actuator Seal Kit	2(two) nos. for each type of Power Cylinder		
7.2.2	Gasket	2(two) Sets. for each type of Power Cylinder		
7.2.3	Complete Set of Power Cylinder	1(one) no. each type for all application		
7.3	Common Items for Control Valve & Power Cylinder			
7.3.1	Position Transmitter complete set	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.		
7.3.2	Control Valve/Power Cylinder E/P Positioner complete Set	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.		
7.3.3	Complete Set of Solenoid Valve for Pneumatic type On/Off Valve/Power Cylinder	2Nos. for each type & ratings		
7.3.4	Solenoid Coil for Pneumatic type On/Off Valve/Power Cylinder	5Nos. for each type & ratings		
7.3.5	Position Limit Switch for Pneumatic type On/Off Valve/Power Cylinder	10Nos. for each type & ratings		
7.3.6	Air Lock Relay	10Nos. for each type		
7.3.7	Signal Air Booster Unit	2Nos. for each type		
8	**NOT USED**			
9	**Local Control Panel and accessories**			
9.1	Selector switch & indicating lamps	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.		
9.2	Mosaic/Conventional Type Push button Station	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.		
9.3	Mosaic Type Push button Station with LED Indication	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.		
9.4	Mosaic Type LED Indication Station	10% of total quantity used in the system or minimum 2(two) nos. whichever is more for each type and model.		
9.5	Indicator / Recorder (as applicable)	1(one) No. each		
9.6	Annunciation System			
9.6.1	Each type of PCB (for non-PLC driven system)	1(one) No. each		
9.6.2	Lamp Box with Facia & Lamps (LED type)	10% with minimum 2 nos.		
9.6.3	Hooter	1(one) No.		
10	**Vibration Monitoring System**			
10.1	Vibration Transducers	10% of total quantity of each type used in the system or minimum 2(two) nos. whichever is more.		
10.2	Power supply module	02 Nos.		
10.3	Vibration Monitor cards	10% of total quantity of each type used in the system or minimum 2(two) nos. whichever is more.		
10.4	Other electronic cards	10% of total quantity of each type used in the system or minimum 2(two) nos. whichever is more.		

984/1409

35720/2020/PS-SR-PM

A REPORT ON SOIL INVESTIGATION FOR PROPOSED 2 X 500 MW NLC THERMAL POWER STATION AT TUTICORIN

Client:

NEYVELI LIGNITE CORPORATION

VOLUME-I

Prepared By:

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Submitted: June - 2005

35720/2020/PS-SR-PM

SUBSURFACE INVESTIGATION FOR PROPOSED 2 X 500 MW THERMAL POWER STATION AT TUTICORIN

VOLUME-1

INDEX

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986/1409

GETS/2005/811

24.08.2005

SOIL INVESTIGATION FOR PROPOSED 2 x 500 MW NLC THERMAL POWER PROJECT AT TUTICORIN, TAMIL NADU.

1.0 INTRODUCTION

M/s Neyveli Lignite Corporation Ltd has proposed to put up 2 x 500 M.W Thermal Power Station at Tuticorin in the Port Trust area. The work of conducting subsurface investigation was awarded to M/s Geostruct Engineering & Testing Services Baroda Vide Letter of Intent Lr. No. TM/IV/T.No.64/2004/CGM/C/2005 Dated 18.02.2005.

The object of the sub soil exploration was (i) To determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table, Static and dynamic properties of soil (ii) To suggest suitable type of foundation along with load bearing capacity.

The Power plant is proposed to be located at Tuticorin Port Trust area near the existing Toothukudi Thermal Power station of TNEB.

This report is in two volumes

Volume –1 covers description of tests carried out, recommendation of safe bearing capacity for different of foundations.

Volume –2 covers borelogs, trialpit logs, stratification sections, graphs and tables.

2.0 FIELD WORK

The actual investigation work was started on 17-04-2005 and was completed on 30.05.2005.

2.1 Boreholes and Trial Pits

Twenty boreholes of 150mm diameter were drilled through the soil up to 5.0m depth in rocky strata. The depth of boreholes varied from 8.5m to 20.0m below existing ground level depending upon the depth at which rock was encountered. The work was in general accordance with IS: 1892 – 1979. The boreholes were located as shown in the location plan attached as Plate - 1. Plate 2 to 21 shows the bore logs detail.

Ten trial pits (3m x 3m) are excavated for visual observation of substrata up to depth of 3.0m. Unconfined compression test were conducted using pocket penetrometer in the field and disturbed / undisturbed samples are collected from each trial pit for laboratory testing (Plate 22 to 26).

2.1.1 Disturbed Samples

Disturbed representative samples were collected, logged, labelled and placed in polythene bags.

2.1.2 Undisturbed Samples

Undisturbed soil samples are collected in 70mm / 100 mm diameter thin walled sampler (Shelby tube) from the borehole. The sampler used for the sampling had smooth surface and appropriate area ratio and cutting edge angle thereby minimising disturbance of soil during sampling.

2.1.3 Water Samples

Water table encountered at a depth of about 0.18m to 0.70m below ground level during the sub soil exploration work carried out in the month of April - May 2005. Water samples were collected in 1 litre PVC cans from each borehole for chemical analysis.

2.1.4 Method of Sampling

Sampler was coupled together with a sampler head to form a sampling assembly. The sampler head provide a non-flexible connection between the sampling tube and the drill

rods. Vent holes are provided in the sampler head to allow escape of water from the top of sampler tube during penetration. The sampling tubes were made free from dust and rust. Coating of oil was applied on both sides to obtain the undisturbed samples in best possible manner.

The sampler was then lowered inside the borehole on a string of rods and driven to a pre-determined level. On completion of driving the sampler is first rotated within the borehole to shear the soil sample at bottom and then pulled out. Upon removal of the sampling tubes, the length of sample in the tube was recorded. The disturbed material in the upper end of the tube, if any, was completely removed before sealing.

The soil at the lower end of the tube was trimmed to a distance of about 10 to 20 mm. After cleaning and inserting an impervious disc at each end, both ends were sealed. The empty space in the sampler, if any, was filled with the moist soil, and the ends covered with tight wrapper. The identification mark was then made on each sample.

2.2 Standard Penetration Test

The standard penetration tests were conducted in each bore as per IS: 2131: 1981 (Reaffirmed 1987). The split spoon sampler resting on the bottom of bore hole was allowed to sink under its own weight, then the split spoon sampler was seated 15 cm with the blows of hammer falling through 750mm. The driving assembly consists of a driving head and a 63.5 kg weight. It was ensured that the energy of the falling weight is not reduced by friction between the drive weight and the guides or between ropes. The rods to which the sampler was attached for driving were straight, tightly coupled and straight in alignment. Thereafter the split spoon sampler was further driven by 30cm. The number of blows required to drive each 15cm penetration was recorded. The first 15cm of drive considered as seating drive. The total blows required for the second and third 15cm penetration is termed as penetration resistance - N value. The N-values for each borehole are given in bore logs attached as Plate 2 to 21.

2.3 Static Cone Penetration Test

The test was performed as per IS: 4968 (part-3): 1976, Reaffirmed - 1987.The test procedure for determining the static cone and frictional resistances consists of pushing the cone alone through the soil strata to be tested, then the cone and the friction jacket, and finally the entire assembly in sequence and noting the respective resistance in the first two cases. The cone was pushed through a distance in accordance with the design of the equipment and the need for the substrata and the cone resistance noted. Thereafter, the cone and the friction jacket were pushed together for a distance depending upon the design of the cone and friction jacket assembly and the combined value of cone and friction resistance noted. This procedure was repeated continuously up to refusal (10 tonne capacity of equipment).

The equipment was securely anchored to the ground at the test point for obtaining the required reaction. The jack of the driving mechanism was be brought to the top most position. The cone-friction jacket assembly was be connected to the first sounding rod and the mantle tube. This assembly was positioned over the test point through the mantle tube guide and held vertically. The plunger of the driving mechanism was brought down so as to rest against the protruding sounding rod.

For obtaining the cone resistance, the sounding rod only was pushed. Switching the gear clutch to the slow position, the drive handle was operated at a steady rate of 1 cm/s approximately so as to advance the cone only to a depth which is possible with the cone assembly available. During this pushing, the mean value of the resistance as indicated by the Bourdon gauges was noted ignoring erratic changes. For finding the combined cone and friction resistance of the soil, the sounding rod was pushed to the extent the cone has been pushed at the rate of 1 cm/s noting the mean resistance on the gauges, ignoring erratic changes. The procedure was repeated after pushing the combined cone friction jacket and mantle tube assembly to the next depth at which the cone and friction resistance values were required. Extension sounding rods and mantle tubes were added after every one metre of pushing as the test proceeds.

2.4 Plate Load Test

Plate load tests were performed in accordance to IS: 1888 - 1982 (Reaffirmed 1988). A pit at the test level, having width equal to five times the test plate, was excavated upto the test depth, which in our case was 0.5 to 0.6m since the test was to be carried out above watertable as per NLC specifications and subsequent letter. The pit was carefully levelled and cleaned and protected against disturbance or change in natural formation. The reaction was transferred by means of anchors away from the test pit. No support of reaction girder was located within the test pit. The test plate (450 mm x 450 mm) was placed on the level ground, so that the centre of plate coincides with the centre of reaction girder/beam. The hydraulic jack (Cap. 50T) was centrally placed over the test plate with the loading column in between the jack and reaction beam so as to transfer load to the test plate. A minimum seating pressure of 70 g/cm^2 was applied and removed before the starting of the load test.

The two supports of the reference rod was placed over the firm ground, fixed with two dial gauges resting at diametrically opposite ends of the plates. The dial gauges were so arranged that settlement was measured continuously without any resetting in-between.

The load on soil in cumulative equal increment was applied. The load was applied through hydraulic jack without impact, fluctuation or eccentricity. The settlement was observed for each increment of load at 1.0, 2.25, 4.0, 6.25, 9.0, 16.0, 25.0, and at hourly intervals or to a time when the rate of settlement gets reduced to a value of 0.02 mm/min. The next increment of load was then applied and the observations were recorded. The test was continued till; a settlement of 40mm had occurred.

2.5 Cyclic Plate Load Test

Cyclic plate load test was performed as per the procedure stated in IS: 5249 & IS: 1888. - 1982 (Reaffirmed 1988).

The load increment was applied through hydraulic jack without impact, fluctuation or eccentricity. The settlement was observed for each increment of load 1.0, 2.25, 4.0, 6.25, 9.0, 16.0, 25.0, and at hourly intervals or to a time when the rate of settlement gets reduced to a value of 0.02 mm/min. The load was then released to zero & rebound was recorded. Then next increment was applied, & again corresponding settlement & rebound recorded.

From the data obtained from cyclic plate load test the elastic rebound of plate corresponding to each intensity of loading was obtained & load versus elastic rebound curve was plotted. The Coefficient of elastic uniform compression Cu is then calculated using following relation.

$Cu = \frac{P}{Se}$; Where P = Pressure intensity kg/cm^2, Se = Elastic rebound in cm, The Coefficient obtained from the test is then corrected for 10 m^2 area of foundation. Barken (1962) suggested that the values of Cu for the area up to 10m^2 can be extrapolated as

$$\frac{Cu_1}{Cu_2} = \sqrt{\frac{A_2}{A_1}}$$

2.5 Block Vibration Test

Block vibration test is conducted for determination of dynamic parameters of the soil for design of machine foundations. The following dynamic parameters of soil are determined using Block vibration test.

a) Shear modulus (G)
b) Elastic Modulus (E)
c) Coefficient of Elastic Uniform Compression ($C\upsilon$)
d) Coefficient of Elastic Uniform Shear ($C\tau$)
e) Coefficient of Non-Uniform Compression ($C\phi$)
f) Coefficient of elastic non-uniform shear ($C\psi$)
g) Damping coefficient of soil (ε)

The block vibration test was conducted as per the procedure stated in I.S.5249: 1992. A test pit of size of 3.0m x 6.0m was dug up to 0.50m depth since water table at test location was at 0.6m depth and as per I.S. the test shall be carried out above watertable or

foundation depth whichever is higher. A plain cement concrete block of M-20 grade concrete of size 1.0m x 1.0m and 1.5 m high was casted with the foundation bolt for mounting the oscillator. The concrete block was cured for a period of 15 days before testing.

Test Setup: The forced vibration tests are carried out and the vibrations are generated with the help of Lazan type of mechanical oscillator, which can produce a sinusoidally varying force in vertical direction only with respect to time. The magnitude of the force depends upon the speed of the oscillator. For running the oscillator a speed controlled DC motor is used. The mechanical oscillator and the D.C. motor are mounted on the concrete block and suitable connection between the power supply, speed control unit, DC motor are made.

Vertical Vibration Test: the vertical vibration tests were carried out as per I.S.5249: 1992 (clause. 5.4.1). The acceleration pickup was fixed on the top of the block such that it senses vertical motion of the block. The mechanical oscillator was mounted on the top of the block such that it generates purely vertical sinusoidal vibrations and the line of action of vibration force passes through the centre of gravity of the block. After choosing a suitable value of angle of eccentricity of masses, the oscillator was made to run at constant frequency. The signals of the acceleration pickups are fed into vibration meter to measure the amplitude of the vibration. The frequency of the oscillator was increased in steps up to maximum frequency of exciter and signals were measured. The same procedure was repeated for various values of angle of setting of eccentricity mass. A graph of amplitude versus frequency is plotted for each excitation level to obtain the natural frequency of the soil and the foundation block.

The coefficient of uniform elastic compression is determined using following expression:

$Cu = \frac{4\pi f^2 nz \quad M}{A}$; Where fnz = Natural frequency obtained from graph, M = Mass of block, exciter and motor; and A = Contact area of block with the soil.

From the value of Cu obtained for the test block of contact area of 1.0 sqm, the value of Cu_1 for the foundation having contact area 10sqm can be obtained from equation.

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Reg. No. : R91/1462

$$Cu_1 = Cu \times \sqrt{1/10}$$

Determination of damping coefficient of Soil: In case of vertical vibration test the value of damping coefficient of soil (ε) can be determined using the relation as shown below:

$$\varepsilon = \frac{f_2 - f_1}{2 f_{nz}}$$

Where f_1 and f_2 are frequencies at which the amplitude is equal to $Xm / \sqrt{2}$

Xm = Maximum amplitude, f_{nz} = Natural frequency obtained from the graph

From the value of Coefficient of elastic uniform compression (Cu) the values of following coefficients can be determined using the relation given in clause no 8.1

a) Coefficient of Elastic Uniform Compression ($C\upsilon$)
b) Coefficient of Elastic Uniform Shear ($C\tau$)
c) Coefficient of Non-Uniform Compression ($C\phi$)
d) Coefficient of elastic non-uniform shear ($C\psi$)

$Cu = 1.5C\tau$
$C\phi = 3.46\ C\tau$
$C\psi = 1.5\ C\tau$

Wave Propagation Test: The wave propagation test was carried out as per I.S.5249:1992 clause: 7 for determination of the Shear Modulus and the Elastic Modulus of soil. The oscillator was mounted on the block such that it generates purely vertical sinusoidal vibrations and the line of action of the vibrating forces passes through the centre of gravity of the concrete block. The oscillator was set to work at constant frequency, which generates Rayleigh (Surface) waves. To measure the wavelength of this wave, one ray was drawn from the centre line of the block in the longitudinal direction. One of the geophones connected to the phase meter is fixed at a distance of 300 mm from the face of the block

along the ray drawn, such that the sensing axis of the geophone is vertical. Another geophone connected to the phase meter was moved along the ray away from the block keeping the sensing axis of the geophone vertical and recording the phase difference and distances between the geophones until the phase difference of more than 90 degree was met. A curve was plotted between the phase angle and the distance between the geophones. From the curve, the distance 'S' between the geophones for a phase difference of 90° was determined. The same procedure was repeated for various eccentricities of eccentric masses of the oscillator. Using the following relation the Rayleighs Wave length can be calculated in cms.

$$\lambda/4 = S$$

As the Rayleighs wave velocity and the shear wave velocity are nearly equal for soils thus the shear wave velocity can be found using the relation

Velocity of shear waves $Vs = \lambda f$

Where λ = Wave length in cm, S = Distance between geophones having phase difference of 90°, f = Frequency of Vibration, Vs = Velocity of shear Waves.

The shear modulus and the elastic modulus can be determined using the relation:

The shear Modulus $(G) = Vs^2 \times \rho$

The Elastic Modulus $(E) = 2 \times G (1 + \varepsilon)$

Where, ρ = Mass density of soil in Kg sec^2 / m^4

ε = Poisson's ratio of soil. Value assumed as 0.4

2.6 Cross-hole Test

The general principle of the cross-hole test is to establish the shear wave (S-wave) and compression wave (P-wave) velocities of the soil and rock layer at selected depths. The

waves are generated in an "impulse" borehole and are detected by the geophones in "receiver" borehole drilled at known distance from the impulse borehole.

Three number of bore holes were drilled in straight line at a spacing of 3m intervals. The source bore was inserted with casing of 100mm diameter while other two source holes, casing of 90mm was inserted as per the specifications of the instrument used. The tests were carried out at 3m interval upto 26m depth. The tests below 27m depth was not possible due to squeezing of source hole. For conducting the test, the hammer and geophone were lowered to the test depth. The cables were marked with 1 m depth interval to ensure that the geophone and the hammer are at the same depth. The hammer was secured in this elevation by inflating the rubber tubes provided at the side of the hammer using air pressure. Similarly the geophones were lowered in the receiving holes and secured at the same elevation as that of hammer in the same manner. The tests were started by pulling the strike rode up with the help of string and then allowing it to fall under its own weight. The signals were enhanced by stacking which were achieved by repeating the process. Striking at least five to ten times stacked the waves. The procedures were repeated at each test depth.

2.7 Field Permeability Test

The test was carried out as by constant head method as per the prosedure stated in I.S. 5529 1985. A hole of 100mm diameter was drilled up to test depth and casing is sunk by drilling and driving. The hole was then cleaned by means of scooping spoons and bailer. The hole was kept full of water while cleaning. The test was started by allowing clean water in the bore through metering system to maintain gravity flow at constant head. The flow is adjusted by the regulating valve to obtain steady water level in borehole. When the rate of flow becomes more or less constant, the rate of inflow was recorded.

$Permeability\ (k) = \left(\frac{Q}{5.5 x\ r\ H}\right)$, Where k = coefficient of permeability, Q = constant rate of flow into the hole, r = internal radius of casing, H = Differential head of water H (Gravity head) – Hf (Head loss due to friction). When k is measured in cm/s, Q in litre/min and H in

metre, above equation may be written as $Permeability\ (k) = C_1 \times \frac{Q}{H}$, where C_1 is constant and its value is 6.06 x 10^{-3} for 100mm diameter casing pipe.

2.8 Field Vane Shear Test :

The field vane shear test is for very soft purely clayey soils which get disturbed during sampling. Such type of purely clayey soft soil was not encountered during investigation hence this test was not conducted.

The summary of fieldwork carried out is given in Table - 1 here under:

Table: 1 Summary of Fieldwork

Bore Hole No	Co-ordinate		R. L. (m)	Depth (m)	No. of SPT	No. of UDS	No. of Core	Water table below GL (m)
BH-1	745W	528S	1.91	15.0	6	2	7	0.35
BH-2	778W	285S	2.29	12.0	7	-	5	0.46
BH-3	685W	664S	1.64	20.0	10	2	12	0.35
BH-4	592W	585S	2.05	14.0	7	2	6	0.49
BH-5	520W	421S	1.46	12.0	7	2	5	0.20
BH-6	517W	121S	1.76	12.0	6	2	5	1.10
BH-7	420W	657S	1.53	14.0	7	2	6	0.20
BH-8	360W	342S	1.92	14.0	6	2	6	0.34
BH-9	360W	482S	1.48	13.5	7	2	6	0.33
BH-10	325W	242S	1.96	8.5	7	-	2	0.71
BH-11	182W	500S	1.84	14.0	9	-	5	0.18
BH-12	50W	489S	2.11	14.0	8	1	5	0.22
BH-13	25E	342S	2.74	15.0	7	2	5	0.20

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Bore Hole No	Co-ordinate		R. L. (m)	Depth (m)	No. of SPT	No. of UDS	No. of Core	Water table below GL (m)
BH-14	145E	589S	2.10	15.0	6	2	5	0.25
BH-15	350E	410S	2.77	15.0	8	-	5	0.40
BH-16	680E	353S	2.34	13.0	7	-	5	0.40
BH-17	725E	550S	2.45	15.0	7	2	5	0.21
BH-18	990E	435S	2.22	12.5	8	-	5	0.25
BH-19	1310E	360S	2.40	14.0	7	2	5	0.19
BH-20	1265E	595S	1.69	13.0	7	-	5	0.70
TP-1	875W	625S	1.18	---	---	3	---	0.75
TP-2	810W	150S	2.24	---	---	3	---	0.45
TP-3	530W	335S	2.13	---	---	3	---	0.45
TP-4	530W	675S	3.87	---	---	3	---	2.0
TP-5	225W	590S	2.23	---	---	3	---	0.2
TP-6	170W	360S	2.85	---	---	3	---	0.3
TP-7	330E	575S	2.52	---	---	3	---	0.3
TP-8	565E	325S	2.21	---	---	3	---	0.25
TP-9	585E	615S	1.89	---	---	3	---	0.20
TP-10	1495E	375S	2.25	---	---	3	---	0.60
SCPT-1	753W	678S	1.70	6.0	---	---	---	---
SCPT-2	660W	482S	1.81	5.6	---	---	---	---
SCPT-3	467W	492S	1.85	6.2	---	---	---	---
SCPT-4	260W	510S	2.62	6.0	---	---	---	---
SCPT-5	430E	410S	2.65	6.4	---	---	---	---

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Bore Hole No	Co-ordinate		R. L. (m)	Depth (m)	No. of SPT	No. of UDS	No. of Core	Water table below GL (m)
SCPT-6	370W	670S	1.60	6.6	---	---	---	---
SCPT-7	360W	495S	1.52	6.6	---	---	---	---
CPLT-1	670W	470S	1.74	0.50	---	1	---	0.6
PLT-1	750W	660S	1.56	0.50	---	1	---	0.5
PLT-2	530W	525S	1.86	0.50	---	1	---	0.5
PLT-3	15E	517S	2.31	0.60	---	1	---	0.6
PLT-4	885E	520S	1.99	0.60	---	1	---	0.65
BVT-1	675W	540S	1.91	0.50	---	1	---	0.6
BVT-2	440W	460S	1.82	0.50	---	1	---	0.7
CBHT-1	500W	430S	1.62	---	---	---	---	---
FPT-1	745W	530S	1.90	2.75	---	---	---	0.35
FPT-2	25E	340S	2.74	2.30	---	---	---	0.20
FPT-3	145E	592S	2.10	3.0	---	---	---	0.19
FPT-4	1310E	368S	2.40	2.25	---	---	---	0.25

BH- Borehole, TP – Trial pit, SCPT – Static cone penetration test, CPLT – Cyclic Plate Load test, CBHT – Cross Bore Hole Test, BVT – Block vibration test, FPT – Field Permeability test.

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3.0 LABORATORY TEST

The laboratory tests on soil and rock samples were started immediately after the receipt of the same in the laboratory. Following laboratory tests are carried out to determine the physical and engineering properties of undisturbed and disturbed soil samples and rock samples.

1. Dry density and moisture content (IS 2720 part – 2 & 29)
2. Particle size analysis – (IS 2720 part – 4 1985)
3. Atterberg's limit - (IS 2720 part – 5 1985)
4. Specific gravity - (IS 2720 part – 3/sec2 1980)
5. Shear test - (IS 2720 part – 11 1986)
6. Consolidation test – (IS 2720 part – 15 1986)
7. Standard Proctor test – (IS 2720 part 7, 1980)
8. Chemical analysis of soil and water- (IS 2720 part –26 1986 & 27 1977)

All laboratory tests are carried out as per the respective Indian Standards.

3.1 Field Dry Density & Natural Moisture Content

The weight of undisturbed soil sample with sampler (Shelby tube) is determined after removing paraffin wax and loose soil. The total length of soil sample recovery was determined after deducting empty length from the total length of sampler. The volume of soil mass retained in sampler is thus determined from the known inside diameter of sampler and total length of soil mass. The soil mass was then removed and the average moisture content was determined by keeping the soil sample along with crucible in oven at 100-105 degree centigrade for 24 hours. The empty weight of the sampler was then found out. From the total weight of sampler with soil mass, the weight of empty sampler was deducted. The field density is then found out as

Field density (bulk) $= \frac{\text{weight of soil mass}}{\text{volume of soil mass}}$; and, Field dry density $= \frac{\text{Field bulk density}}{1+w}$

Where w is water content.

3.2 Particle Size Analysis

The sieve analysis is carried out in accordance with IS: 2720 (Pt.IV). The results are presented in the form of Grain size distribution curve.

Representative soil sample is obtained from the bulk soil sample collected or received from site by method of coning and quartering. Quantity of soil taken will be dependent on the maximum size of particle size present in the soil. Sieve analysis is conducted in two parts:

Soil fraction retained on 4.75mm ISS: Soil portion retained on 4.75 ISS is weighed. The sample is then separated into various fractions by sieving through the following sieves: 100, 75, 19 and 4.75 mm ISS

While sieving through each sieve, sieve is agitated so that sample rolls in irregular motion over the sieve, at no time the particles are pushed through; Care is also taken to see that no individual soil particles are broken, though particles adhering one another are rubbed by rubber pestle when required. Care is also taken not to over load the sieve beyond the permitted maximum load for respective sieve. The mass of the material retained on each sieve is recorded The percentage of soil retained on each sieve is then calculated on the basis of the total mass of soil taken and from these results, the percentage passing through each sieve is calculated.

Soil fraction passing 4.75 ISS: The portion of the soil passing 4.75 mm ISS is oven dried at 105 to 110 c. The portion is coned & quartered to obtain required representative quantity of the material. The material is weighed and placed in tray/bucket filled with water for soaking and loosening the adhered cohesive materials. The soaked soil specimen is then washed on 75 micron IS Sieve until the water passing the sieve is almost clear. The material retained on 75 micron IS Sieve is then transferred in a tray, dried in oven.

Sieve analysis is then conducted on a nest of sieves (viz. 2 mm, 425 and 75 micron ISS) either by hand or by using mechanical sieve shaker. The fraction retained on each of the sieves is weighed separately and masses recorded. Cumulative mass of soil fraction retained on each sieve is then calculated The weights are then converted into cumulative percentage retained and passing on the basis of the mass of the sample passing 4.75 ISS taken. The combined gradation on the basis of the total sample taken for analysis is finally calculated.

3.3 Atterberg's Limit

Liquid and plastic limits are determined by using procedure given in IS: 2720 (Pt-V). The results are given in result sheet. The weight of cone plus rod and plate is 148 gm. A soil sample weighing about 150gm from the thoroughly mixed portion of soil passing 425 micron was used for testing. The thoroughly wet soil paste is transferred to the cylindrical trough 150mm diameter and 50mm high of the cone penetrometer apparatus and levelled up to the top of trough. The penetrometer is adjusted such that the cone point just touches the surface of the soil paste in trough. The scale of the penetrometer is adjusted to zero and the vertical rod is released so that the cone is allowed to penetrate into the soil paste under its own weight. The penetration is noted after 30 sec. from the release of the cone. The reading is considered if the penetration reading is between 20mm and 30 mm. The moisture content of the soil paste corresponding to this is determined. The liquid limit of the soil which corresponds to the moisture content of a paste which would give 25 mm penetration of the cone is determined using formula:

$$W_{LL} = Wx + 0.01 (25 - W) (Wx + 15)$$

For determination of plastic limit, a soil sample weighing at least 20 gm from the soil sample passing 425micron IS sieve is thoroughly mixed with water such that it can be easily moulded with fingers. A ball is formed with about 8 to 10 gm of this soil & is rolled between the fingers and the glass plate with just sufficient pressure to roll the mass into a thread of uniform diameter of 3mm throughout its length. The soil is then kneaded together to a uniform mass and rolled again. The process is continued until the thread crumbles.

The pieces of crumbled soil thread are collected and moisture content is determined and reported as plastic limit.

3.4 Specific Gravity

The specific gravity of soil solids is determined by a 50ml density bottle. The weight (W1) of the empty dry bottle is taken first. A sample of oven-dried soil about 10-20 g cooled in a desiccator, is put in the bottle, and weight (W2) of the bottle and the soil is taken. The bottle is then filled with distilled water gradually removing the entrapped air either by applying vacuum or by shaking the bottle. The weight (W3) of the bottle, soil and water (full up to the top) is then taken. Finally the bottle is emptied completely and thoroughly washed and clean water is filled to the top and the weight (W4) is taken.

$$\text{Specific Gravity (G)} = \frac{(W_2 - W_1)}{(W_2 - W_1) - (W_3 - W_4)}$$

3.5 Shear Test

Triaxial (undrained) tests are carried out to determine the shear parameters. The shear tests are carried out in accordance with IS: 2720 (pt. X, XI, XII and XIII) on saturated samples. For unconsolidated undrained triaxial compression test, the undisturbed soil specimen having diameter 38 mm and height to diameter ration 2 is prepared and placed on the pedestal of the triaxial cell. The cell is then assembled with the loading ram and then placed in the loading machine. The cell fluid is admitted to the cell and the pressure is raised to the desired value. An initial reading of the gauge measuring axial compression of the specimen is recorded. The test is then commenced and sufficient number of simultaneous readings of load and compression measuring gauge being taken. The test is continued until the maximum value of the stress has been passed or until an axial strain of 20 per cent has been reached. Additional tests are carried out on identical specimen at confining pressure of 1 kg/cm^2, 2 kg/cm^2 and 3 kg/cm^2. The shear parameters are obtained from the plot of Mohr circles.

Direct shear test is carried out using shear box with the specimens (60mmx60mm). Specimen with plain grid plate at the bottom of the specimen and plain grid plate at the top of the specimen is fitted into position in the shear box housing and assembly placed on the load frame. The serrations of the grid plates are kept at right angle to the direction of shear. The loading pad is kept on the top grid plate. The required normal stress is applied and the rate of longitudinal displacement/shear stress application so adjusted that no drainage can occur in the sample during the test (1.25mm/min). The upper part of the shear box is raised such that a gap of about 1mm is left between the two parts of the box. The test is conducted by applying horizontal shear load to failure or to 20 percent longitudinal displacement whichever occurs first. The test is repeated on identical specimens.

3.6 Consolidation Test

The consolidation tests were carried out on undisturbed soil specimen in order to determine the settlement characteristics of soil at different depths. The tests were conducted in accordance to IS: 2720 (Pt-XV).

An undisturbed soil specimen is extruded to the consolidation ring of 60mm diameter. The edge is trimmed carefully such that the sample flushes with the top and bottom edges of the ring. The thickness of the specimen is measured and the weight is recorded. The bottom porous stone is then centred on the base of the consolidation cell.

The specimen is placed centrally between the bottom porous stone and the upper porous stone. A filter paper is provided in-between specimen and porous stones. Then the loading cap is placed on the top. The consolidometer is placed in position in the loading device and suitably adjusted. The dial gauge is then clamped into position for recording the relative movement between the base of the cell and the loading cap. A seating pressure of 0.05 kg/cm^2 is applied to the specimen. The cell is kept filled with water. After 24 hours the test is continued using a loading sequence on the soil specimen of 0.25, 0.5, 1.0, 2.0, 4.0, and 8.0 kg/cm^2. For each loading increment after application of load, readings of the dial

gauge is taken using time sequence 0, 0.25, 1, 2.25, 2, 6.25, 9, 16, 25, 36, 49 ... up to 24 hrs. From the observations of all incremental pressure, void ratio versus log (pressure) curve is obtained. The slope of the straight line portion is designated as compression index cc.

3.7 Standard Proctor Test

The test is conducted in accordance to IS: 2720 (pt-7) 1980 to determine the moisture content relationship. A 5 kg air dried soil passing 20 mm IS sieve is taken and thoroughly mixed. The mould with base attached is weighed to the nearest 1 g. The soil is then moistened by adding 8 to 10 per cent water and compacted in to the mould in three equal layers. Each layer is being compacted by 25 blows of 2.6 kg rammer dropped from a height of 310 mm. The blows are distributed uniformly over the surface of each layer. The extension collar is removed, soil is trimmed and mould with base plate is then weighed to nearest 1 g. The compacted soil specimen is removed and moisture content is determined. The process is repeated by adding more water of about 2 per cent of dry soil till the density of sample decreases. The curve in-between dry density and moisture content is plotted and maximum dry density and corresponding optimum moisture content is reported.

3.8 Chemical Analysis

pH value, Sulphate and chloride contents of soil and ground water are determined.

pH Value (IS 2720 Pt.26 - 1987): A 30 gm of the soil passing 425 micron IS sieve is taken in a 100 ml beaker. 75 ml of distilled water is added to it and then stirred. The pH Value is then measured using pre-calibrated pH meter.

Sulphate: To determine soluble sulphate (IS 2720 Pt 27) 10gm of soil sample is placed in a 250 ml bottle0 allowed to stand overnight frequently stirred. Filter and 25 ml of filtrate in a beaker is taken and added concentrated hydraulic acid to just neutralize the solution if it is found alkaline. More acid is added to make the solution acidic. Solution is then boiled. Barium chloride solution is then added in the stream with constant stirring till there is no precipitation with further addition. Beaker is then placed on the steam bath for a

minimum period of 4 hour and precipitates are allowed to settle. Precipitates are then filtered through ash less filter paper, dry and ignited & Cooled in the desiccator, weighed and noted the weight of the residue. This is the weight of barium sulphate. A corresponding weight of sodium sulphate is calculated and its percentage is determined.

The chemical analysis of water is done as per IS 3025 - 1964.

Sulphate in the sample are precipitated by barium chloride and precipitate weighed as barium sulphate and reported as sulphate in mg/lit.

Chloride: The sample after neutralisation is titrated against standard silver nitrate solution using potassium chromate indicator. 100 ml of the sample is taken and 1 ml of potassium chromate indicator is added. It is then titrated against standard silver nitrate solution with constant stirring until there is perceptible reddish coloration. Chlorides (as Cl) is then calculated and reported in mg/lit.

The following laboratory tests are carried out on rocky samples and the tests are briefly described as below.

1. Classification of rock
2. Water absorption
3. Bulk density
4. Uniaxial compressive strength

All the laboratory tests are carried out as per relevant IS Codes. The procedure is briefly described as below :

3.1.1 Water Absorption

a) This method of test covers the procedure for determining the water absorption of rock sample in form of lumps of irregular shape-geometry and the rock which do not swell or disintegrate when immersed in water & oven dried.

b) A representative sample comprising of least min. 10 lumps of irregular geometry each of about 50 g or a min. dimension of atleast 10 times the max. grain size, whichever is greater is selected. The sample is washed in water to remove loose particles. The sample is saturated in water immersion vessels & entrapped air is removed by gentle agitation.

c) The vessels is then emptied & the sample is allowed to drain to become surface dried. The sample is then weighed (B). The sample is then dried in oven at 100 to 110 degree centigrade for not less than 24 hours. It is then cooled to room temperature & weighed (A). The water absorption is calculated from the following formula :

$$\text{Water absorption} = \frac{B - A}{A} \times 100 \text{ , percent}$$

3.1.2 Bulk Density of Rock sample

The procedure given for water absorption test in sub para (a) is followed :

a) The saturated sample is then carefully introduced in a water displacement vessel to measure volume of sample. This vessel is siphon type. Water equal to the rock sample gets displaced by over flowing under siphon action and thereby volume of rock sample is determined. (V)

The bulk density is then determined by following formula.

Bulk dry density = w/v, g/cc

Uniaxial Compressive Strength

This test is conducted on the core samples having length about 1.5 to 2.0 times the diameter of the sample on the universal compression-testing machine. For carrying out this test and analysis of the test provisions of IS: 9143: 1979 has been adopted.

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4.0 SUB SOIL STRATIFICATION

Field and laboratory test data reveal in general that the sub soil strata are poorly graded fine silty sand up to about 5.0m to 6.0m depth. Below that there is a layer of weathered calcareous limestone having thickness of about 2.0m. Below that and up to the depth investigated, the calcareous lime stone is available. There is no much variation in sub strata, however there is a presence of about 1.0m to 3.0m thick clayey silt pocket nearby borehole BH-1 and BH-8 at about 3.0m to 4.0m depth from the existing ground level. Plate 27 to 28 shows the generalised cross sectional profile of the sub strata along North – South and East – West direction.

The rock core obtained from each borehole during drilling operation was examined and its detail geological description was given in the form of Table attached as Plate 29.

5.0 DISCUSSION ON FIELD AND LABORATORY TEST RESULTS

5.1 Field Test

5.1.1 Standard Penetration Test

A comparative study of observed N value (i.e. number of blows /30cm penetration) has been done for all the boreholes. The SPT N values for individual borehole are given in Plate 2 to 21. The depth wise SPT – N value (observed) in different boreholes is shown in Table 2. The SPT-N values (observed) are in the range of 5 to more than 50 in sandy stratum. This range values indicates loose to dense silty sandy stratum. From the SPT – N values variation it infers that the sub stratum up to about 1.0m depth and in between 4.0m to 5.0m depth is loose to medium in nature at many locations. The SPT – N value below 6.0m depth is further increases to more than 50 indicating dense sandy stratum in all the boreholes with few exceptional values. The SPT – N values in weathered rock shows more than 100 in all the boreholes. The SPT-N values variation in each borehole is shown in bore logs attached as Plate 2 to 21.

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Table 2: Summary of SPT Results

Depth(m)	Bore Hole BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	BH9	BH10	BH11	BH12	BH13	BH14	BH15	BH16	BH17	BH18	BH19	BH2
1	2	43	46	7	5	58	28	20	13	69	27	4	5	14	14	30	12	23	8	41
2		48								60	25	25			50	48		22		43
3	24	56	2	9	17	21	19	24	25	10	46	27	30	19	49	53	14	30	16	39
4		5								8	19		13		56	7		31		20
5	5	10	88	83	28	27	73	76	>100	10	24	17	31	27	50	7	30	6	39	15
6		.	76	>100	86	86	91		>100	>100	>100	>100					50	10	42	9
7										>100		>100								
7.5	>100	>100	46	>100	>100	>100	>100	>100	>100		>100		>100	>100	55	>100	>100	>100	>100	>10
8																				
8.5			>100																	
9																				
10																				
10.5	>100	>100	>100	>100	>100	>100	>100	>100	>100		>100	>100	>100	>100	>100	>100	>100	>100	>100	
11.5					>100															
12																				
13									>100											
13.5			>100				>100	>100			>100	>100	>100	>100	>100		>100		>100	
14	>100			>100																
16.5			>100																	
19.5			>100																	

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5.1.2 Static Cone Penetration Test (SCPT)

Seven SCPT were conducted at location shown in location map (Plate - 1). The tests are conducted up to 6.0m to 7.0m depth as per procedure shown above. The observation table along with graphs of depth versus cone penetration resistance (qc) in kg/cm^2 are shown in Plate 30 to 36. The observed value is corrected and the average value of qc at each location is determined between the level of the base of footing (assumed as 1.50m depth below existing GL) and the depth equal to 1.5 to 2 times the width of the footing (assumed as 1.0m). The weighted average of the qc values is determined for each location and minimum of the average values is used for the further computation.

From plot of depth versus cone penetration resistance (Plate 30 to 36), it infers in general that the cone resistance value is very low in upper 1.0m depth and in between 4.0m to 6.0m depth in all the tests. The cone resistance value increases in between depth of about 1.0m to 4.0m. The weighted average cone penetration resistance within the average influence zone for shallow foundation (assumed as 1.50m to 4.0m depth below ground level) from the various tests are works out as shown in Table 3 below:

Table 3: Weighted Average Cone Resistance Value

Test	Weighted Average Cone resistance (kg/cm^2)
SCPT1	32.75
SCPT2	31.15
SCPT3	42.45
SCPT4	74.58
SCPT5	80.27
SCPT6	59.53
SCPT7	51.94

The minimum average cone resistance value is 31.15 kg/cm^2, and therefore it is selected for further computation.

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As per IS Code (IS: 6403), let $q_{ult-net} / q_c = 0.13$ (For B = 1.0m)

Therefore, $q_{ult-net} = 0.13 \times 31.15 = 4.0495$ kg/cm^2.

$q_{net-safe} = q_{ult-net} / FOS\ (3) = 4.0495 / 3 = 1.349$ kg/cm^2. say 13.49 t/m^2.

Settlement can be computed using Meyerhof's approach as shown below:

$q_{safe-pr} = 0.392\ qc \left(\frac{B+0.3}{B}\right)^2$ (For 25mm settlement).

where qc = 31.15 kg/cm^2, and B = width of footing.

Thus for 1m width, qsafe-pr = $0.392 \times 31.15 \left(\frac{1+0.3}{1}\right)^2 = 20.64$ t/m^2 for 25 mm settlement.

5.1.3 Plate Load Test

Plate 37 to 40 shows the load settlement curve of plate load test conducted at 0.5m to 0.6m depth using 45 x 45 cm size of plate. The general nature of the load settlement curve is interpolation type shear failure, except in load test no. 2, where local shear type of failure was observed. Load test no. PLT-1 to PLT-4 shows net safe bearing capacity as shown in Table 4 below:

Table 4: Summaries of Plate Load Test Results

Test	Location	RL of test	Depth (m)	Net safe bearing
PLT1	750W, 660S	1.56	0.5	2.0
PLT2	530W, 525S	1.86	0.5	1.12
PLT3	15E, 517S	2.31	0.6	19.6
PLT4	885E, 520S	1.99	0.6	5.2

The net safe bearing capacity is evaluated from the graph by drawing tangent lines as shown on load settlement curves attached as plate 37 to 40.

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5.1.4 Cyclic Plate Load Test

Plate - 41 shows load settlement curve of cyclic plate load test conducted at 0.5 m depth below existing ground level using 45 cm x 45 cm plate size. From each loading - unloading cycle, elastic rebound was determined and a plot of load versus elastic rebound was generated as shown in Plate 41. The slope of load intensity - settlement plot is the coefficient of elastic uniform compression (Cu). $Cu = P/Se$ kg/cm^3

Where P = Load intensity in kg/cm^2, and Se = Elastic rebound corresponding to P in cm.

The Cu varies with the contact area of the base. Hence, the value of Cu obtained from the test needs a correction due to contact area. Barken (1962) suggested that the values of Cu for the area up to 10m^2 can be extrapolated as $\frac{Cu_1}{Cu_2} = \sqrt{\frac{A_2}{A_1}}$. The Cu value evaluated from cyclic plate load test for foundation area of 10 sq m is 0.268 kg/cm^3.

Compression index Cu, the coefficient of elastic uniform shear $C\tau$, the coefficient of elastic non uniform compression $C\phi$, and the coefficient of elastic non uniform shear $C\psi$ are related to each other by the relation given below (Ref. IS: 5249 – 1992) :

$Cu = 1.5$ to $2\ C\tau$
$C\phi = 3.46\ C\tau$
$C\psi = 1.5\ C\tau$
Therefore $C\tau = 0.134$ to 0.179 kg/cm^3
$C\phi = 0.464$ to 0.619 kg/cm^3
$C\psi = 0.201$ to 0.269 kg/cm^3

5.1.5 Block Vibration Test

Two block vibration tests are carried out in a test block of size 1.0m X 1.0m X1.50m. Both wave propagation and vertical vibration tests are carried out at both the places. Plate 42 and 43 shows test observation along with graphs and computation of dynamic parameters for both the tests. The computation of dynamic parameters are shown in Plate 42 and 43 for test 1 and test 2 respectively. For test 1(BVT1), the dynamic parameters Cu, $C\tau$, $C\phi$, and

Cψ are 4.97kg/cm^3, 2.49kg/cm^3, 8.60kg/cm^3, and 3.73kg/cm^3 respectively. While for test 2(BVT2), Cu, Cτ, Cϕ, and Cψ are 5.22kg/cm^3, 2.61kg/cm^3, 9.03kg/cm^3, and 3.92kg/cm^3 respectively.

5.1.6 Cross-hole Test

From the recorded first arrivals of P wave (tp) and S wave (ts) various dynamic parameters are determined as shown in Plate 44. The summary of dynamic parameter as obtained from the test is shown in Table 5 here under.

Table 5: Summary of Dynamic Parameters

Depth (m)	Soil Type	Unit weight (kN/m^3)	Dynamic Shear Modulus (G), MPa	Dynamic Young's Modulus (E), MPa	Poisson's ratio
Location: Test bore-1, Distance: 2.97m					
3	Fine Sand	17	164	422	0.29
6	Clayey Sand	18	189	506	0.34
9	Weathered Rock	20	415	1082	0.30
12	Weathered Rock	20	419	1083	0.29
15	Weathered Rock	20	460	1179	0.28
18	Weathered Rock	20	460	1143	0.24
21	Weathered Rock	20	432	1081	0.25
24	Weathered Rock	20	652	1641	0.26
26	Weathered Rock	20	628	1567	0.25
Location: test bore 2, Distance: 6.03m					
3	Fine Sand	17	156	404	0.29
6	Clayey Sand	18	204	541	0.33
9	Weathered Rock	20	407	1062	0.31

Depth (m)	Soil Type	Unit weight (kN/m^3)	Dynamic Shear Modulus (G), MPa	Dynamic Young's Modulus (E), MPa	Poisson's ratio
12	Weathered Rock	20	439	1137	0.30
15	Weathered Rock	20	456	1175	0.29
18	Weathered Rock	20	449	1112	0.24
21	Weathered Rock	20	425	1061	0.25
24	Weathered Rock	20	713	1770	0.24
26	Weathered Rock	20	699	1734	0.24

5.1.7 Field Permeability Test

Four in-situ permeability tests were carried out using constant head method as discussed above. The observation table along with calculation is shown in Plate 45 to 48. The in-situ permeability values for different tests are as shown in Table 6 below:

Table 6: Summaries of Field Permeability Tests

Test No	Location	Type of Soil	Depth of Test (m)	Permeability (cm/s)
FPT1	745W, 530S	Silty fine sand	2.75	$2.58x10^{-5}$
FPT2	25E, 340S	Silty fine sand	2.30	$1.67x10^{-5}$
FPT3	145E, 592S	Fine sand	2.25	$1.38x10^{-4}$
FPT4	1310E, 368S	Yellow fine sand	3.0	$1.15x10^{-4}$

5.2 Laboratory Test

The detail result sheets are attached as Plate 49 for soil test results and Plate 50 for rock test results..

5.2.1 Field Density - Field Moisture Content

Field dry density and moisture content vary with depth. The dry density varies in the range of 1.21g/cc to 1.67g/cc with average value of 1.46g/cc. the moisture content is in the range of 7 percent to more than 50 percent at certain locations. Silty clayey stratum shows higher moisture content compare to sandy stratum. This higher moisture content is due to high water table in the vicinity.

5.2.2 Particle Size Analysis

Plate 51 to 67 shows the gradation curves of the various soil samples. Silty clayey soil shows more than 50 percent fines in almost all the results. The silty sandy strata show more than 50 percent presence of sand particles. The detail results are tabulated in results sheets attached as plate 49.

5.2.3 Atterberg's Limit

Silty clayey layer shows liquid limit, plastic limit and plasticity index in the range of 26% to 84%; 24% to 46%; and 9% to 47% respectively. Silty sandy layer shows non-plastic behaviour.

The soil is classified as per I. S. Classification system using sieve analysis and Atterberg's limit results as shown in result sheet attached as Plate 49.

5.2.4 Specific Gravity

The values are given in result sheet attached as Plate 49. The general range of specific gravity for all the three layers is in-between 2.52 to 2.66 with some exceptional values.

5.2.5 Direct Shear Test

Triaxial shear (uu) test are performed on silty-clayey soil samples, while direct shear tests are conducted for silty-sandy soil of samples. Triaxial shear test shows the cohesion value in the range of 0.25 kg/cm^2 to 0.40 kg/cm^2 with some exceptional high and low values.

Samples show angle of internal friction in the range of 0 to 4 degrees. Samples are tested after saturation.

Direct shear test on silty -sandy stratum shows no cohesion with angle of internal friction in the range of 25 to 32 degree.

Plate 68 to 99 shows the failure envelops for direct shear test and triaxial shear test.

5.2.6 Consolidation Test

Consolidation tests were conducted on various soil samples collected from different bore holes at various depths. The results of consolidation tests of various soil samples are shown in result sheets attached as Plate 49. Test result shows Cc value in the range of 0.07 to 0.23 with pre-compression pressure in the range of 0.55kg/cm^2 to 1.30 kg/cm^2 (Plate 100 to 109). The 'm_v' parameters for the pressure range of 2-4 kg/cm^2 are in the range of 0.0057cm^2/kg to 0.0254cm^2/kg.

5.2.7 Standard Proctor

Plate 110 to 119 shows Standard Proctor test curves. The test results obtained are as shown in Table 7.

Table – 7 Standard Proctor Test

Location	Depth (m)	Std. Proctor Test	
		MDD (g/cc)	OMC (%)
BH-3	0.5	1.44	22.1
BH-4	0.5	1.62	12.5
BH-5	0.5	1.66	14.0
BH-6	0.5	1.65	8.0
BH-7	0.5	1.53	16.0

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Location	Depth (m)	Std. Proctor Test	
		MDD (g/cc)	OMC (%)
BH-8	0.5	1.58	14.0
BH-16	2.0	1.50	11.0
BH-17	1.0	1.60	15.2
BH-20	0.5	1.61	12.0
BH-20	2.0	1.52	17.0

5.2.8 Chemical Analysis

Results of chemical analysis of various soil and water samples are presented in Table-8 and 9.

Table - 8 Chemical Analysis of Soil

Borehole No	Depth (m)	pH	Chloride (%)	Sulphate (%)	
				SO_3 (2 Water: 1Soil)	SO_3 (10 Water: 1 soil)
BH-1	0.5	7.9	4.0	3.00	1.31
BH-2	2.0	7.8	4.5	3.31	1.39
BH-4	4.0	7.8	4.2	3.45	1.39
BH-7	3.0	8.0	4.8	3.80	1.64
BH-9	1.0	7.9	5.0	3.40	1.48
BH-10	0.5	8.2	4.4	3.13	1.31
BH-11	2.0	8.0	4.2	3.72	1.49
BH-14	3.0	7.8	3.8	3.64	1.43
BH-16	2.0	7.7	4.0	3.60	1.44
BH-18	3.0	7.8	4.5	3.72	1.39

Table – 9 Chemical Analysis of Water

Bore hole No	pH	Chloride (mg/l)	Sulphate SO_3(mg/l)
BH-1	7.4	5000	1639
BH-2	7.2	6000	1721
BH-4	7.2	6500	1967
BH-7	7.4	7000	2131
BH-9	7.2	6820	1967
BH-11	7.2	7200	1639
BH-13	7.7	5700	1800
BH-15	7.5	6000	2295
BH-17	7.5	6500	3459
BH-19	7.4	7000	2787

Soil and water sample shows high concentration of sulphate, and hence precautions against sulphate attack is necessary. As per IS 456: 2000, Supersulphated or sulphate resisting Portland cement is recommended. Minimum cement content shall be 370 kg/m3 and maximum Face Water – Cement ratio shall be 0.45. Also, as ground water samples shows high concentration of sulphate and chloride, it is not suitable to use for construction purpose.

5.2.9 Rock Test Results

The rock samples as obtained from the different boreholes in the form of rock cores are further tested in the laboratory for compressive strength. The rock at the site is calcareous sand stone and its compressive strength varies in the range of 40 kg/cm^2 to 160 kg/cm^2, water absorption varies from 0.7% to 3.0% and specific gravity varies from 2.34 to 2.70 with

some exceptional high and low values. This variation is due to extent of weathering effect and mode of formation of rock t the site. The bore wise detail test results are shown in Plate 50.

6.0 SOIL BEARING CAPACITY

The following formula is used for calculating ultimate net bearing capacity in the case of strip footings: (Ref: IS: 6403 - 1981)

a) In case of general shear failure:

$$d = C\,Nc + q\,(Nq-1)\,0.5\,Br\,Nr.$$

b) In case of local shear failure:

$$d = 2/3\,C\,N'c + q\,(N'q-1) + 0.5\,Br\,Nr'$$

The ultimate net bearing capacity obtained for strip footing is modified to take into account, the shape of the footing, inclination of loading, depth of embedment and effect of water table. The modified bearing capacity formula is given as under:

a) In case of general shear failure:

$$Qa = C\,Nc\,Scdc\,ic + q\,(Nq-1)\,Sq\,dq\,iq + 0.5\,Br\,Nr\,Sr\,dr\,ir.\,W'$$

b) In case of local shear failure:

$$Qu' = 2/3\,C\,N'c\,Sc\,dc\,ic + q\,(N'q-1)\,Sq\,dq\,iq + 0.5\,Br\,N'r\,Sr\,dr\,ir\,W'$$

Shape Factor

	Sc	Sq	Sr
i Continuous strip	1.00	1.00	1.00
ii Rectangular	1+0.2 B/L	1+0.2 B/L	1-0.4 B/L
iii Square	1.3	1.2	0.8
iv Circle	1.3	1.2	0.6

Depth Factor

$$dc = 1 + 0.2\frac{D_f}{B}\sqrt{N\phi}, \text{ Where } \sqrt{N\phi} = \left(45 + \phi/2\right)$$

dq = dr = 1 for φ < 10 degree dq = dr = $1 + 0.1\frac{D_f}{B}\sqrt{N\phi}$, for $\phi > 10$ degree

In addition to above, the safe bearing capacity is also evaluated using field test as discussed below:

6.1 Design Parameters for Shallow Foundations

6.1.1 Shear and Settlement Criteria

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Parameters	
Cohesion (kg/sq.cm)	0.00
Angle of Internal friction (degree)	28
Dry density (g/cc)	1.46
Bulk density (g/cc)	1.76
Specific Gravity	2.59
Coeff. of volume change, m_v (cm^2/kg)	0.012
Water Table	At G L
Factor of safety	2.5

Void ratio, $e = \frac{G\gamma_w}{\gamma_d} - 1 = \frac{2.59 \times 1}{1.46} - 1 = 0.77$

Thus, local shear failure was considered for safe bearing capacity computation. The net safe bearing capacity for various sizes of individual rigid footings having vertical static load intensity is evaluated as in Table - 10. The settlement analysis was carried out using Static Cone Resistance value as discussed above in Para 5.1.6.

From the observations of SPT and SCPT results, it reveals that the soil is soft / loose in nature up to top 1.0m and from about 4.0m to 5.0m depth. So, it is recommended to provide foundation depth at 1,0m or 1.5m depth and width of foundation such that pressure bulb remains above soft strata. So if foundation depth is 1.5m and width of foundation is 1.0m, then pressure bulb will remains within the depth of 1.5m to 3.5m. Foundations for heavy load shall be placed on hard stratum, and as rock is available at relatively shallow depth, end bearing pile is suggested.

S B C Calculation (I S 6403)	
Type of Footing	Square Footing
Size (m x m) Depth (m)	1.0 x 1.0 x 1.0
Cohesion (kg/cm^2)	zero
Angle of Internal Friction (Degree)	28
Water Table Consideration	G.L
Shape Factor (Sc, Sq, Sγ)	1.30, 1.20,0.8
Depth Factor (dc, dq, dγ)	1.333,1.166,1.166
Bearing Capacity Factor N'c, N'q, N'γ	14.473,6.156,5.099
$q_{ult} = c\,N'_c\,S_c d_c\,i_c + q\,(N'_q-1)\,S_q\,d_q\,i_q + 0.5\,Br\,N'_r\,S_r\,d_r\,i_r.\,w'$	
q_{ult}=0+0.91*1*(6.156-1)*1.2*1.166 +0.5*1*1.91*5.099*0.8*1.166* 0.5= 8.84 t/m^2	(Factor of Safety = 2.5)
Net Safe Bearing Capacity = 8.84 /2.5 = 3.53 t/m^2	

Table - 10 shows the summary of SBC and SBP evaluated based on shear and settlement parameters.

Table - 10 Summaries of SBC & SBP

Size (m)	Depth (m)	Safe Bearing Capacity (SBC) (t/m^2)	Safe Bearing Pressure from SCPT (SBP) (t/m^2) for 25mm settlement	Recommended value (t/m^2)
1.0X1.0	1.0	3.54	20.64	3.54
1.0X1.0	1.5	5.2	20.64	5.2
1..5X1.5	1.0	3.8	17.58	3.8
1..5X1.5	1.5	5.3	17.58	5.3

6.1.2 Plate Load Test

Plate – 37 and 40 show load settlement curve for plate load test conducted at 0.5 m depth. Load –settlement curve indicates safe bearing capacity in the range of 1.12t/m^2 to 5.2t/m^2 with exceptional values of 19.6t/m^2 at PLT-3 location. As the soil stratum at test depth of 0.5m is soft / loose in nature which reflects in lower safe bearing capacity.

6.2 Design Parameters for Deep (pile) Foundations

The vertical static load carrying capacity of individual pile is evaluated as end bearing pile resting on rock which is available at about 5.0m to 9.0m depth below existing ground level. However the average rock level available at about 7.0m depth. For piles resting on weathered rock it may be necessary to provide socketing to piles so that they can be loaded to their safe structural capacity. The socket length in such cases is 3 times the diameter of the pile. In this method load capacity is assumed to be derived from point resistance only.

This assumption can be considered as safe, since the bearing capacity of the rock is available, irrespective of construction procedure. The load carrying capacity of individual pile based on properties of rock cores can be found out using relation $Q_{ap} = A_p\ q_a$, where $q_a = q_u\ K_{sp}\ K_{ap}$, q_u = average unconfined compressive strength of rock core, K_{sp} = empirical factor, known as bearing pressure coefficient which includes FOS of 3 (assumed as 0.25 for wide spacing of discontinuities), K_{ap} = depth factor = **0.8 + 0.2 L/D** (where L = length of socket in rock and D is diameter of the socket).

Consider average unconfined compressive strength of rock (q_u) up to the depth of 10m equal to 90.4 kg/cm^2. Let K_{sp} = 0.25, and K_{ap} = 0.8 + 0.2 * (3D/D) = 1.4. Therefore, $q_a = q_u * K_{sp} * K_{ap}$ = 90.4 * 0.25 * 1.4 = 31.64kg/cm^2.

$Q_{ap} = q_{ap} * A_p$. For 45 cm diameter pile, Qap = 31,64 * (π/4 *45 *45) = 50321 kg (50.32 T).

Table-11 provides load carrying capacity of individual pile subjected to load test verification.

Table - 11 Summaries of Load Capacity of Pile Foundation

Pile Diameter (m)	Socket Length in rock (m)	Pile capacity in Compression (t)
0.45	1.35	50.30
0.5	1.50	62.13
0.6	1.80	89.46

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7.0 RECOMMENDATION

1. Sub soil strata are poorly graded fine silty sand up to about 5.0m to 6.0m depth. Below that there is a layer of weathered calcareous lime stone having thickness of about 2.0m. Below that and up to the depth investigated, the calcareous lime stone is available. There is no much variation in sub strata is observed, however there is a presence of about 1.0m to 3.0m thick clayey silt pocket nearby borehole BH-1 and BH-8 at about 3.0m to 4.0m depth from the existing ground level.

2. The safe bearing capacity considering laboratory shear and settlement parameters is recommended as given in Table – 10 for minor and light loaded foundations. The recommended value of SBC shall be for static vertical loading only. The foundation depth shall be as shown in Table -10.

3. Load –settlement curve indicates safe bearing capacity in the range of 1.12 t/m^2 to 5.2 t/m^2 with exceptional values of 19.6t/m^2 at PLT-3 location.

4. Table - 11 gives the vertical static load carrying capacity of individual pile for heavy structures. The pile capacities as mentioned in Table - 11 is subjected to a conformation by performing a Pile load test as mentioned in IS: 2911 Part-iv

5. The soil does not show swelling characteristics and is suitable for back filling as well as for road construction purpose.

6. The coefficient of Active and Passive earth pressure shall be considered as 0.36 and 2.77 respectively. This is computed using angle of internal friction value of 28 degree of the sub strata.

7. Soil and water sample shows high concentration of sulphate, and hence a precaution against sulphate attack is necessary. As per IS 456: 2000, Super sulphated or sulphate resisting Portland cement is recommended. Minimum cement content shall be 370 kg/m3 and maximum Face Water – Cement ratio shall be 0.45. Ground water is not suitable for use in construction purpose.

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8. A Field permeability value varies in the range of 1.15×10^{-4} cm/s to 2.58×10^{-5} cm/s.

9. As the topsoil is sandy in nature and high water table, stability of excavated trench shall be maintained properly by providing strutting wherever necessary.

10. Cross-hole test shows average dynamic parameter as under:

Soil Type	Dynamic Shear Modulus G MPa	Dynamic Young's Modulus E MPa	Poisson's Ratio	Unit weight kN/m^3
Fine sand	160	413	0.29	17
Clayey sand	196.5	523.5	0.335	18
Weathered rock	503.8	1273.4	0.267	20

11. The average dynamic soil parameters as obtained from block vibration test is as under:

Parameters	Test 1	Test 2	Average value
Coefficient of elastic uniform compression (kg/cm^3)	4.97	5.22	5.095
Coefficient of elastic uniform shear (kg/cm^3)	2.49	2.61	2.55
Coefficient of elastic non uniform compression (kg/cm^3)	8.60	9.03	8.81
Coefficient of elastic uniform shear (kg/cm^3)	3.73	3.92	3.83

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Report No. GETS/2005/811 dated 24.08.2005

Parameters	Test 1	Test 2	Average value
Damping coefficient	0.162	0.329	0.245
Shear Modulus (kg/sq.cm)	276.9	342.9	309.9
Elastic modulus (kg/sq.cm)	775.5	960.0	869.25

For GEOSTRUCT ENGINEERING & TESTING SERVICES

(G. J. TALATI)

35720/2020/PS-SR-PM

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1026/1409

VETTING OF SOIL INVESTIGATION REPORT FOR PROPOSED 2 X 500 MW NLC THERMAL POWER STATION AT TUTICORIN

Investigated by :

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1027/1409

It is found from the soil investigation report that a good number of laboratory tests on soil samples and rock samples have been carried out, which is adequate. The findings of laboratory results match with the Field Tests results such as Static Conc Penetration test, Standard Penetration Test, Plate Load Test, etc.

The dynamic parameters obtained from:

1) Block Vibration Test

2) Cross Hole Test

3) Wave Propagation Test

are quite reliable and are required in the design of machine foundation and vibration analysis.

The overall planning in carrying out the test is quite satisfactory, but the soil conditions upto 6.0 depth are poorly graded sand(Q_{nsafe} = 3 to 5 t/m^2) which needs to be improved by resorting to some ground improvement techniques or pile foundation as mentioned in the report.

The report is well documented and tests results are in tune with the soil characteristics.

From the plate 2 to 21 in the report, the borelog shows highly weathered calcarious sandstone from approximately 6.0 m depth onwards for thickness of strata ranging from 1m to 5m. This zone may be detrimental to the structures because sandstone is a sedimentary rock, which usually contains caverns occurring at or near the water table. The roofs of caverns may collapse when loaded. Since pile's tip is to rest in the weathered rock, it is suggested that the pile load test should be carried out to determine the safe pile load carrying capacity. The report also recommends for pile load test, which is in right direction.

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After going through the complete report, the following recommendations are made:

1) The top sandy layers are too weak for shallow foundations and some ground improvement techniques should be applied or pile foundation should be used. However, for very small loadings, the foundations can be constructed on such soils.

2) The pile's tip should preferably cross the highly weathered calcareous sand stone.

3) The pile load test should be carried out to evaluate the safe load carrying capacity of a pile as mentioned in the soil investigation report.

Vetted by (Dr. A.K.Verma)

Head
Structural Engg.Dept.

PRINCIPAL

35721/2020/PS-SR-PM

VOLUME: II B

SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

SPECIFICATION NO. PE-TS-483-600-C001

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

	TITLE: TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING	SPECIFICATION NO. PE-TS-483-600-C001
		VOLUME - II B
		SECTION - D | SUB-SECTION – D1
		REV.NO. 0 DATE 30/06/2020
		SHEET 2 OF 22

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.0	SCOPE	3
2.00.00	GENERAL	3
3.00.00	EXECUTION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	19
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6.00.00	INFORMATION TO BE SUBMITTED BY THE BIDDER	20

STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following

manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction

likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the

engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0 Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :
i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
iii) soling of roads, paths, etc., and hard core ;
iv) macadam surfaces such as water bound, and bitumen/tar bound;
v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :
i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded

in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :
i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the

workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades

etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be

provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his

responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

3.5.4.5 Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.

All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably praticable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer’s prior approval on the method of pumping to be adopted shall be

taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS: 4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

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

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

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

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified as below:

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) In case of open footings (rafts/ pilecaps/ drains/ cable trench/ pipe trench/ sub soil beams etc.) up to the depth of 2.0 metres from ground level, alround excavation of 30 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional/excess excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for item of work on excavation, backfilling, carriage, dewatering etc. Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in the quoted rates in the schedule of quantities.

d) In case of open footings (Rafts/ pilecaps / drains/ cable trench/ pipe trench/ sub soil beams etc.) at a depth of more than 2.0 metre from ground level, alround excavation of 75 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional/excess excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for item of work on excavation, backfilling, carriage, dewatering etc. Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in the quoted rates in the schedule of quantities.

e) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a

deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

f) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

g) The authorized quantity (calculated on the basis of authorized width/ working space under clause no. 5.2.0 c & 5.2.0 d) or those actually excavated, whichever, are less, shall be measured for payment.

h) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of

spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-483-600-C002

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)

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

	TECHNICAL SPECIFICATION FOR CEMENT CONCRETE (PLAIN & REINFORCED)	SPECIFICATION NO. PE-TS-483-600-C002 VOLUME - II B SECTION - D SUB SECTION - D2 REV.NO. 0 DATE : 30/06/2020 SHEET 2 OF 56

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SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Prepare detailed drawings of supports, templates, hangers, etc. required for

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other*waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour

Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the

edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture:	Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete. For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
b) Aggregate:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c) Water:	Impurities tests.
d) Cement:	Tests to satisfy relevant IS Specifications.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at

site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space - 12 mm

Reinforced concrete
Except foundation - 20 mm

Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Lean concrete	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case

shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in-spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to

placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of

placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 *mm* in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortars.

k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes,

ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for

acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or

other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417.

Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the

contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in .the finished concrete surface & should not be taken as tolerances for the entire structure

taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and

to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved

laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by

the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm

Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the

Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer’s satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concrete is completed shall be drilled

into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals

and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required

strength.
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.

b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include all arrangement for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be

payable to the contractor as per BOQ item.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.

b) No deductions shall be made for the following:

i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;

ii) Opening upto 0.1 sq.m.

iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23^0C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.

c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.

d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.

f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.

e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.

e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of embedded steel parts, supplied by Engineer

shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement

IS: 455 - Indian Standard Specification for Slag Cement

IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive

Structures

IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete

IS: 702 - Indian Standard specification for industrial bitumen.

IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement

IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks

IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS: 2571 - Code of practice for laying in-situ cement concrete floors.

IS: 2645 - Integral cement water proofing compound

IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS: 2750 - Indian Standard Specification for steel scaffoldings.

IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS: 3414 - Code of practice for design and installation of joints in buildings.

IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS: 3696 - Safety Code for Scaffolding and Ladders

IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS: 4014 - Code of practice for steel tubular scaffolding.

IS: 4031 - Indian Standard Specification for Method of Tests for

Hydraulic Cement

IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS: 4926 - Indian Standard Specification for Ready Mixed Concrete

IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground

IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.

IS: 5256 - Code of practice for sealing joints in concrete lining on canals.

IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping

Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.

IS: 8989 - Safety Code for Erection of Concrete Framed Structures.

IS: 9012 - Recommended method for shortcreting.

IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.

IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

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SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-483-600-C003

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

	TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY	SPECIFICATION NO. PE-TS-483-600-C003 VOLUME - II B SECTION - D SUB SECTION - D3 REV.NO. 0 DATE : 30/06/2020 SHEET 2 OF 7

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CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

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3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848 - Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)

IS: 1003 - Timber panelled and glazed shutters.

IS: 2191 - Wooden flush door shutter (Cellular and hollow core type).

IS: 2202 - Wooden flush door shutters (solid core type).

IS: 4021 - Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in “Schedule of Item” for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges,

holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

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	TECHNICAL SPECIFICATION FOR ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-483-600-C004
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SECTION – D

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ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

SPECIFICATION NO. PE-TS-483-600-C004

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

	TECHNICAL SPECIFICATION FOR ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-483-600-C004 VOLUME - II B SECTION - D SUB SECTION - D4 REV.NO. 0 DATE : 30/06/2020 SHEET 2 OF 14

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ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix

by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two lavers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

3) Hessian base self finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Hessian base self-finished felt, type 3, grade I.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Fiber base self-finished felt, type 2, grade 2.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Fiber base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fiber-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70^0C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing By Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at leas 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

i) Primer (For vertical faces only), as per I.S. 3384.

ii) Hot applied blown bitumen at the rate of 1.2 Kg/m2

iii) Hessian base, bitumen felt type 3 grades 2

iv) Hot applied blown bitumen @ 1.2 Kg/m2

v) Hessian base, bitumen felt type 3 grade 2

vi) Hot applied blown bitumen @ 1.2 Kg/m2

B) Extra Heavy treatment (Three layers of felt)

i) Primer (for vertical faces only) as per I.S. 3384

ii) Hot applied bitumen at the rate of 1.2 Kg/m2

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m2

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m2

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m2

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

a) IS: 73 - Paving Bitumen

b) IS: 702 - Industrial Bitumen

c) IS: 1203 - Methods of testing tar and bitumen

d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.

e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.

f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice

g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings

h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

	TECHNICAL SPECIFICATION FOR ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS	SPECIFICATION NO. PE-TS-483-600-C004 VOLUME - II B SECTION - D SUB SECTION - D4 REV.NO. 0 DATE : 30/06/2020 SHEET 14 OF 14

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

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SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

SPECIFICATION NO. PE-TS-483-600-C005

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

TITLE: **TECHNICAL SPECIFICATION FOR METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.**	SPECIFICATION NO. PE-TS-483-600-C005
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ATTACHMENT

ANNEXURE – A	SCHEDULE OF FIXTURES	12

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardwares where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy

himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper “Lines and levels”, and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the

requirements stipulated in IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures

h) Provision for hardware and fixtures to be installed at site.

i) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items

a) Installations shall be at correct location, elevation and in general, on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for Doors, windows etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall by retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.

Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition frames shall be in Kg. Panelling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

   i) 100 mm brass butt hinges with screws - 3 Nos.

   ii) 150 mm brass tower bolts with screws - 1 No.

   iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.

   iv) 30 mm brass ring pull handle with Plates and screws - 1 No.

   v) 150 mm brass coat hook with screws - 1 No.

   vi) Heavy duty, cylinder looks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

   i) Concealed hanging arrangement for door leaves.

   ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.

   iii) Heavy duty, cylinder look on active leaf.

   iv) Pull handle of approved design on both leaves.

   v) Doors stops for both leaves.

   vi) Overhead door closure for both leaves.

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i) 100 mm butt hinges - 3 Nos. on each leaf.

ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.

iii) 200 mm anodized aluminum pull handle - 1 No. of each leaf.

iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i) 100 mm butt hinges - 3 Nos.

ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside face

iii) 200mm anodised aluminum Pull handle - 1 No.

iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, see "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 12" peg stays - 1 No. per leaf

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.

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ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.
(As per IS-1948 latest editions)

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 300 mm peg stays - 1 No per leaf

iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf

iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment - 2 Nos. per leaf

iii) Spring Catch - 1 No. per leaf

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GLASS AND GLAZING

SPECIFICATION NO. PE-TS-483-600-C006

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C006
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GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or beat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.

c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.

d) Obscure glasses shall have a cast surface in one side.

e) Coloured and figured glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.

g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes were six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor’s own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 I.S. CODES

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice’ for fixing and glazing metal doors, windows ventilators.

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5.00.00 RATES

Rates of glass and glazing if not included in respective items for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ items provided. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.

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ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-483-600-C007

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C007
	TECHNICAL SPECIFICATION FOR ROLLING STEEL SHUTTERS AND GRILLS	VOLUME - II B
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ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.

f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be

in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.

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MISCELLANEOUS METAL

SPECIFICATION NO. PE-TS-483-600-C008

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

	TITLE: TECHNICAL SPECIFICATION FOR MISCELLANEOUS METAL SIDING	SPECIFICATION NO. PE-TS-483-600-C008
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MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundary shop.

2.01.02 Shop Connections

a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

b) Welding of steel shall be done in accordance with IS: 816.

c) Welding of aluminium shall be done accordance with IS: 2812, “Arc welding of Aluminium and Alloys.” Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied be brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

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2.02.00 Erection

2.02.01 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight

chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturer's instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as

nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more then $\pm$0.05mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye

sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:
Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02 Barbed Wire Fencing

The barbed wire shall be conform to IS:278 latest edition. The barded wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less then 13mm and not more than 18mm. The distance between two barbs shall be 75$\pm$12mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured

to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less then 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be as follows

i) Permissible deviation from, straightness – 1 in 1000.

ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks, and other blemishes.

d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278	Specification for Galvanised Steel Barbed wire for fencing.
IS:816	Code of practice for use of Metal Arc welding for general construction in mild steel.
IS:1367	Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
IS:2721	Specification for Galvanised Steel Chain Link fence fabric.
IS:2812	Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASURMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.
Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

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5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.

	TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS	SPECIFICATION NO. PE-TS-483-600-C009
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MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-483-600-C009

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

	TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORKS	SPECIFICATION NO. PE-TS-483-600-C009 VOLUME - II B SECTION - D SUB SECTION - D9 REV.NO. 0 DATE : 30/06/2020 SHEET 2 OF 12

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MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without

loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without

segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.
Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall

consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overbumt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other paftem as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

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4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc); up to 0.1 sqm in section;

e) Chases of section not exceeding 50 cm in girth;

f) Iron fixtures, such as wall ties and hold fasts for doors and windows;

g) Cement concrete blocks as fcr hold fasts and holding down bolts;

h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

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FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-483-600-C010

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

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FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve

working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the

Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on

the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punting shall be applied by skilled workman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and

approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

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5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

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PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-483-600-C011

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

	TITLE: TECHNICAL SPECIFICATION FOR PAINTING, WHITEWASHING, POLISHING	SPECIFICATION NO. PE-TS-483-600-C011
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PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer’s test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

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2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted .The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

IS: 2338 (I & II) Code of Practice for finishing of wood and wood based materials.

IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.

IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.

IS: 2932 Specification for enamel, exterior type-1.

IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.

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SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

SPECIFICATION NO. PE-TS-483-600-C012

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C012
	TECHNICAL SPECIFICATION FOR FLOOR FINISH AND ALLIED WORKS	VOLUME - II B
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		REV.NO. 00 DATE 30/06/2020
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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

i) Integral finish to concrete base

ii) Terrazzo finish

iii) Granolithic finishes

iv) Patent Stone

v) Metallic Hardener like “Ironte”/Hardonate Finish

vi) Mastic Asphalt finishes

vii) Chemical Resistant finish

b) Tiled Finishes

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesse rae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.
The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still `green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may very in thickness to provide necessary slopes.The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed
The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to

3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Seive No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled f or horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface ' of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per

approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/ `Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is `green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brash as soon as possible.

The finish shall be laid while the concrete underbed is still very `green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned

in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed
As per clause 2.02.01 (c).

d) Laying
As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

c) Laying
Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or

suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed
Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm2. The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer’s trademark, the thickness, sizes, batch number, and date of

manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

TITLE: TECHNICAL SPECIFICATION FOR FLOOR FINISH AND ALLIED WORKS	SPECIFICATION NO. PE-TS-483-600-C012
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4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	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.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C012		
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5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.

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SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-483-600-C013

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C013
	TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	VOLUME - II B
		SECTION - D | SUB-SECTION – D13
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C 0 N T E N T

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3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	5
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TITLE: TECHNICAL SPECIFICATION FOR SHEET WORK IN ROOF AND SIDING	SPECIFICATION NO. PE-TS-483-600-C013
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SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED (SANDWICHED INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF_2) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm.

iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.

iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap.

v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having

minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF_2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii. **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007	:	Code of practice for laying of asbestos cement sheets.
IS: 2527	:	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS: 1626	:	Specification for asbestos cement building pipes, gutters and fittings.
IS: 277	:	Specification for galvanized steel sheets (plain and corrugated).

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5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in "Schedule of Items" and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.

TITLE: TECHNICAL SPECIFICATION FOR SUSPENDED CEILING	SPECIFICATION NO. PE-TS-483-600-C014		
	VOLUME - II B		
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VOLUME: II B

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-483-600-C014

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C014
	TECHNICAL SPECIFICATION FOR SUSPENDED CEILING	VOLUME - II B
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3.00.00	SAMPLES	5
4.00.00	SHOP DRAWINGS	5
5.00.00	ACCEPTANCE CRITERIA	6
6.00.00	RATES AND MEASUREMENTS	6

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,

unless otherwise shown on drawings. Angle cleats or other suitable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

a) Plaster of Paris board (decorative)

b) Expanded polystyrene insulation board with plastic fascia.

c) Fibre Insulation board.

d) Bonded wooden particle board (Plain and decorative)

e) Glass fibre reinforced polystyrene sheets.

f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C " or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

a) A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.

b) Typical Intermediate framing for support where required.

c) Hanger fastening details.

d) Panels - unit support at ceiling penetrations.

e) Details of splicing method for main and cross runners.

f) A table indicating load bearing capacity of main and cross runner

g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

TITLE: TECHNICAL SPECIFICATION FOR SUSPENDED CEILING	SPECIFICATION NO. PE-TS-483-600-C014
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5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.

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SECTION - D

SUB-SECTION – D15

WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-483-600-C015

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C015
	TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE AND SANITATION	VOLUME - II B
		SECTION - D | SUB-SECTION – D15
		REV.NO. 00 DATE 30/06/2020
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C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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3.00.00	INSTALLATION	6
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5.00.00	I.S. CODES	20
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WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:

a) Cast Iron pipe

b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)

c) Concrete pipe

d) Asbestos cement pipe

e) PVC pipe

f) Stoneware pipe

g) Vitrified pipe

h) Lead pipe (not to be used for portable water)

2.02.01 Fixtures

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/ Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) **European type**

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium

plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) **Squatting type**

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll bolder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation

shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc.

Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-

syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient

turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and

shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to

be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leakproof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 m dia whose top shall he provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt.XVI)	:	Laying of water and sewer lines, including appurtenant items.
IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt.I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS: 1592	:	Asbestos cement pressure pipes,

IS: 1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).
IS: 2065	:	Code of Practice for Water Supply in buildings.
IS: 2501	:	Copper tubes for general engineering purposes.
IS: 2556	:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement
IS: 2633	:	Method of testing, uniformity of coating on zinc coated articles.
IS: 3076	:	Low density polyethylene pipes for portable water supplies.
IS: 3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter).
IS: 3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).
IS: 4827	:	Specification for electro plated coatings of nickel and chromium on copper and copper alloy.
IS: 4964	:	High-density polyethylene pipes for portable water supplies.
IS: 12701	:	Rotational moulded polyethylene water storage tanks

6.00.00 RATE AND MEASUREMENT

6.01.00 RATE

6.01.01 G.I. Pipes For Water Supply

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.

6.01.02 Rainwater Down-comers

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of "Schedule of Items". Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in "Schedule of Items".

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in "Schedule of Items".

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in "Schedule of Items".

TITLE: TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	SPECIFICATION NO. PE-TS-483-600-C016		
	VOLUME - II B		
	SECTION - D	SUB-SECTION – D16	
	REV.NO. 00	DATE 30/06/2020	
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VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-483-600-C016

ROAD AND DRAINAGE

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C016
	TECHNICAL SPECIFICATION FOR ROAD AND DRAINAGE	VOLUME - II B
		SECTION - D | SUB-SECTION – D16
		REV.NO. 00 DATE 30/06/2020
		SHEET 2 OF 36

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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Standard Technical Specification
For Road and Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade ± 25 mm
Sub-base ± 20 mm
Base course ± 15 mm
Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the

positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6

8.	Semi-dense carpet	10	-	-	-	20***	6	
9.	Asphaltic Concrete	8	-	-	-	10***	4	

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of

trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall

be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.
Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically

free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the

pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	**Test method**	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640**	40 percent maximum
2.	Base	a) Loss Angeles Abrasion value*	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640 **	40 percent maximum
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be

done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the

Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII

Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX
Aggregates Grading For 75mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportio ning of materials and producing a uniform mix. A variation in binder content

upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet		
i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted

with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of

binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown

on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the

satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing and Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.

TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-483-600-C017			
	VOLUME - II B			
	SECTION - D		SUBSECTION -D17	
	REV.NO.	0	DATE	30/06/2020
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VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

SPECIFICATION NO. PE-TS-483-600-C017

FABRICATION OF STRUCTURAL STEEL WORK

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

TITLE: TECHNICAL SPECIFICATION FOR FABRICATION OF STRUCTURAL STEEL WORK	SPECIFICATION NO. PE-TS-483-600-C017			
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	REV.NO.	0	DATE	30/06/2020
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C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification

and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 - Structural steel (Standard Quality)

IS : 800 - Code of Practice for general construction in steel.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Rolled steel beams, channels, and angle sections

IS : 813 - Scheme of symbols for welding

IS : 814 - Covered electrodes for metal arc welding of structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 - Code of practice for training and testing metal arc welders

IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS : 822 - Code of practice for inspection of welds

IS : 919 - Recommendations for limits and fits for Engineering

IS : 961 - Structural Steel (High Tensile)

IS : 1148 - Rivet bars for structural purposes

IS : 1149 - High tensile rivet bars for structural purposes

IS : 1161 - Steel Tubes for structural purposes

IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS : 1239 - Mild Steel Tubes

IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (dia, range 6 to 39 mm)

IS : 1367 - Technical supply conditions for threaded fasteners

IS : 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS : 1731 - Dimensions for steel flats for structural and general engineering purposes

IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS : 1977 - Structural steel (ordinary quality) St-42-0

IS : 2062 - Steel for General Structural Purposes

IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS : 2595 - Code of Practice for Radiographic Testing

IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural steel High Tensile

c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS : 1148 - Rivet Bars for structural purpose

b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS : 814 - Covered electrodes for metal arc welding of structural steel

b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS : 7280 - Bare wire electrodes for submerged arc welding of

structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this

contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of

these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	**%**	**Remarks**
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulpher	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum

procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the

test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact

with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork,

including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by

tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection .The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the

Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When

the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport, handling, and

erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

   i) 10% at random on fillet-joints.

   ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos

as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer’s mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary

operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder’s rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the

foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for

welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection

marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 18

SPECIFICATION NO. PE-TS-483-600-C018

ERECTION OF STRUCTURAL STEELWORK

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C018			
	TECHNICAL SPECIFICATION FOR ERECTION OF STRUCTURAL STEELWORK	VOLUME - II B			
		SECTION - D		SUBSECTION – D18	
		REV.NO.	0	DATE	30/06/2020
		SHEET	2	OF	17

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SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the

Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well

designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owne, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.

7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member

or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural

steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

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ROOF DECKING

SPECIFICATION NO. PE-TS-483-600-C019

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C019
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ROOF DECKING

1.00.00 Scope

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deareator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 150 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets,

fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing

3.02.01 Sequence of Manufacture/Erection

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps

End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's

recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

a) Side and end laps

b) Absence of damage in the sheeting.

c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS : 513 - Specification for cold rolled carbon steel sheets.

IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.

IS : 4431 - Specification for carbon & carbon manganese free cutting steel.

IS : 1573 - Electroplated Coatings of zinc on iron and steel.

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6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

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FALSE FLOORING

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

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FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of $\pm$ 0.2mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of $\pm$ 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer’s installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system

shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorised representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer’s specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks :

a. Level

b. Alignment of joints

c. Thickness of joints

d. Surface finish

e. Colour and texture

f. Details of edges, junctions etc.

g. Performance

h. Criteria specified for strength.

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5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings atc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

VOLUME: II B

SECTION - D

SUB-SECTION – D21

BORED CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-483-600-C021

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C021
	TECHNICAL SPECIFICATION FOR BORED CAST-IN-SITU RCC PILES	VOLUME - II B
		SECTION - D | SUB-SECTION – D21
		REV.NO. 00 DATE 30/06/2020
		SHEET 2 OF 26

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TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENTS

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carryout the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pullout loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner along with this specification. The ultimate load capacity of a pile may be estimated using suitable static formula and the minimum factor of safety shall be 2.5. However, safe load carrying capacity shall be conformed and guaranteed by conducting initial and routine load tests.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Derating is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.

2.10.00 In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.

2.11.00 In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.

2.12.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.13.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.

2.14.00 The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.

2.15.00 **AVAILABLE SUB-SOIL DATA**

An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.

3.00.00 MATERIALS

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Grade and minimum cement content
Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03 Slump of concrete
The slump of concrete shall vary between 150 to 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02 The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.05 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

3.03.06 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.07 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.08 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a 'particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.09 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.10 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.11 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.

4.01.04 Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 Installation Criteria

4.02.01 For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.

4.02.02 For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of NX size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.

4.02.03 In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.

4.02.04 Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.

4.02.05 A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.

4.02.06 The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.

4.02.07 Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.

4.03.00 Control of position and alignment

4.03.01 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference.

a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more then 750mm) from their designed position at the working level.

4.04.00 Boring

4.04.01 Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.

4.04.02 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (direct mud circulation) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.

4.04.03 Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.

4.04.04 Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.

4.04.05 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

4.04.06 The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

4.04.07 The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.

4.05.00 Chiselling

4.05.01 Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.

4.06.00 Cleaning of Pile bore

4.06.01 On completion of the pile bore upto the required depth, the bottom of the hole shall be cleaned very carefully before concreting work is taken up. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.08.05 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.

4.08.06 The concreting operations shall not be taken up when the specific gravity of bottom slurry is more than 1.2 and sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 5.

4.08.07 Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

4.08.08 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

4.08.09 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.

4.09.00 Cut off level (COL)

4.09.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.

4.09.02 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

4.09.03 When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.

4.10.00 Sequence of Piling

4.10.01 Each pile shall be identified with a reference number.

4.10.02 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

4.11.00 Building up of Piles

4.11.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.12.00 Breaking off of Piles

4.12.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.13.00 Preparation of Pile head

4.13.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.

4.13.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.

4.13.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.

4.13.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.

4.13.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.14.00 Rejection and Replacement of Defective Piles

4.14.01 The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.

4.15.00 Recording of Piling Data

4.15.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shell be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment,

deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.

b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimens vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.03.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified else where with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

5.08.01 On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.

5.08.02 For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.

a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles and on all test piles or as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to

testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.

b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.

c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.

d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.

e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.

f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.

g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities and to fix a more accurate driving criteria viz. set/bow, total number of blows and approximate depth etc. of founding level. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). The maximum test load shall be as

mentioned in bill of quantities.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles for 0.5% of total no. of piles (for each mode and type). Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be born by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 432 (Part 1 & 11)	-	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	-	Code of practice for plain and reinforced concrete.
IS: 1200 (Part 23)	-	Measurement of Building and Civil Engineering works Piling.
IS: 1786	-	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
IS: 1892	-	Code of practice for Subsurface Investigation for foundation.
IS: 2131	-	Method of Standard Penetration Test for Soils
IS: 2911 Part I/Sec 2	-	Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.
IS: 2911 Part IV	-	Code of practice for design and construction of pile foundation - Load test on piles.
IS: 6926	-	Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.
IS: 10262	-	Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts.

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.

8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.

8.01.04 The quoted rate for piling for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.

8.01.05 The quoted rate for piling as per description of item works shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.

8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results.

8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile locations, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials,

equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.

8.01.08 The quoted rate for piling shall also include chiselling, if any, required for socketing the pile in rock.

8.01.09 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.

8.01.10 The quoted rate for piling shall also include providing reinforcement and its cleaning, straightening, cutting, bending, binding with annealed wire, welding, tackwelding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc.

8.02.11 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.

8.01.12 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

8.01.13 The quoted rate for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.

8.01.14 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not lave been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.

8.02.00 Measurement

8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be considered for reconciliation of cement consumption. No extra payment shall be made for the length from existing ground to cut-off level.

8.02.02 Reinforcement steel shall be measured for reconciliation purpose only and the measurement shall be done for providing and placing reinforcement in piles, by weight in tones, up to third place of decimal in the following manner:

i) The weight shall be arrived at by multiplying the actual length measured alongwith standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.

ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.

iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.

8.02.03 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.

8.02.04 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.

8.02.05 The item for pile integrity test shall be measured in terms of no. of piles tested.

ANNEXURE-A

Specific Requirements for Bored Cast-in-situ RCC Piles

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M³

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	**Horizontal/ Lateral (MX)**	**Pul lout/Tension (MT)**
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

a) Minimum length of the pile shall be _____* m below COL.

b) The pile shall be terminated after penetrating through the strata having SPT penetration less than __* cm for ____* blows, for a minimum length of _____* times the diameter of the pile.

A2.2 In Rock

a) Piles shall be installed and socketed into the rocks for a length (socketing length) equal to _____* times the pile diameter subject to a minimum of _____* meter below the socketing horizon.

b) Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____* kg/sq.cm.

A3. Average cut-off level for tender design and initial load test can be assumed as _____* m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately depending upon subsoil strata of the site.

ANNEXURE-B

List of Equipments

SI.No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.

ANNEXURE-C

Bentonite suspension used for piling work shall satisfy the following requirements

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5.

ANNEXURE-D

PILE DATA

1. Reference No. Location (Co-ordinates) _____area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:

    i) Freshly supplied mud
    Liquid limit -

    Sand content -

    Density -

    Marsh viscosity -

    Swelling index -

    pH value -

    ii) Contaminated mud
    Density -

    Sand content -

14. SPT* N values in soil (from the nearest bore hole).
+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test
** Unconfined compression strength

15. Chiseling if any, from...….. m to …..... m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity
Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement	Stirrups: Type
No._____	No._____
Dia. _____	Dia._____
Depth _____	Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.

TABLE -1

FREQUENCY OF SAMPLING AND TESTING

SI. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.7 Each Pile	As per Annexure C As per annexure C
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 4.3
5.	Cleaning of pilebore	-	As per Cl. 5.8	Each Pile	Pilebore be free from bored materialcuttings debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
7.	Concrete a) Workability b) Cubes	 Slump cone test Compressive Strength test	 Each pile As per spec.	 As per Cl. 5.5 As per Cl. 5.5	 As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

TITLE:	SPECIFICATION NO. PE-TS-483-600-C022
TECHNICAL SPECIFICATION FOR SITE LEVELLING & GRADING WORKS	VOLUME - II B
	SECTION - D | SUB-SECTION – D22
	REV.NO. 00 DATE 30/06/2020
	SHEET 1 OF 16

VOLUME: II B

SECTION - D

SUB-SECTION – D22

SITE LEVELLING & GRADING WORKS

SPECIFICATION NO. PE-TS-483-600-C022

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C022
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		SHEET 2 OF 16

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	SCOPE	3
3.00.00	MATERIALS	4
4.00.00	QUALITY CONTROL	6
5.00.00	EXECUTION	6
6.00.00	RATES AND MEASUREMENTS	15

GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for **"Site Levelling and Grading Works including Slope Protection"** etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works, Part-1: Earthwork

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

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground Blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a)Materials from swamps, marshes and bogs
b)Expansive clays
c)Peat, logs, sod and perishable materials
d)Materials susceptible to combustion
e)Any material or industrial and domestic produce which will adversely affect other materials of work
f)Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with

the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and

rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**
The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officerin-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine. Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities. Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed

from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as

determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed

layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, crosssections
and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

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

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

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

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

VOLUME – II B

SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-483-600-C023

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

	TITLE:	SPECIFICATION NO. PE-TS-483-600-C023
	TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT	VOLUME - II B
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TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.
All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.
Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by

rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.
A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **ACCEPTANCE CRITERIA**

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 **RATES**

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 **METHOD OF MEASUREMENT**

Complete work of anti-termite treatment shall be measured for plinth area treated.

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This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional chemical treatment measures.