

**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM**

PACKAGE - 1

TENDER DOCUMENTS

(NIP NO. HRBC/PL. & DN./06 of 2013-2014, dt: 31.08.2013)

**BOOK -1
Volume I, II & III**

HOOGHLY RIVER BRIDGE COMMISSIONERS

(A Statutory Organisation under Government of West Bengal)

TRANSPORT DEPARTMENT

MUNSHI PREMCHAND SARANI

(ST. GEORGE'S GATE ROAD)

KOLKATA 700 021

NOVEMBER 2013

**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
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BOOK – 1

VOLUME I

HOOGLY RIVER BRIDGE COMMISSIONERS

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TRANSPORT DEPARTMENT

MUNSHI PREMCHAND SARANI

(ST. GEORGE'S GATE ROAD)

KOLKATA – 700 021

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TENDER DOCUMENTS
FOR
CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
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PACKAGE - 1

BOOK – 1

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**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM**

PACKAGE - 1

Volume I

HOOGHLY RIVER BRIDGE COMMISSIONERS
(A Statutory Organisation under Government of West Bengal)
TRANSPORT DEPARTMENT
MUNSHI PREMCHAND SARANI
(ST. GEORGE'S GATE ROAD)
KOLKATA – 700 021

NOVEMBER 2013

Volume - I SECTION 1

Invitation for Bids

Tenderer's Signature and Stamp

Letter for Invitation for Bids

No. HRBC/12C-170/2013/

Date:

**From: Sri S. Saha
Director (Pl. & Dn.)**

To : _____

Sub: Invitation for bids in connection with “Construction of 4(four) Super Speciality Hospitals under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum – (Package-1)

Ref: N.I.P. NO. HRBC/PL. & DN./06 of 2013-2014, Dated: 31.08.2013

Dear Sirs,

1. This is to inform you that you have been prequalified for submitting bid for the above work for which you have already conveyed your willingness.
2. You are now invited along with other prequalified bidders to submit sealed bids for the above work.
3. The tender document can be downloaded from the website of HRBC i.e. **www.hrbc.in** from **27.11.2013 onwards**. The bidder shall have to pay **Rs. 20,000/- (Rupees twenty thousand only)** in the form of Bank Draft issued by any Nationalized or Scheduled Bank in India in favour of **“Hooghly River Bridge Commissioners”** payable at Kolkata as the cost of tender document which shall be enclosed with the offer at the time of submission of tender document.
4. All bids must be accompanied by the Bid Security in the form and amounts specified in the tender documents. The tender must be submitted in the tender box kept in the chamber of the Director (Pl. & Dn.), HRBC at Munshi Prem Chand Sarani, Kolkata – 700021 **at/or before 2.00 PM on 04.12.2013.**
5. The bids shall be in **“2 envelope”** format detailed in the “Instruction to Bidders”. The bids will be opened in two stages. Initially submission of technical proposal shall be reviewed and evaluated and subsequently only those bids which are considered responsive and technically qualified shall be subjected to financial review.
6. Technical Proposals will be opened on **04.12.2013 at 2.30 PM** and Financial Proposals of only the responsive bidders will be opened on **06.12.2013 at 12.30 AM** in presence of the representatives of the bidders who will intend to remain present along with authorization letter.

Contd...

Tenderer's Signature and Stamp

7. Please confirm receipt of this letter immediately in writing by courier and/or by fax or e-mail. If you do not intend to bid, we would appreciate being so notified also in writing and/or by fax or e-mail at your earliest opportunity.

Yours truly,

Director (Pl. & Dn.), HRBC

No. HRBC/12C-170/2013/ /1(2)

Date:

Copy forwarded for kind information to:

- 1) Vice-Chairman , HRBC
- 2) Chief Project Manager , HRBC

Director (Pl. & Dn.), HRBC

Tenderer's Signature and Stamp

Volume - I SECTION 2

Instructions to Bidders

Tenderer's Signature and Stamp

Vol. I Section 2. Instructions to Bidders

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Tenderer's Signature and Stamp

Vol. I Section 2. Instructions to Bidders

A. General

1. Scope of Bid

1.1 Scope of work:

The scope of the work under these terms of reference would consist of – but not limited to the provisions laid down in the General Conditions of Contract, BOQ, Technical Specifications and other documents of the Contract.

The proposed Super Speciality Hospitals under BRGF scheme shall be stand alone self sufficient projects and they shall be established in vacant land within the premises of existing hospitals in different districts of the state, but will be completely separate in all respects including administrative block & staff quarters. The main hospital building will be 5 storied having around 7,500 sq.m. or a little more of built up area with provision of foundation for 10 storied building. Besides, the Administrative Block, Staff Quarters along with roads and pathways, drainage, water supply, sewerage, electricals, landscaping and beautification etc. shall be built.

The building are to be completed with all necessary fittings and fixtures as will be specified in BOQ with subsequent additions & alterations and as per specifications complete in all respect including water supply, sanitary & plumbing works, electrical fittings, fixtures, internal & external wiring/electrical lines/cabling and air conditioning & communication system as necessary as per BOQ and technical specifications. The project work shall consist of all other allied civil engineering works like erection of boundary wall with gates, internal roads with surface drain, external electrification works with service connection, transformer, pump room, deep tube well etc. The building shall be provided total fire fighting system including necessary water reservoir.

After completion, all work areas shall be rendered clean as directed by the Engineer.

2. Eligible Bidders

Eligible bidders are those who are declared prequalified after scrutiny of documents submitted by applicants in response to Notice Inviting Prequalification.

3. Qualification of the Bidder

3.1 To be qualified for award of Contract, bidders shall:

- (a) Submit a written power of attorney authorizing the signatory of the bid to commit the bidder

Tenderer's Signature and Stamp

4. Bid per Bidder

Each bidder shall submit only one bid either by himself, or as a partner in a joint venture. A bidder who submits or participates in more than one bid will be disqualified.

5. Cost of Bidding

- 5.1 The bidder shall bear all costs associated with the preparation and submission of his bid and the Employer will in no case be responsible or liable for those costs.

6. Site Visit

- 6.1 The bidder is advised to visit and examine the Site of Works and its surroundings and obtain for himself on his own responsibility all information and data including all topographical and geo-technical data, that may be necessary for preparing the bid and entering into a contract for construction of the Works and if successful, for carrying out all the construction. The costs of visiting the Site and collection of information and data shall be at the bidder's own expense.

- 6.2 The bidder and any of his personnel or agents will be granted permission by the Employer to enter upon his premises and lands for the purpose of such inspection, but only upon the express condition that the bidder, his personnel and agents, will release and indemnify the Employer and his personnel and agents from and against all liability in respect thereof and will be responsible for death or personal injury, loss of or damage to property and any other loss, damage, costs and expenses incurred as a result of the inspection.

B. Bidding Documents

7. Content of Bidding Documents

- 7.1 The bidding documents shall comprise Technical Proposal and Financial Proposal which are to be submitted in separate envelopes. Bid security to be submitted will be a part of technical bid which is also to be submitted in separate sealed cover.
- 7.2 The bidder is expected to examine carefully the contents of the Bidding documents. Failure to comply with the requirements of bid submission will be at the bidder's own risk. Bids which as per opinion of the employer are not substantially responsive to the requirements of the bidding documents will be rejected.

8. Deleted

9. Amendment of Bidding Documents

At any time prior to the deadline for submission of tenders, the Engineer may, for any reason, whether at his own initiative or in response to a clarification or query raised by a prospective tenderer, modify the tender documents by issuing addenda.

Tenderer's Signature and Stamp

The said amendment in the form of an addendum will be sent to all prospective tenderers who have received the tender documents, on or prior to last date mentioned in Clause 19.1. This communication will be in writing or by telefax and the same shall be binding upon them. Prospective tenderers should promptly acknowledge receipt thereof by telefax or e-mail to the Engineer.

In order to afford prospective tenderers reasonable time for preparing their tenders after taking into account such amendments, the Engineer or the Employer may, at his discretion, extend the deadline for the submission of tenders in accordance with Sub-clause 19.2.

C. Preparation of Bids

10. Language of Bid

- 10.1 The bid, and all correspondence and documents, related to the bid, exchanged between the bidder and the Employer shall be written in English language. Supporting documents and printed literature furnished by the bidder may be in another language provided they are accompanied by an accurate translation of the relevant passages in the English language, in which case, for purposes of interpretation of the bid the English translation shall prevail.

11. Documents Comprising the Bid

- 11.1 The bid submitted by the bidder shall comprise the documents furnished under Sub-Clause 18.5 of Section 2. The documents listed under Sub-Clause 18.5 of Section 2 shall be filled-in without exception as necessary, subject to extensions thereof in the same format.
- 11.2 The rates quoted by the bidder in the form of bid, Section 1A, Vol. IV shall inter-alia include all constructional plant, labour, supervision, materials, transport, temporary and ancillary works, erection, maintenance, insurance, overheads, profits, taxes and duties together with all general risks, liabilities and obligations set out or implied in the Contract.
- 11.3 Deleted
- 11.4 All the Documents comprising the Bid shall be signed on every page and submitted in the required number of copies to the Tender Inviting Authority by the date specified in Clause 19.1.

12. Bid Prices

- 12.1 Unless stated otherwise in the bidding documents, the Contract shall be for the whole Works as described in Sub-Clause 1.1, based on the Priced Bill of Quantities with the contractual rate offered by the bidder.

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12.2 The Summary Sheet of Bill of Quantities has three parts.

Part A : Priced Bill of Quantities of a) Civil Works, b) Water Supply, Sanitary & Drainage Works, c) Electrical Works and d) HVAC Works.

Part B: Non-Priced Bill of Quantities of e) Civil Works, f) Water Supply, Sanitary & Drainage Works, g) Fire Protection System, h) Electrical Works, i) Medical Gas Pipeline, j) Modular OT and k) HVAC Works.

Part C : Provisional sum Items namely l) Escalation m) Supplementary works.

12.3 The bidder is required to quote his rate in the following manner.

i) **For Part A :** Priced Bill of Quantities - the bidder shall offer At PAR /.....% Above (both in figures and in words) /% Below (both in figures and in words) the priced bill of quantities at the place specified in the Summary Sheet of Bill of Quantities.

The amount of Part A after application of contractual percentage as quoted above shall be calculated and written in the place specified under Part A format of Summary Sheet.

ii) **For Part B :** Non-priced Bill of Quantities - the bidder shall fill in the rates and amounts for all items described in the detailed non-priced Bill of Quantities of Part B. All rates to be quoted both in figures and in words under rate columns of the Bill of Quantities.

Thereafter, amount of respective subheads like- e) Civil Works, f) Water Supply, Sanitary & Drainage Works, g) Fire Protection System, h) Electrical Works, i) Medical Gas Pipeline, j) Modular OT and k) HVAC Works shall be written in the place specified under Part B in the Summary Sheet of Bill of Quantities. Subtotal of Part B should be drawn and written in Part B format of the Summary Sheet.

iii) The aggregate value of Part A after application of contractual percentage and value of Part B shall be calculated and written in the column specified there under.

iv) **In addition** the bidder may also like to **offer a discount in percentage** on the aforesaid sum of aggregate value of Part A and Part B at the bottom of Part B format of Summary Sheet of Bill of Quantities to arrive at the final **contract price**.

v) Regarding **Part C : Provisional Sum**, for item (l) Escalation (described in clause 37 of General Conditions of Contract), both contractual percentage rate and discount, if there be any, offered by the tenderer will be applicable. For the other Provisional Sum item namely (m) Supplementary Works payment shall be made as per clause 36 of General Conditions of Contract.

12.4 All duties, taxes and other levies including Educational Cess etc., as imposed by Govt. of India & Govt. of West Bengal valid on date of bidding, payable by the Contractor under the Contract, or for any other cause, shall be included in the rates. HRBC will not make any payments towards taxes, duties, levies etc for the entire contract period.

Tenderer's Signature and Stamp

- 12.5 The rates quoted by the bidder are FIRM & not subjected to adjustment during the performance of the Contract for the period of contract including the period of extension.
- 12.6 The rates as per accepted Bill of Quantities shall hold good till completion of works and no additional claim or amount shall be admissible on account of fluctuations in market rates, increase in any taxes, levies, fees, royalties etc. barring adjustment to be made due to increase or decrease in the base prices of reinforcement steel and cement only. For further details CI-52 of General Conditions of Contract is referred to.

13. Deleted

14. Bid Validity

- 14.1 Bids shall remain valid for a period of 120 (one hundred and twenty) days after the date of submission of bids.
- 14.2 In exceptional circumstances, prior to expiry of the original bid validity period, the Employer may request that the bidders extend the period of validity for a specified additional period. A bidder may refuse the request without forfeiting the bid security. A bidder agreeing to the request will not be required or permitted to modify his bid, but will be required to extend the validity of his bid security for the period of extension.

15. Bid Security

- 15.1 The bidder shall furnish, as part of his bid, a bid security of Rs.3,50,00,000.00 (Rupees three crore fifty lac only) at the time of submission of tender in the form of Bank Guarantee in favour of HRBC from Nationalised or Scheduled Bank of India to be acceptable to the Employer. The format of the Bank Guarantee shall be in accordance with the form of bid security included in Vol.- I, Section-3 of the Tender Document. Other formats may be permitted, subject to the prior approval of the Employer.
- 15.2 Deleted.
- 15.3 Any bid not accompanied by an acceptable bid security shall be rejected outright by the Employer as non-responsive
- 15.4 The bid securities of unsuccessful bidders will be returned as promptly as possible, after the performance of contract agreement.
- 15.5 The bid security of the successful bidder will be returned when the bidder has signed the Agreement and furnished the required performance security.
- 15.6 The bid security may be forfeited
- (a) if the bidder withdraws his bid during the period of bid validity;
 - (b) if the bidder does not accept the correction of his bid price, pursuant to Clause 26
 - (c) in the case a successful bidder fails within the specified time limit to
 - (i) sign the Agreement
 - (ii) furnish the required performance security

Tenderer's Signature and Stamp

16. Format and Signing of Bid

- 16.1 The bidder shall prepare the Bid documents comprising the bid as described in Clause 11 of these Instructions to Bidders, with three bound volumes, viz, Book-1, Book-2 and Book-3 containing Technical Proposal, Financial Proposal and Contractor's Technical Submission respectively.
- 16.2 The bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the bidder, pursuant to Sub-clauses 3.1(a). All pages of the bid shall be initialed by the person or persons signing the bid.
- 16.3 The bid shall contain no alterations, omissions or additions, except those to comply with instructions issued by Employer, or as necessary to correct errors made by the bidder, in which case such corrections shall be initialed by the person or persons signing the bid.

17. Deleted

D. Submission of Bids

18. Sealing and Marking of Bids

- 18.1 For submission, evaluation and selection of the Agency a "Two Stage" process will be adopted. The proposal should be submitted in two parts in two separate sealed envelopes. These two sealed envelopes shall be put together in one single outer sealed envelope. The two parts of the proposal are
- 1) Technical proposal
 - 2) Financial Proposal
- 18.2 The bidder shall seal and mark each of the two envelopes, i.e, Envelope-1: Technical proposal, Envelope-2: Financial proposal. These two sealed and marked envelopes along with the separate sealed envelope containing the Bank Guarantee for bid security and the Bank Draft for cost of tender document shall be put together in one single outer envelope which also shall be sealed. These two sealed and marked envelopes shall be put together in one single outer envelope which also shall be sealed. The bid security will be a part of Technical Proposal.
- 18.3 The sealed envelope shall
- (a) be addressed to:
Director (Pl. & Dn.)
Hooghly River Bridge Commissioners
HRBC Bhawan, 3rd Floor,
Munshi Prem Chand Sarani
(St. George's Gate Road),
Kolkata 700 021

Tenderer's Signature and Stamp

(b) bear the following identification:

- i) Name of the Work: Construction of 4(four) Super Speciality Hospitals under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum (Package 1).
- ii) Name and Address of the bidder along with Telephone no, Mobile no, Fax no and Email address and the name of authorized agent delivering the sealed cover containing the offer, on the bottom left hand corner.

18.4 If the envelope is not properly sealed and marked as above, the Employer will assume no responsibility for the misplacement or premature opening of bid and all consequences shall rest on the bidder including rejection of the bid.

18.5 Contents of envelopes are detailed hereunder:

Single Outer Envelope	Envelope -1 Part – 1 Technical Proposal	Separate Sealed Envelope		i) Bank Guarantee for Bid Security ii) Bank Draft for cost of tender document
		BOOK-1	Volume -I	TECHNICAL PROPOSAL Section 1 Invitation for Bids Section 2 Instructions to Bidders Section 3 Section 3A Form of Agreement Section 3B Form of Performance B.G Section 3C Form of B.G for Advance Payment Section 3D Form of Bid Security (Bank Guarantee) Section 3E Declaration Section 4 General Conditions of Contract
			Volume II	Technical Specification
			Volume III	Contract Drawings
		BOOK-3	Volume V	Contractor's Technical Submission (in hard copy as well as in soft copy). Other documents as per sub clause 18.6.1 hereafter.
	Envelope -2 Part - 2 Financial Proposal	BOOK-2	Volume IV	FINANCIAL PROPOSAL Section 1 Section 1A Form of Bid Section 1B Appendix to Bid (if there be any) Section 2 Bill of Quantities

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18.6 CONTENTS OF PROPOSALS

18.6.1 Technical Proposal

(a) Along with the Technical proposal (Book-1 : issued by HRBC), the Bank Guarantee for Bid Security as specified in Cl. 15 of Instructions to Bidder (Vol I, Sec -2) and the Bank Draft for cost of tender document as mentioned in Invitation for Bids (Vol I, Sec -1) shall be deposited in a separate sealed envelope and to be put in Envelope 1 along with the Contractor's Technical submission (Vol V in Book-3 : to be prepared and furnished by bidder). Besides a written power of Attorney authorizing the signatory of the bid to commit the bidder shall be furnished. Any other non financial data like Articles of Association etc. may be given in Envelope-1.

(b) Contractor's Technical submission (Vol V in Book-3 : to be furnished by bidder) of finally selected agency will become the part of the Agreement. Any failure to comply with the provision therein shall make the contractor liable for action in terms of Sub Cl. 49.1 of General Conditions of Contract.

(c) Contractor's Technical submission is designated as Volume - V in Book-3 and should cover in detail the following :

- (1) List of technical personnel identified by name, who will be assigned to the project implementation in different capacities. Their educational qualification, work experience, nature of employment (regular employee of the firm or on contract basis) etc. should be provided in the list.
- (2) List of all machineries to be deployed for execution of work of the project. List should indicate make, capacity, date of purchase (if owned), quantity or number of each type of machines, whether owned or to be taken on lease etc.
- (3) General approach and methodology proposed for carrying out different services like survey, planning, design, preparation of work drawings, as built drawings, target / milestone - achievement report of works, execution of different work items as per BOQ and scope of works etc. including all other related information as deemed relevant.
- (4) Work Program and Work Achievement : A detail work program indicating quantity, timing and duration of all major items of works under the Contract Package in the form of bar chart based on milestone format.
- (5) Quality Assurance Plan : The plan shall contain information elaborating the proposed method of achieving quality standards for each work items, generally as specified in Schedule of Rates of PWD, Govt. of W.B./CPWD/IS Codes, including materials & work specifications, provisions of field quality testing laboratory as well as central quality testing laboratory, frequency of quality testing as also quality control staff, management etc.
- (6) Adequate proposal ensuring any adverse environmental impact is minimized during construction.

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18.6.2 Financial Proposal :

- (a) The Financial Proposal shall contain :-
- (1) The Financial bid which is to be quoted in Form of Bid (Vol. IV, Section 1A) of the tender document.
 - (2) The bound book of Tender Document, containing Vol IV in Book-2 issued by HRBC, and duly signed by the authorized representative of the bidder in all pages conforming to provision of tender conditions.
- (b) Financial proposals will be opened on the date and time as specified (Unless altered by issuing corrigenda notice) in presence of intending tenderers who have qualified after evaluation of Technical proposals.
- (c) Provided all other requirement as per provision of tender conditions is complied with. Final selection of the tenderer will be through evaluation of financial proposal and accepting normally the lowest contract price.

19. Deadline for Submission of Bids

- 19.1 Bids must be received only by Director (Pl. & Dn.), HRBC in his office Tender Box at the address specified above not later than on 04.12.2013 at 14.00 hours. No bid will be accepted if submitted in any other office or Receiving Section of HRBC.

At 14.30 hours on 04.12.2013, the Envelope –1 containing the bank guarantee for bid security, the bank draft for cost of tender document, technical proposal and non-financial document will be opened in presence of the participating bidders in the conference room of HRBC. After opening, only the details of bid security will be declared. Other documents of technical proposal will be evaluated by a constituted evaluation committee.

- 19.2 Director (Pl. & Dn.), HRBC may, at his discretion, extend the deadline for submission of bids, in which case all rights and obligations of the Employer and the bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.

20. Late Bids

- 20.1 Any bid received by the Director (Pl. & Dn.), HRBC after the deadline for submission of bids prescribed in Clause 19 will be rejected and returned unopened to the bidder by Registered Post with A/D, which shall be treated as the fulfillment of obligation by the employer.

21. Modification and Withdrawal of Bids

- 21.1 The bidder may modify or withdraw his bid after bid submission, provided that written notice of the modification or withdrawal is received by the Employer prior to the deadline for submission of bids.

Tenderer's Signature and Stamp

- 21.2 The bidder's modification or withdrawal notice shall be prepared, sealed, marked and delivered in accordance with the provisions of Clause 18, additionally marked "MODIFICATION" or "WITHDRAWAL" as appropriate.
- 21.3 No bid may be modified by the bidder after the deadline for submission of bids.
- 21.4 Withdrawal of a bid during the interval between the deadline for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in the forfeiture of the bid security pursuant to Clause 15.

E. Bid Opening and Evaluation

22. Bid Opening

- 22.1 Director (Pl. & Dn.), HRBC will open each proposal in stages

Technical proposal would be first opened and evaluated and firms scoring the qualifying marks as mentioned would be considered for further evaluation. Financial proposal would then be opened on 06.12.2013 at 12.30 hours in the chamber of Director (Pl. & Dn.), HRBC/Conference room. The financial proposal of only those firms, who score qualifying marks in the Technical Proposal would be opened and evaluated. The final selection of the firm will be the bidder who has offered the lowest evaluated bid price as in sub-clause 27.2 provided that his financial proposal is otherwise qualified as per provisions of the tender.

- 22.2 Envelopes marked "WITHDRAWAL" shall be opened and read out first, Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause 21 shall not be opened.

23. Process to be Confidential

- 23.1 Information relating to examination, clarification, evaluation and comparison of bids and recommendations for the award of a contract shall not be disclosed to bidders or any other persons not officially concerned with such process until the award to the successful bidder has been announced. Any effort by a bidder to influence the Employer's processing bids or award decisions may result in the rejection of the bidder's bid.

24. Clarification of Bids

- 24.1 To assist in the examination, evaluation and comparison of bids, the Employer may, at his discretion, ask any bidder for clarification of his bid. The request for clarification and the response shall be in writing or by cable, but no change in the price or substance of the bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the bids in accordance with Clause 26.
- 24.2 The rate for each item shall be reasonable and not unbalanced. Should the Engineer/Employer come across any unbalanced rates, he may require the tenderer to furnish detailed analysis to justify the same. Should the tenderer fail to comply with this, his tender shall be liable to be rejected by the Employer, who may award the Contract to any other tenderer.

Tenderer's Signature and Stamp

25. Examination of Bids and Determination of Responsiveness

- 25.1 Prior to the final evaluation of bids, the Employer will determine whether each bid (i) meets the eligibility criteria (ii) has been properly signed; (iii) is accompanied by the required securities; (iv) is substantially responsive to the requirements of the bidding documents; and (v) provides any clarification and/or substantiation that the Employer may require pursuant to Sub-Clause 24.1
- 25.2 A substantially responsive bid is one, which conforms to all the terms, conditions and specifications of the bidding, documents, without material deviation or reservation. A material deviation or reservation is one (i) which affects in any substantial way the scope, quality or performance of the Works; (ii) which limits in any substantial way, inconsistent with the bidding documents, the Employer's rights or the bidder's obligations under the Contract; or (iii) whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids.
- 25.3 If a bid is not substantially responsive, it will be rejected by the Employer, and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation.
- 25.4 The criteria of non-responsiveness are as stated below but are not limited to them:
- i) The bids which do not incorporate obligatory parameters
 - ii) Failure to comply with the requirements of bid submission
 - iii) Failure to comply with the requirements of Clause 11 and does not enclose the documents as detailed therein
 - iv) Failure to submit Bid Security as per Clause 15
 - v) Failure of Bid to conform to all the terms, conditions and specifications of bidding, bidding documents
 - vi) A bid which materially deviates from the requirements of the bid documents or is a conditional offer
 - vii) Any other reason which in the opinion of the Employer / renders the bid non-responsive.
- The Employer's decision as to the non-responsiveness of any bid shall be final.

26. Correction of Errors in Financial Bids

- 26.1 Bids determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows:
- a) Where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and
 - b) Where there is a discrepancy between the unit rate and the line item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern, unless in the opinion of the Employer there is an obviously gross misplacement of the decimal point in the unit rate, in which case the line item total as quoted will govern and the unit rate will be corrected.

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- 26.2 The amount stated in the Form of Bid will be adjusted by the Employer in accordance with the above procedure for the correction of errors and shall be considered as binding upon the bidder, If the bidder does not accept the corrected amount of his bid, his bid will be rejected, and the bid security may be forfeited in accordance with Sub-Clause 15.6(b).

27. Evaluation and Comparison of Bids

- 27.1 For evaluation of Technical Proposal marks assigned to different items therein are as below.

Sl. No.	Description	Marks
1.	Exclusive Technical personnel to be assigned for project implementation	20
2.	Construction machineries compatible to work program to be deployed	20
3.	General approach and methodology proposed for carrying out different services for successful completion of the project.	20
4.	Achievable Work program and bar chart on milestone format preferably supported by material planning matching with desired progress	15
5.	Quality Assurance Plan including arrangement of quality testing and documentation.	20
6.	Proposal to minimize adverse environmental impact during construction.	5
	TOTAL	100

The firm should score at least 75 marks for qualifying in the next stage for opening of financial proposal provided deposit of Bid Security and other requirement are adequate as per tender conditions. Financial proposals of non-qualified bidders scoring less than 75 marks will not be opened.

- 27.2 For evaluation of Financial Proposal, comparison of rates offered by the bidders, who have qualified after evaluation of Technical Proposal, shall be made. The contract price will be evaluated on the basis of the cost of the full work at the rates quoted by the tenderer for different items included in the Part B of Bill of Quantities as also in the Summary Sheet of Bill of Quantities. The lowest contract price offered by the contractor will be normally accepted for final selection of the bidder, if there be no other discrepancy.

F. Award of Contract

28. Award

Subject to Clause 27, the Employer will award the Contract to the bidder whose bid has been determined to be substantially responsive to the bidding documents and who has offered the lowest contract price subject to Cl. 3.1.

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29. Employer's Right to Accept any Bid and to Reject any or all Bids

Notwithstanding Clause 27, the Employer reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders of the grounds for the Employer's action. In any event right is also reserved to carry out negotiations with any or all contractors whose financial proposals had been opened and evaluated in accordance with sub clause 27.2 with a view to obtain bid price lower than those received in response to the invitation for competitive offers.

30. Notification of Award

Prior to expiration of the period of bid validity prescribed by the Employer, the Employer will notify the successful bidder in writing by registered letter/fax/e-mail that his bid has been accepted. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") shall name the sum which the Employer will pay the Contractor in consideration of the execution, completion and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Conditions of Contract called "the Contract Price").

The notification of award will constitute the formation of the Contract.

Upon the furnishing by the successful bidder of a performance security, the Employer will promptly notify the other bidders that their bids have been unsuccessful.

31. Signing of Agreement

At the same time that he notifies the successful bidder that his bid has been accepted, the Employer will send the bidder the Form of Agreement provided in the bidding documents, incorporating all agreements between the parties.

Within seven days of receipt of the Form of Agreement, the successful bidder shall sign the Form and return it to the Employer.

32. Performance Security/Guarantee

Within seven days of receipt of the notification of award from the Employer, the successful bidder shall furnish to the Employer a performance security in the form of Bank Guarantee in favour of 'Hooghly River Bridge Commissioners' from Nationalised or Scheduled Banks of India to be acceptable to the Employer of an amount of 7.5% of the Contract Price in accordance with the Conditions of Contract. The form of Performance Bank Guarantee provided in Section 3B of the bidding documents may be used or some other form acceptable to the Employer which will have provision of extending the Bank Guarantee with extension of time approved by the Employer.

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33. Annulment of the Award

Failure of the successful bidder to comply with the requirements of Clauses 31 or 32 shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security.

34. Issue of Notice to Commence

After receipt of Performance Security from the contractor as stipulated in Clause 32 of Instructions to Bidders and Clause 6 of General Conditions of Contract or even after award of the contract through issue of Letter of Acceptance, the Engineer will notify the contractor to commence work as soon as reasonably possible with due expedition and without delay. If the contractor fails to commence works physically at the site within 10(Ten) days from the date of issue of Notice to Commence Work, that will constitute a breach of contract and in that case the Employer will have right to annul the contract with forfeiture of Performance Security and if the same is not deposited forfeiture of Bid Security.

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VOLUME I - SECTION 3

SECTION 3A FORM OF AGREEMENT

SECTION 3B FORM OF PERFORMANCE B.G

SECTION 3C FORM OF BG FOR ADVANCE PAYMENT

SECTION 3D FORM OF BID SECURITY

(BANK GUARANTEE)

SECTION 3E DECLARATION

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Vol.I Section 3A. Form of Agreement

AGREEMENT

THIS AGREEMENT made the ____ day of _____ 201__ between The Vice Chairman of the Hooghly River Bridge Commissioners (hereinafter called "the Employer") of the one part and _____ of _____ (hereinafter called "the Contractor") of the other part.

WHEREAS the Employer is desirous that certain Works should be executed by the Contractor, viz. "Construction of 4(four) Super Speciality Hospitals under BRGF at Metiaburz and Kakdwip in South 24Parganas,at Sagardighi in Murshidabad and at Bolpur in Birbhum : Package-1"and has accepted a Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

NOW THIS AGREEMENT WITNESSETH as follows:

1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.:
 - (a) Agreement
 - (b) Letter of Acceptance
 - (c) The offer submitted by the Contractor in the prescribed form and accepted by the Employer (Section 1A, Vol IV).
 - (d) Appendix to Bid (Section 1B, Vol IV)
 - (e) Addenda to Tender Documents, if any
 - (f) Invitation for Bid (Section 1, Vol I)
 - (g) Instructions to Bidders (Section 2, Vol I)
 - (h) General Conditions of Contract (Section 4, Vol I)
 - (i) Technical Specifications (Vol II)
 - (j) Bill of Quantities with Provisional Sums (Section 2, Vol IV)
 - (k) Contract Drawings (Vol III)
 - (l) Contractor's Technical Submission (Vol V)
 - (m) Other documents as agreed upon
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.
4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

Contd...

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Vol. I Section 3A - Form of Agreement (continued)

It is mutually agreed:-

- 5(1) That the Contractor will carry out the work in accordance with the provisions of the contract and remedy any defect therein at rates offered by him in the summary sheet of Bill of Quantities as also in the Part B of Bill of Quantities. The contract price comes to Rs. _____ (Rupees _____) only (as derived in the Summary Sheet of Bill of Quantities)
- 5(2) That the implementation of this Agreement shall start upon issuance of the Notice to Commence by the Engineer to the Contractor.
- 5(3) That this Agreement shall extend and be binding upon the parties hereto, executors, successors and permitted assigns, who shall jointly and severally be entitled to the benefits of this Contract.

(Signed, sealed)

Binding Signature of Contractor

Binding Signature of Employer

Tenderers stamp, signature and date

Witness 1

Witness 2

Tenderer's Signature and Stamp

Vol. I Section 3B - Form of Performance Bank Guarantee

THIS AGREEMENT is made on the _____ day of _____ 201____
between _____ [name of bank] of
_____ [address of bank] (hereinafter called "the Guarantor") of the
one part and _____ [name of Employer] of _____ [address
of Employer] (hereinafter called "the Employer") of the other part.

WHEREAS

- (1) this Agreement is supplemental to a contract (hereinafter called "the Contract") made between _____ [name of Contractor] of _____ [address of Contractor] (hereinafter called "the Contractor") of the one part and the Employer of the other part whereby the Contractor agreed and undertook to execute the Works of _____ [name of Contract and brief description of the Works] for the sum of _____ [amount in Contract currency] being the Contract Price; and
- (2) the Guarantor has agreed to guarantee the due performance of the Contract in the manner hereinafter appearing.

NOW, THEREFORE, the Guarantor hereby agrees with the Employer as follows:

- (a) If the Contractor (unless relieved from the performance by any clause of the Contract or by statute or by the decision of a tribunal of competent jurisdiction) shall in any respect fail to execute the Contract or commit any breach of his obligations there under then the Guarantor will indemnify and pay the Employer the sum of[amount of Guarantee] _____ [in words], such sum being payable in the types and proportions of currencies in which the Contract Price is payable, provided that the Employer or his authorized representative has notified the Guarantor to that effect and has made a claim against the Guarantor before the issue of the Defects Liability Certificate.
- (b) The Guarantor shall not be discharged or released from his guarantee by an arrangement between the Contractor and the Employer, with or without the consent of the Guarantor, or by any alteration in the obligations undertaken by the Contractor, or by any forbearance on the part of the Contractor, whether as to the payment, time, performance, or otherwise, and any notice to the Guarantor of any such arrangement, alteration, or forbearance is hereby expressly waived.

This Guarantee shall be valid until a date 28 days from the date of issue of the Taking Over Certificate. If works are not completed within stipulated date of completion, it is understood that the Bank will extend this guarantee under the said conditions for the required time on demand by the Employer and at the cost of the Contractor.

Given under our hand on the date first mentioned above.

SIGNED BY _____
for and on behalf of the
Guarantor in the presence of

(Witness)

Tenderers stamp, signature and date

Tenderer's Signature and Stamp

SIGNED BY _____
for and on behalf of the
Employer in the presence of

(Witness)

Vol. I Section 3C- Form of Bank Guarantee for Advance Payment

To
(Name of Employer)
(Address of Employer)

(Name of Contract)

Gentlemen:

In accordance with the provisions of the General Conditions of Contract, Clause 10 ("Advance Payment") of the above-mentioned Contract, _____ (name and address of Contractor) (hereinafter called "the Contractor") shall deposit with the (name of Employer) a bank guarantee to guarantee his proper and faithful performance under the said Clause of the Contract in an amount of _____ (amount of Guarantee) _____ (amount in words).

We, the _____ (bank or financial institution), as instructed by the Contractor, agree unconditionally and irrevocably to guarantee as primary obligator and not as Surety merely, the payment to _____ (name of Employer) on his first demand without whatsoever right of objection on our part and without his first claim to the Contractor, in the amount not exceeding _____ (amount of Guarantee) _____ (amount in words), such amount to be reduced periodically by the amount recovered by you from the proceeds of the Contract.

We further agree that no change or addition to or other modification of the terms of the Contract or of Works to be performed there under or of any of the Contract documents which may be made between _____ (name of Employer) and the Contractor, shall in any way release us from any liability under this guarantee, and we hereby waive notice of any such change, addition or modification.

No drawing may be made by you under this Guarantee until we have received notice in writing from you that an advance payment of the amount listed above has been paid to the Contractor pursuant to the Contract.

This guarantee shall remain valid and in full effect from the date of the advance payment under the Contract until _____ (name of Employer) receives full repayment of the same amount from the Contractor.

Yours truly,

SIGNATURE AND SEAL: Name of Signatory _____

Capacity of Signatory
Name of Bank or Financial Institution
Address _____
Date _____

Tenderers stamp, signature and date

Tenderer's Signature and Stamp

Vol. I Section 3 D - FORM OF BID SECURITY (BANK GUARANTEE)

WHEREAS, (name of bidder) _____

(hereinafter called "the Bidder") has submitted his Bid dated (date) _____ for the execution of "*Construction of 4(four) Super Speciality Hospitals under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum : Package – 1*" (hereinafter called "the Bid"). KNOW ALL PEOPLE by these present that we (name of Bank) _____ of registered office at _____ (hereinafter called "the Bank") are bound unto _____ (hereinafter called "the Employer") in the sum of _____ for which payment well and truly to be made to the said Employer, the Bank binds himself, his successors, and assigns by these presents.

SEALED with the Common Seal of the said Bank this _____ day of _____ 201_____

THE CONDITIONS of this obligation are:-

- (1) if the Bidder withdraws his Bid during the period of Bid validity specified in the Instructions to Bidders; or
- (2) if the Bidder refuses to accept the correction of errors in his Bid; or
- (3) if the Bidder, having been notified of the acceptance of his Bid by the Employer during the period of Bid validity;
 - (a) fails or refuses to execute the Form of Agreement in accordance with the Instructions to Bidders, if required; or
 - (b) fails or refuses to furnish the Performance Security, in accordance with the Instruction to Bidders;

We undertake to pay to the Employer up to the above amount upon receipt of his first written demand, without the Employer having to substantiate his demand, provided that in his demand the Employer will note that the amount claimed by him is due to him owing, to the occurrence of one or both of the two conditions, specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date 28 days after the date of expiration of the Bid Validity as stated in the Instructions to Bidders, or as it may be extended by the Employer, notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

SIGNATURE OF THE BANK _____
NAME _____
DESIGNATION _____
DATE _____

SEAL _____

SIGNATURE OF WITNESS _____
NAME _____
ADDRESS _____

The bidder should insert the amount of the guarantee in words and figures. This figure should be the same as shown in Clause 15.1 of Instruction to Bidder. The attention of joint venture bidders is drawn to Clause 15.3 of the Instructions to Bidders.

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Vol. I Section 3 E

DECLARATION

It is to certify that

- 1) I/We have submitted the tenders in the proforma as downloaded directly from the website and there is no change in formatting, number of pages etc.
- 2) I/We have submitted tender documents which are same /identical as available in the website.
- 3) I/We have not made any modification/corrections/additions etc. in the tender documents downloaded from web by me/us.
- 4) I/We have checked that no page is missing and that all pages of tender documents submitted by us are clear and legible.
- 5) I/We have signed (with stamp) all the pages of the tender document before submitting the same.
- 6) I/We have ensured that the print out of tender document is taken on A-4 size of paper except some contract drawings which are to be taken on A-3 size of paper.
- 7) I/We have ensured that the downloaded tender documents is properly bound and sealed the tender documents properly before submitting the same.
- 8) I/We have submitted the cost of tender document along with the bid security.
- 9) In case at any stage later, it is found there is difference in our downloaded tender documents from the original as uploaded in HRBC website, HRBC shall have the absolute right to take any action as deemed fit without any prior intimation to me/us.

Dated :

.....
STAMP & SIGNATURE OF AUTHORIZED SIGNATORY

- NOTE:**
1. In case of JV/Consortium, the undertaking shall be submitted by each member of the JV/Consortium.
 2. The undertaking shall be signed by authorized signatory of the tenderer or constituent member in case of JV/Consortium.

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Volume I - SECTION 4
General Conditions of Contract

Tenderer's Signature and Stamp

I N D E X

TERMS AND CONDITIONS OF CONTRACT

Sl. No.	Item
1.0	DEFINITIONS:
2.0	PARTIES TO THE CONTRACT:
3.0	ENGINEER’S AUTHORITY TO DELEGATE
4.0	ASSIGNMENT AND SUB-CONTRACTING :
5.0	CONTRACT DOCUMENT:
6.0	PERFORMANCE SECURITY
7.0	CLAIMS UNDER PERFORMANCE SECURITY:
8.0	RETENTION MONEY:
9.0	PAYMENT OF RETENTION MONEY:
10.0	ADVANCE PAYMENT:
11.0	CONTRACT AGREEMENT:
12.0	SUFFICIENCY OF OFFER:
13.0	CONTRACTOR’S RATE TO INCLUDE ALL COSTS FOR COMPLETING WORKS
14.0	UNFORESEEN PHYSICAL OBSTRUCTIONS OR CONDITIONS:
15.0	PROGRAMME TO BE SUBMITTED :
16.0	CASH FLOW ESTIMATE TO BE SUBMITTED
17.0	SAFETY, SECURITY AND PROTECTION OF ENVIRONMENT:
18.0	SUPPLY OF WATER AND ELECTRICAL POWER
19.0	INSURANCE
20.0	POLICY IN JOINT NAMES OF CONTRACTOR AND EMPLOYER
21.0	COMPLIANCE WITH STATUTES OR REGULATIONS:
22.0	PATENT RIGHTS:
23.0	CONTRACTOR'S EMPLOYEES:
24.0	CONTRACTOR TO KEEP ROAD LANES CLEAR:
25.0	CONTRACTOR TO KEEP SITE CLEAR:
26.0	CLEARANCE OF SITE AFTER COMPLETION:
27.0	CONTRACT PERIOD:
28.0	LIQUIDATED DAMAGES:
29.0	LIMIT OF LIQUIDATED DAMAGES AND ITS REDUCTION:
30.0	QUALITY TEST OF MATERIALS AND WORKMANSHIP AND COST OF TEST:
31.0	INDEPENDENT INSPECTION:
32.0	COMMENCEMENT OF WORK:
33.0	SETTING OUT:
34.0	ACCESS ROAD
35.0	OPPORTUNITIES FOR OTHER CONTRACTORS:
36.0	SUPPLEMENTARY WORKS AND FIXATION OF RATES:
37.0	PROVISIONAL SUMS AND ITEMS:
38.0	MEASUREMENT:

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39.0	ARBITRATION:
40.0	DESIGN, DRAWINGS AND AS-BUILT DRAWINGS:
41.0	INSPECTION OF OPERATION:
42.0	REMOVAL OF IMPROPER WORK MATERIALS OR PLANT:
43.0	CONTRACTOR'S SUPERINTENDENCE
44.0	TAKING OVER CERTIFICATE :
45.0	DEFECTS LIABILITY :
46.0	DEFECT LIABILITY CERTIFICATE:
47.0	HRBC'S RISK:
48.0	BRIBES AND COMMISSION:
49.0	TERMINATION:
50.0	PAYMENT UPON TERMINATION:
51.0	DISPUTES AND RESOLUTION ARISING OUT OF INTERPRETATION OF CONTRACT CONDITIONS:
52.0	PRICE ADJUSTMENT
53.0	SUBSEQUENT LEGISLATION
54.0	JOINT AND SEVERAL LIABILITY :
55.0	DETAILS TO BE CONFIDENTIAL:
56.0	MONTHLY PAYMENTS
57.0	REGISTRATION AND COLLECTION OF CESS
58.0	DELETED
59.0	TIME OF PAYMENT
60.0	CORRECTION OF CERTIFICATES
61.0	STATEMENT AT COMPLETION
62.0	FINAL STATEMENT
63.0	DISCHARGE
64.0	FINAL PAYMENT CERTIFICATE
65.0	CESSATION OF EMPLOYER'S LIABILITY
66.0	ENGINEER AT LIBERTY TO OBJECT
67.0	SHEDS, STORES, YARDS
68.0	ROADS AND WATER COURSES, ACCESS TO PREMISES AND SAFETY OF PUBLIC
69.0	CARE OF WORKS
70.0	FORCE MAJEURE
71.0	TEMPORARY WORKS
72.0	LABOUR CAMP
73.0	INDEMNITY

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GENERAL CONDITIONS OF CONTRACT

1.0 DEFINITIONS:

- 1.1 The terms "**Contractor**" shall mean and include the person or persons, firm or company whose tender for the captioned work has been accepted by HOOGHLY RIVER BRIDGE COMMISSIONERS on its behalf as specified and in the case of natural persons, him/her, his/her heirs, executors and administrators and in the case of a partnership firm, the partner or partners for the time being of the firm.
- 1.2 The term "**Work**" shall mean the activities as stated in the contract.
- 1.3 The term "**Letter of Intent**" shall mean and include the terms and conditions of contract, Letter of acceptance, the Agreement and mutually accepted conditions in the authorized correspondence exchanged with the Bidder by the Commissioners and any other document forming part of the contract.
- 1.4 The term "**Contract Price**" shall mean the aggregate value of PART A : BOQ after application of Contractual percentage and PART B : BOQ as per rates quoted by the bidder with application of discount (if there be any) on the aggregate value excluding Provisional Sums as worked out in the Summary Sheet of Bill of Quantities.
- 1.5 The "**Authorized representative**" shall mean any officer authorized by the HRBC to act on behalf of the HRBC.
- 1.6 The term "**Government**" shall mean the Government of West Bengal and shall include the Governor of West Bengal.
- 1.7 The term "**Governor of West Bengal**" shall mean and include his successors and assigns.
- 1.8 The term "**Commissioner**" shall mean Hooghly River Bridge Commissioners (HRBC).
- 1.9 The term "**Employer**" shall mean the Vice Chairman, HRBC and include his successor and assign.
- 1.10 The term "**Site**" means the location provided by the HRBC where the stipulated work as per the scope of contract is to be carried out.
- 1.11 The term "**Engineer**" means the Chief Project Manager, HRBC appointed by the Employer to act as Engineer for the purposes of the Contract.
- 1.12 The term "**Engineer's Representative/Assistant**" means a person appointed from time to time by the Engineer who will be responsible to the engineer and shall carry out such duties and exercise such authority as may be delegated to him by the engineer.
- 1.13 The term "**Resident Engineer**" means a person appointed by HRBC on contract or through agency and deemed to be delegated by the Engineer as Engineer's Representative.
- 1.14 The term "**Field Engineer**" means a person appointed by HRBC through agency and deemed to be delegated by the Engineer as Engineer's Representative.

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Any communication given by the engineer's representative/assistant to the contractor shall have the same effect as though it had been given by the engineer. If the contractor questions any communication of the engineer's representative/assistant he may refer the matter to the engineer who shall confirm, reverse or vary the contents of such communications.

- 1.15 **“Contract”** means this conditions, the specification the drawings, the bill of quantities, the tender, the letter of intent, the letter of acceptance, the contract agreement and such further documents as may be expressly incorporated in the letter of intent, letter of acceptance or contract agreement.
- 1.16 **“Specifications”** means the Technical specification of the works included in the contract and any modifications thereof or additions thereto submitted by the contractor and approved by the engineer.
- 1.17 **“Bill of quantities”** means the priced and completed bill of quantities forming part of the tender.
- 1.18 **Interpretation:** Words importing persons or parties shall include firms, companies and corporations and any other organization having legal capacity.
- 1.19 **Singular and Plural:** Words importing the singular only also include the plural and vice versa where the context so requires.
- 1.20 **Notices, Consents, Approvals, Certificates and Decisions:** Where ever in the contract provision is made for the giving or issue of any notice, consent or approval or certificate or determination by any person, unless otherwise specified such notice, consent, approval, certificate or determination shall be in writing and the words "notify", "certify" or "Decide" shall be construed accordingly. Any such consent, approval, certificate or determination shall not unreasonably be withheld or delayed.

Notices of any other action to be taken on behalf of the HRBC may be given/taken by the engineer/authorized representative duly authorized for the purpose on its behalf.

- 2.0 **PARTIES TO THE CONTRACT:** The parties to the contract shall be the offerer/bidder, whose bid is accepted by the HRBC and Hooghly River Bridge Commissioners (HRBC).
- 2.1 The persons signing the offer or any other document forming the part of contract on behalf of other persons of a firm shall be deemed to have due authority to bind such person/s or the firm as the case may be, in all matters pertaining to the contract. If it is found that the person concerned has no such authority, the HRBC may, without prejudice to any other Civil/Criminal remedies, terminate the Contract and hold the signatory and/or the firm liable for all costs and damages for such termination.

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3.0 ENGINEER'S AUTHORITY TO DELEGATE

- 3.1 The Engineer may from time to time delegate to the Engineer's Representative / Assistant any of the duties and authorities vested in the Engineers and he may at any time revoke such delegation.
- 3.2 Any failure of the Engineer's Representative / Assistant to disapprove any work, materials or Plant shall not prejudice the authority of the Engineers to disapprove such work, materials or plant and to give instructions for the rectification thereof.
- 3.3 If the Contractor questions any communication of the Engineer's Representative / Assistant he may refer the matter to the Engineer who shall confirm, reverse or vary the contents of such communications.

4.0 ASSIGNMENT AND SUB-CONTRACTING :

- 4.1 The contractor shall not assign the Contract or any part thereof, or any benefit or interest therein or thereunder without the prior consent of the Employer.
- 4.2 The Contractor shall not subcontract any part of the works without the prior consent of the Employer. Any such consent shall not relieve the contractor from any liability or obligation under the contract and he shall be responsible for acts, defaults and neglects of any subcontractors, his agents or workmen as fully as if they were the acts, defaults or neglects of the contractor, his agents or workmen .

5.0 CONTRACT DOCUMENT:

- 5.1 **LANGUAGE:** The language of the contract is English.
- 5.2 **LAW:** The contract shall be governed and construed in accordance with the law of India. No suit or other proceedings relating to performance or breach of Contract shall be filed or taken by the contractor in any Court of Law except principal Court of Ordinary Civil Jurisdiction of the state of West Bengal.
The law in force is that of West Bengal, India within the jurisdiction of the High Court, Kolkata.
- 5.3 **PRIORITY OF CONTRACT DOCUMENTS:** The several contract document forming the Contract shall be taken as mutually explanatory of one another, but in case of ambiguities or discrepancies the same shall be explained and harmonized by the officer in charge who shall issue to the Contractor necessary instruction thereon and in such event unless otherwise provided in the Contract the priority of the documents forming the contract shall be as follows:
- (a) Agreement
 - (b) Letter of Acceptance
 - (c) The offer submitted by the Contractor in the prescribed form and accepted by the Employer (Section 1A, Vol IV).
 - (d) Appendix to Bid (Section 1B, Vol IV)
 - (e) Addenda to Tender Documents, if any
 - (f) Invitation for Bid (Section 1, Vol I)

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- (g) Instructions to Bidders (Section 2, Vol I)
- (h) General Conditions of Contract (Section 4, Vol I)
- (i) Technical Specifications (Vol II)
- (j) Bill of Quantities with Provisional Sums (Section 2, Vol IV)
- (k) Contract Drawings (Vol III)
- (l) Contractor's Technical Submission (Vol V)
- (m) Other documents as agreed upon

6.0 PERFORMANCE SECURITY:

- 6.1 The contractor shall submit performance security in the form of Bank Guarantee/s from the banks acceptable to Employer. Performance Security of 7.5% of the Contract Price (as defined in sub-clause 1.4 of General Conditions of Contract) may be in the form of bank guarantees initially valid for 19 months (i.e. up to 1 month beyond the stipulated period of contract (Eighteen months). Validity of Performance Security will be extended in both cases if extension of time is granted.
- 6.2 The performance security shall be refunded to the contractor within one month of issue of taking over certificate on taking over of completed works (provided there is no claim of the HRBC against the Contractor) after a specific written request is received from the contractor.

7.0 CLAIMS UNDER PERFORMANCE SECURITY:

The claims under performance security shall be made by the HRBC after notifying the contractor stating the nature of the default in which respect the claim is made.

8.0 RETENTION MONEY:

A retention amounting to 10% of the intermediate payment certificate subject to maximum of 5% of the contract price shall be made by the engineer from the first and following interim payment certificates.

9.0 PAYMENT OF RETENTION MONEY:

9.1 REFUND OF 50% :

Upon the issue of taking over certificate / completion certificate with respect to the whole of the works one half of the retention money shall be certified by the engineer for payment.

9.2 REFUND OF BALANCE 50% :

Upon the expiration of the defect liability period for the works, the other half of the retention money shall be certified by the engineer for payment to the contractor. Provided also that if at such time, there shall remain to be executed by the contractor any work instructed, in respect of the works, the engineer shall be entitled to withhold certification until completion of such work of so much of the balance of the retention money as shall, in the opinion of the engineer, represent the cost of the work remaining to be executed.

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10.0 ADVANCE PAYMENT:

On written request of the contractor, the employer will make an interest free advance payment to the contractor amounting to 10(ten)% of the Contract Price exclusively for the costs of mobilization and will be disbursed in 2 (two) installments. Payment of such advance amount will be due under separate certification by the engineer after (a) execution of the Form of Agreement by the parties hereto, (b) provision by the contractor of the performance security in accordance with provision in the contract and (c) provision by the contractor of an unconditional bank guarantee in a form and by a bank acceptable to the employer in amounts equal to the advance payment. Such bank guarantee shall remain effective until the advance payment has been repaid pursuant to the paragraph below, but the amount thereof shall be progressively reduced by the amount repaid by the contractor as indicated in Interim Payment Certificates issued in accordance with this Clause.

The advance payment shall be used by the Contractor exclusively for mobilization expenditures, including the acquisition of construction equipment in connection with the works. Should the Contractor misappropriate any portion of the advance payment, it shall become due and payable immediately by the contractor. In case of failure of the contractor to repay this sum, the engineer/employer shall be entitled to recover such sum from any of the contractor's dues or by encashment of the B.G furnished against this advance.

The advance mobilization loan shall be repaid through percentage deductions from the interim payments certified by the Engineer under the Contract.

The first installment of advance at the rate of 5% of the Contract Price shall be given after adequate mobilization of men, materials, machineries and setting up of labour camp at the project sites and remaining 5% shall be disbursed after completion of Milestone – 1 (MS -1) as given in Clause 28 of General Condition of Contract in Section 4, Vol I.

Deduction in respect of 1st installment of 5 (five) percent shall commence in the next Interim Payment Certificate following that in which the total of all such payments to the Contractor has reached 10 (ten) percent of the Contract price, and shall be made at a rate of 17 (seventeen) percent of the amount of monthly Interim Payment Certificate of the month from which the payment starts and so on, so that it is completely repaid prior to the time when 40 (forty) percent of the Contract Price for permanent works as per Bill of Quantities has been certified for payment.

Deduction in respect of 2nd installment of 5 (five) percent shall commence in the next Interim Payment Certificate following that in which the total of all such payments to the Contractor has reached 40 (forty) percent of the Contract price, and shall be made at a rate of 12.5 (twelve point five) percent of the amount of monthly Interim Payment Certificate of the month from which the payment starts and so on, so that it is completely repaid prior to the time when 80 (eighty) percent of the Contract Price for permanent works as per Bill of Quantities has been certified for payment.

11.0 CONTRACT AGREEMENT:

The contractor shall when called upon so to do, enter into and execute the contract agreement, to be prepared and completed at the cost of the contractor in the form annexed to these conditions with such modifications as may be necessary.

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12.0 SUFFICIENCY OF OFFER:

The contractor shall be deemed to have satisfied himself as to correctness and sufficiency of the offer which shall, except in so far as it is otherwise provided in the contract, cover all his rights and obligations under the contract and all matters and things necessary for proper completion of the work.

13.0 CONTRACTOR'S RATE TO INCLUDE ALL COSTS FOR COMPLETING WORKS

- 13.1 The Contractor shall, with due care and diligence design (to the extent stated in the contract), execute and complete the works and remedy any defects therein as provided in the contract. The Contractor shall provide all superintendence, materials, plant, contractor's equipment and all other things required.
- 13.2 The rates and prices stated in the Bill of Quantities as well as for items under Provisional Sums shall be deemed to cover all his obligations under the contract including those stated above and also in respect of the supply of goods, materials, plants, services, contingencies and all matter and things necessary for proper execution and completion of each item of work in accordance with the Technical Specifications and remedying of any defects therein. The Contractor shall take into consideration of all such costs while quoting his rates. No separate payment shall be made by the Employer to the contractor on account of any allied work in respect of the BOQ as well as Provisional Sums for completing the works in all respects.

14.0 UNFORESEEN PHYSICAL OBSTRUCTIONS OR CONDITIONS:

During the period of the contract, if the contractor encounters physical obstructions or physical conditions other than climatic conditions which obstructions or conditions in his opinion not foreseeable by an experienced Entrepreneur, the contractor shall give notice to the Employer. The Employer in such cases may consider such measures as to extend the period of contract without any financial repercussions on either side save and except whatever has been specifically provided for in the contract. The decision of Employer shall be final and binding in such cases.

15.0 WORK PROGRAM AND WORK ACHIEVEMENT TO BE SUBMITTED:

A contractor shall, within 10 days from the date of issue of Engineer's notice to commence work, submit to the engineer for his consent a detail work program indicating quantity, timing and duration of all major items of works under the Contract Package in the form of bar chart based on milestone format. The contractor shall also provide, in writing, a general description of the arrangements and methods it proposes to adopt for timely execution of the works along with the program of execution. The work programme shall be prepared as per requirement outlined in sub-clause 18.6.1 (c) (4) of Instructions to Bidder.

During the period of construction, the contractor has to submit Work Achievement report vis-à-vis work program of all major items of works under the Contract Package every month or as per direction of the Engineer.

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16.0 CASH FLOW ESTIMATE TO BE SUBMITTED

- 16.1 The Contractor shall within 10 (ten) days from the date of issue of Engineer's notice to commence work submit to the Engineer a detailed cash flow estimate in quarterly periods of all payments to which the Contractor will be entitled under the contract. The Contractor shall also submit revised cash flow estimates at quarterly intervals, if required to do so by the Engineer.

17.0 SAFETY, SECURITY AND PROTECTION OF ENVIRONMENT:

- The contractor shall throughout the period of contract have full regard for safety of all persons entitled to be upon the site in an orderly state appropriate to the avoidance of danger to such persons specially from moving traffic.
- 17.1 The contractor shall provide all necessary safety equipment such as reflective vests, helmets to the persons.
- 17.2 The Contractor shall provide and maintain adequate lights, guards, warning signs when and where ever required.
- 17.3 The Contractor shall throughout the process of execution and remedying any defects thereafter during the Defect Liability Period take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation. Among various steps, interalia, the following arrangement should be taken by the Contractor during execution of works as listed below :
- a) The construction area should be barricaded, in addition to usual barricading for safety of pedestrians and vehicles, by providing cover of polythene or hessian sheets to mitigate movement of dust outside the project area.
 - b) The wheels of all vehicles including those of machineries and equipments should be cleaned with water before leaving the project site so that no dust particles spreads from those vehicles.
 - c) All construction materials like sand, cement, stone chips, bricks etc. should be properly stored and provided with covers.
 - d) Everyday after the end of work activities the project site should be made clean and kept free from dust.
- 17.4 The Contractor shall take all steps to comply with the Central and West Bengal State Environmental Protection Acts and Rules thereunder. Cost for taking all such measures to prevent pollution are to be considered in their rates while offering the bids. No separate payment will be made in this regard.

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18.0 SUPPLY OF WATER AND ELECTRICAL POWER

The Contractor shall be responsible for arrangements to obtain supply of water and electrical power necessary for the works.

19.0 INSURANCE

19.1 REQUIREMENTS

Before commencing execution of works, it shall be obligatory for the Contractor to obtain at his own cost stipulated insurance cover under the following requirements:

- a. Contractor's All Risk and Third Party Cover.
- b. Liability under the Workmen's Compensation Act, 1923, Minimum Wages Act, 1948 and Contract Labour (Regulation and Abolition) Act, 1970.
- c. Accidents to staff, Engineers, Supervisors and others who are not governed by workmen's Compensation Act.
- d. Damage to material, machinery and works due to fire, theft etc.
- e. Any other risk to be covered by insurance as may be specified by the Employer in the Special Conditions of Contract.

20.0 POLICY IN JOINT NAMES OF CONTRACTOR AND EMPLOYER

The policy referred to under sub-clause 19.1(a) above shall be obtained in the joint names of the Contractor and the Employer and shall inter-alia provide coverage against the following, arising out of or in connection with execution of works, their maintenance and performance of the Contract :

- Loss of life or injury involving public, employee of the Contractor, or that of Employer and Engineer, labour etc.
- Injury, loss or damage to the Works or property belonging to public, Government bodies, local authorities, utility organizations, contractors, Employer or others.

20.1 CURRENCY OF POLICY

The policies shall remain in the force throughout the period of execution of the Works and till the expiry of the maintenance period. The Contractor shall, whenever called upon, produce to the Engineer or his representative the various insurance policies obtained by him as also the rates of premia and the premia paid by him to ensure that the policies indeed continue to be in force. If the contractor fails to effect or keep in force or provide adequate cover in the Insurance policies mentioned in Sub-clause 19.1, or any other insurance he might be required to effect under the Contract, then in such cases, the Employer may effect and keep in force any such insurance or further insurance and the cost and expenses incurred by him in this regard shall be deductible from payments due to the Contractor or from the Contractor's Performance Security.

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21.0 COMPLIANCE WITH STATUTES OR REGULATIONS:

The Contractor shall comply with all Central or State Statutes, Rules or other Regulations in all respects;

22.0 PATENT RIGHTS:

The Contractor shall save harmless and indemnify the HRBC from and against all claims and proceedings for or on account of infringement of any patent rights, design trade mark or name or other protected rights in respect of contractor's equipment material or plants used by Contractor in connection of the work.

23.0 CONTRACTOR'S EMPLOYEES:

23.1 The HRBC shall be at liberty to require the contractor to remove from the construction works such person who in the opinion of the HRBC misconducts himself or is incompetent or negligent in the proper performance of his duties or whose presence at the site is considered undesirable.

24.0 CONTRACTOR TO KEEP ROAD LANES CLEAR:

During the construction work the Contractor shall keep the other traffic lanes and adjoining area free from all unnecessary obstruction and shall see that the traffic flow is smooth and is not affected and the obstructions do not become a cause of accident or complaint from public.

25.0 CONTRACTOR TO KEEP SITE CLEAR

25.1 During the execution of the Works the Contractor shall keep the Site reasonably free from all unnecessary obstruction and shall store or dispose of any Contractor's Equipment and surplus materials and clear away and remove from the Site any wreckage, rubbish or Temporary Works no longer required at the earliest. If the contractor fails to remove such materials despite request from the Engineer, the same may be arranged to be removed by the Engineer and cost thereof will be recovered from the dues of the contractor.

26.0 CLEARANCE OF SITE AFTER COMPLETION

26.1 Upon the issue of any Taking-Over Certificate the Contractor shall clear away and remove from that part of the Site to which such Taking-Over Certificate relates all Contractor's Equipment, surplus material, rubbish and Temporary Works of every kind, and leave such part of the Site and Works clean and in a workmanlike conditions to the satisfaction of the Engineer. Provided that the Contractor shall be entitled to retain on Site, until the end of the Defects Liability Period, such materials, Contractor's Equipment and Temporary Works as are required by him for the purpose of fulfilling his obligations during the Defects Liability Period subject to approval of the Engineer. If the contractor fails to effect the above requirement, HRBC may take steps to effect the same and the cost involved will be recovered from any dues of the contractor.

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27.0 CONTRACT PERIOD:

27.1 TIME FOR COMPLETION:

18 (Eighteen) months from the date of notice to commence work.

At the same time, the contractor should adhere to the time limit set for each milestone for the contract package.

27.2 EXTENSION OF TIME

Extension of time may be granted in the event of:

- a) the amount or nature of extra or additional work,
- b) any cause of delay referred to in these Conditions.
- c) any delay, impediment or prevention by the Employer, or
- d) other special circumstances which may occur, other than through a default of or breach of contract by the Contractor or for which he is responsible, being such as fairly to entitle the Contractor to an extension of the Time for Completion of the Works, or any Section or part thereof. The Engineer shall, after due consultation with the Employer and the Contractor, determine the amount of such extension without any price variation and shall notify the Contractor accordingly, with a copy to the Employer. For any extension of time granted for delays due to Employer or due to Contractor or for any other reason, that will in no way affect or vitiate the contract or alter the character thereof or entitle the contractor to any kind of damages or compensation.

28.0 LIQUIDATED DAMAGES:

The time allowed for carrying out the work as entered in the tender shall be strictly observed by the contractor and shall be reckoned from the date of notice to commence work. The work shall throughout the stipulated period of the contract be proceeded with all due diligence (time being deemed to be of the essence of the contract on the part of the contractor). The contractor shall commence works within 10 (ten) days from the date of notice to commence work and ensure good progress conforming to the milestones achievement of the programme as below:

Sl.	Milestone marked as	Progressive target of achievement in percentage of the value of Contract Price	Progressive time period for achievement in months
a)	MS - 1	20	5
b)	MS - 2	40	9
c)	MS - 3	60	13
d)	MS - 4	80	16
e)	MS - 5	100	18

If the contractor fails to comply to achieve the milestones of targets stated above within specified time period, for such default or delay in execution, the contractor shall be liable to pay a sum of 1 (one) percent of Contract Price as Liquidated Damages for every week or part of the week for elapse of time to achieve milestones of targets. This sum to be recovered not as a penalty but from the monies due from the contractor for such default.

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29.0 LIMIT OF LIQUIDATED DAMAGES AND ITS REDUCTION

The liquidated damage shall be subject to the applicable limit of 10% of the contract price.

30.0 QUALITY TEST OF MATERIALS AND WORKMANSHIP AND COST OF TEST

All materials and workmanship shall be of respective kinds described in the contract and in accordance with the Engineer's instructions and shall be subjected from time to time to quality checking tests as required per technical specification and Indian Standards. The cost of making any test shall be borne by the Contractor and no separate payment shall be made in this regard

31.0 INDEPENDENT INSPECTION

31.1 The Engineer may delegate inspection and testing of materials or works to any Independent Inspector who shall be considered as an assistant to the Engineer in accordance with Cl. 3.0 of General Condition of Contract in Section 4, Vol I.

32.0 COMMENCEMENT OF WORKS

32.1 The Contractor shall commence the works within 10 (ten) days from the date of issue of Engineer's notice to commence work failing which action under Sub Cl. 49.1 may be resorted to by the Employer.

33.0 SETTING-OUT

- 33.1 The Contractor shall be responsible for :
- (a) the accurate setting-out of the Works in relation to original points, lines and levels of reference given by the Engineer in writing.
 - (b) the correctness, subject as above mentioned, of the position, levels, dimensions and alignment of all parts of the Works, and
 - (c) the provisions of all necessary instruments, appliances and labour in connection with the foregoing responsibilities.
- 33.2 If, at any time during the execution of the Works, any error appears in the position, levels, dimensions or alignment of any part of the Works, the Contractor, on being required so to do by the Engineer, shall, at his own cost, rectify such error to the satisfaction of the Engineer.
- 33.3 The checking of any setting-out or of any line or level by the Engineer shall not in any way relieve the Contractor of his responsibility for the accuracy thereof and the Contractor shall carefully protect and preserve all bench-marks, sight – rails, pegs and other things used in setting-out the Works.

34.0 ACCESS ROAD

The contractor shall provide necessary access roads to the site of work from the nearest public through fare and right of way at his cost unless otherwise provided for in the contract.

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35.0 OPPORTUNITIES FOR OTHER CONTRACTORS

- 35.1 The Contractor shall, in accordance with the requirements of the Engineer, afford all reasonable opportunities for carrying out their work to :
- (a) any other contractors employed by the Employer and their workmen,
 - (b) the workmen of the Employer, and
 - (c) the workmen of any duly constituted authorities who may be employed in the execution on or near the Site of any work not included in the Contract or of any contract which the Employer may enter into in connection with or ancillary to the Works.
 - (d) Any agency or the Employer by allowing use of any roads or ways for the development and maintenance of which the contractor is responsible. For affording all such opportunities mentioned above no additional payment or compensation shall be made by the Employer to the Contractor.

36.0 SUPPLEMENTARY WORKS AND FIXATION OF RATES

- 36.1 The Engineer shall have power to make any alteration in, omissions from, additions to or substitutions for, the original specifications, drawings, design and instruction, that may appear to him to be necessary or advisable during the progress of the work and the contractor shall be bound to carry out the work in accordance with any instructions which may be given to him in writing signed by the Engineer and such alterations, omissions, additions or substitutions, shall not invalidate the contract but shall be deemed to have formed as work included in the original tender and any altered, additional or substituted work which the contractor may be directed to do in the manner above specified as part of the work shall be carried out by the contractor on the same condition in all respects on which they agreed to do the main work and at the same rates, if any, may be specified in the tender for the main work with application of contractual percentage rate and discount, if there be any specified in the tender for the main work. The time for the completion of the work shall be extended in the proportion that the altered, additional or substituted work bears to the original contract work and the certificate of the Engineer shall be conclusive as to such proportion. And if the altered additional or substituted work includes any class of work, for which no rate is specified in this contract, then such class of work shall be carried out at the rates entered in the Specifications for PWD (WB) schedule of rates for Building and S&P Works(effective from 01.08.2010) with the latest corrigendum (4th Corrigendum dated 10.12.12). For any kind of road works like internal campus roads, pathways, culverts etc. P.W.(Roads) Dept. Schedule of Rates effective from 14.11.2008 with latest Corrigendum (7th Corrigendum, dated 30.04.2012) shall be followed for analysis of rates of supplementary items instead of PWD Schedule. When such rates are determined on analysis from Schedule of Rates of PWD and or PW (Roads) Dept stated above, contractual percentage rate and discount, if there be any specified in the tender for the main work shall be applicable. Rates which are not available in the PWD schedule of rates, or P.W.(Roads), schedule of rates analysis of rate for the item has to be worked out from current market rate of materials and labour. Final rate based on current market rate of materials should be arrived with application of 10% overhead plus 10% profit on value of materials and labour (if applicable) procured from market.

In support of market rates at least three quotations from bonafied concerns have to be furnished. In the event of disagreement by the contractor the rate fixed by the Engineer in the consultation with the Employer shall be final and binding.

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The value of supplementary or substituted items, analysis of which would be fixed based on current market rates of materials, labour etc., shall not be subjected to application of Price Adjustment clause no 52 of the General Condition of Contract and the rates so analysed will not be subjected to application of contractual percentage rate and discount, if there be any, in the tender for main work.

- 36.2 The authority of the Engineer to order and determine the rate of supplementary work is limited to 5 (five) % of the contract price. If the variation or supplementary amount of work exceeds the above aforesaid limit, prior approval of employer has to be taken by the Engineer for ordering and fixing rates of such works.

37.0 PROVISIONAL SUMS:

In the Summary Sheet of Bill of Quantities under Part C, two items designated as (l) Escalation and (m) Supplementary Works are provided as Provisional Sums for payment of Escalation due to price adjustment in terms of Clause 52 of General Conditions of Contract and for execution of any part of works or for supply of goods/materials/any kind of services etc. as supplementary works as per Clause 36 of General Conditions of Contract which sum may be used on the instruction of the Engineer.

38.0 MEASUREMENT

- 38.1 The quantities set out in the bill of quantities are the estimated quantities for the work and these are not to be taken as the actual and correct quantities of the works to be executed by the Contractor to fulfill his obligation under the contract.
- 38.2 The Engineer shall, except as otherwise stated, ascertain and determine by measurement the value of work in accordance with the contract. For the purpose, the Contractor shall send request for inspection to the Engineer or his delegated representatives to inspect and take measurements of works completed. The request for inspection should be sent well in advance in consultation with the Engineer. Before covering any item of work the contractor shall be responsible to get the measurements of the items to be covered to be jointly measured and recorded for subsequent incorporation in the bills for payment. For the purpose of measuring such permanent works as are to be measured by records and drawings the contractor shall prepare records and drawings jointly with the Engineers or his delegated representatives as the work proceeds and shall be signed jointly by both of them for incorporation in the payment bills.

All measurements for permanent works for the purpose of payment shall be recorded in printed measurement sheets to be signed jointly by the contractor's authorized representative and the Resident Engineer or Field Engineer appointed by HRBC on contract or through agency to work as delegated representatives of the Engineer. Resident Engineer shall check measurements of works valued at least 20% of work bill amount and certify compliance accordingly before forwarding the bill to the Engineer.

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39.0 ARBITRATION

- 39.1 Except where otherwise provided in the contract all questions and disputes relating to the meaning of the specifications, designs, drawings and instructions herein before mentioned and as to the quality of workmanship or materials used on the work or as to any other questions, claim, right, matter or thing whatsoever, in any arising out of or relating to the contract, designs, drawings, specifications, estimates, instructions orders or those conditions or otherwise concerning the works, or execution, or failure to execute the same, whether arising during the progress of the work, after the completion, after termination or abandonment thereof shall be referred to the Arbitral Panel of three arbitrators. The Panel shall be composed of one arbitrator to be nominated and appointed by the Employer and one to be nominated and appointed by the Contractor. The third who will act as Chairman of the Panel, but not as Umpire, will be chosen jointly by the two nominees from a panel of three candidates, none of whom would be in regular employment of the Central and / or State Government provided by the Engineer-in-Chief & Ex-Officio Secretary, Public Works Department, Government of West Bengal. If either of the parties fail to appoint his arbitrator, or fail to agree on the nominee for the third Arbitrator, within sixty days after receipt of notice for the appointment of such an arbitrator, the Engineer-in-Chief & Ex-Officio Secretary, Public Works Department, Government of West Bengal shall appoint upon request from either party and form such panel or otherwise such Arbitrator(s) for the matter in dispute. The appointee for Arbitration Panel may be of any nationality residing in India.
- 39.2 For referring such disputes to an Arbitral Panel the Employer or the Contractor may give notice of intention to commence arbitration as to the disputes to the other party.
- 39.3 The decision of the majority of Arbitrators shall be final binding on the parties. The award shall be a speaking one, that is, the Arbitration Panel shall recite facts and assign reasons in support of the award after discussing fully the claims and contentions of the parties. Save as aforesaid and / or otherwise provided in the Contract, the arbitration shall be conducted in accordance with the provisions of the Indian Arbitration and Conciliation Act, 1996 or any statutory modification or enactment thereof and shall be held at such a place and time in India as the Arbitration Panel may determine. The fees of the Arbitrators will be borne equally by the Employer and the Contractor or as the Arbitration Panel may determine.

40.0 DESIGN, DRAWINGS AND AS BUILT DRAWINGS

- 40.1 The Engineer shall supply drawings for all permanent works from time to time to the contractor in duplicate. The contractor shall make at his own cost any further copies required by him. The contractor shall submit a schedule of requirement of drawings for permanent work, subject to approval of the schedule by the Engineer, well in advance to enable the engineer supplying the drawings in time. For temporary and minor works, all design and drawings shall be prepared by the contractor at his own cost and obtain approval from the Engineer. Approval by the Engineer shall not relieve the contractor of any of his responsibilities under the contract.
- 40.2 Any deviation from working drawings and engineering drawings that may be required by the exigencies of construction, or otherwise, will in all cases be determined and authorized by the Engineer in writing.

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- 40.3 One set of Contract document including all approved drawings furnished to the Contractor as aforesaid shall be kept by the Contractor at site and same shall be at all reasonable times be available for inspection by the Employer and / or the Engineer and by any other person authorized by the Engineer in writing.
- 40.4 Progressively as the Works are completed the Contractor shall furnish to the Engineer the “As built” drawings all clearly revised and completed and brought up-to-date showing the permanent construction as actually made, failing which a lump sum amount as decided by the Employer will be deducted from the final bill. The last lot of “As built” drawings shall be submitted within 2 months of completion of the Works. These drawings shall show apart from the number, title, date of drawing, dates of revisions and the name of the project, name of the Contractor, clear details as to the identity and location of Work as well as title and number. The drawings shall be submitted as reproducible in 2 (two) nos. soft copies in the form of CD. Also, 6(six) sets of hard copies of prints in A-3 Size of all “As built” drawings shall also be submitted in number of bound sets arranged for each project site location wise. All these submissions shall become the property of the Employer. For complying with the above provisions the contractor shall not be entitled to any additional payment or any kind of compensation.

41.0 INSPECTION OF OPERATIONS

- 41.1 The Engineer, and any person authorized by him, shall at all reasonable times have access to the Site and places where materials or Plant are being manufactured, fabricated or prepared for the Works and the Contractor shall afford every facility for and every assistance in obtaining the right to such access.

42.0 REMOVAL OF IMPROPER WORK, MATERIALS OR PLANT

- 42.1 The Engineer shall have authority to issue instructions from time to time, for :
- (a) total removal from the Site, within such time or times as may be specified in the instruction, of any materials or Plant which, in the opinion of the Engineer, are not in accordance with the Contract.,
 - (b) the substitution of proper and suitable materials or Plant, and
 - (c) the removal and proper re-execution, notwithstanding any previous test thereof or interim payment thereof, of any work which, in respect of
 - i) materials, plant or workmanship, or
 - ii) design by the Contractor or for which he is responsible,is not, in the opinion of the Engineer, in accordance with the Contract.
- 42.2 In case of default on the part of the Contractor in carrying out such instructions within the time specified therein or, if none, within a reasonable time, the Employer shall be entitled to employ and pay other persons to carry out the same and all costs consequent thereon or incidental thereto shall, after due consultation with the Employer and with intimation to the Contractor, be determined by the Engineer and shall be recoverable from the Contractor by the Employer, and may be deducted by the Employer from any monies due or to become due to the Contractor and the Engineer shall notify the Contractor accordingly, with a copy to the Employer.

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43.0 CONTRACTOR'S SUPERINTENDENCE

The Contractor shall provide all necessary superintendence during the execution of the Works and as long thereafter as the Engineer may consider necessary for the proper fulfilling of the Contractor's obligations under the Contract. The Contractor, or a competent and authorised representative approved of by the Engineer, which approval may at any time be withdrawn, shall give his whole time to the superintendence of the Works. Such authorised representative shall receive, on behalf of the Contractor, instructions from the Engineer or, subject to the provisions of Clause 2, the Engineer's Representative.

If approval of the representative is withdrawn by the Engineer, the Contractor shall, as soon as is practicable, having regard to the requirement of replacing him as hereinafter mentioned, after receiving notice of such withdrawal, remove the representative from the Works and shall not thereafter employ him again on the Works in any capacity and shall replace him by another representative approved by the Engineer.

44.0 TAKING OVER CERTIFICATE:

When the whole of the Works have been completed and have satisfactorily passed any Tests on Completion prescribed by the Contract, the Contractor may give a notice to that effect to the Engineer, with a copy to the Employer, accompanied by a written undertaking to finish with due expedition any outstanding work during the Defects Liability Period. Such notice and undertaking shall be deemed to be a request by the Contractor for the Engineer to issue a Taking-Over Certificate in respect of the Works. The Engineer shall, within 21 days of the date of delivery of such notice, either issue to the Contractor, with a copy to the Employer, a Taking-over Certificate, stating the date on which, in his opinion, the works were substantially completed in accordance with the contract, or give instructions in writing to the Contractor specifying all the work which, in the Engineer's opinion, is required shall also notify the Contractor of any defects in the Works affecting substantial completion that may appear after such instructions and before completion of the Works specified therein. The Contractor shall be entitled to receive such Taking-Over Certificate within 21 days of completion, to the satisfaction of the Engineer, of the works so specified and remedying any defects so notified.

45.0 DEFECTS LIABILITY:

- 45.1 The defect liability period shall mean the period of 12(twelve) months calculated from the date of issue of taking over certificate for whole of the works comprised in the contract.

46.0 DEFECT LIABILITY CERTIFICATE:

The contract shall not be considered as completed until a defect liability certificate shall have been signed by the engineer and delivered to the employer with a copy to the contractor, stating the date on which the contractor shall have completed his obligations to execute and complete the works and remedy any defects therein to the engineer satisfaction.

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47.0 HRBC'S RISK:

The HRBC's risks are

- a) War, Hostilities, Invasion, act of foreign enemies
- b) Rebellion, revolution, insurrection, or military or usurped, civil war.
- c) Ionizing radiation or contamination by radioactivity from any nuclear fuel, or from any nuclear waste from combustion of nuclear fuel, radioactive toxic explosive or other hazardous properties of any explosive nuclear assembly or nuclear component thereof.
- d) Riot, commotion, disorder, unless solely restricted to employees of the Contractor and arising from conduct of the work, provided that the same is not temporary or transitory and affect the work appreciably.
- e) Any other operation of the forces of nature against which an experienced Contractor could not reasonably have been expected to take precaution.

48.0 BRIBES AND COMMISSION:

Any bribes, commission, gift or advantages given, promise of bribe by or on behalf of the CONTRACTOR/s or servants or any one on their behalf to any officer, employee, representative or Contractor of the HRBC or any person on his or their behalf of showing favour of disfavour to any person in relation to the contract, in any manner whatsoever will entitle the HRBC to cancel his contract and also to claim from CONTRACTOR's payment, any loss or damage resulting from such cancellation.

49.0 TERMINATION:

- 49.1 If the Contractor is deemed by Law unable to pay his debts as they fall due or enters into voluntary or involuntary bankruptcy, liquidation or dissolution (other than a voluntary liquidation for the purpose of amalgamation or reconstruction), or becomes insolvent or makes an arrangement with, or assignment in favour of his creditors, or agrees to carry out the contract under a committee of inspection of his creditors or if a receiver, administrator, trustee or liquidator is appointed over any substantial part of his assets or if under any law or regulation relating to reorganization, arrangement or readjustment of debts, proceedings are commenced against the Contractor or resolutions passed in connection with dissolution or liquidation of if any steps are taken to enforce any security interest over a substantial part of the assets of the CONTRACTOR, or if act is done or event occurs with respect to the Contractor or his assets which, under any applicable law has a substantially similar effect to any of the foregoing events. The contract shall forthwith stand terminated. Further if the Engineer certifies to the Employer, with a copy to the Contractor that in his opinion, the Contractor:
- a) Has repudiated the contract
 - b) Has failed to comply with the instructions issued by Hooghly River Bridge Commissioners or his authorised officer or has failed to commence the work within 10 days after receiving the "Notice to Commence with the work"
 - c) Despite previous warning is otherwise persistently or flagrantly neglecting to comply with any of the obligations under the contract.

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- d) Committed any breach of any of the terms of contract, or
- e) Has given false or untrue information regarding eligibility to bid, as revealed at the selection process is over or even earlier or
- f) Non courteous, rude behavior with the public
- g) Breach of any of the terms and conditions of the contract for any reason whatsoever

then the Employer may, after giving 10 days notice to the Contractor, enter upon the site and works and terminate the Employment of the Contractor without thereby releasing the Contractor from any of his obligations or liabilities under the contract or affecting the rights and authorities conferred on the Employer or the Engineer by the contract, and may himself complete the works or may employ any other contractor to complete the works.

- 49.2 If the CONTRACTOR/s being a natural person/s die/dies or being a natural person or a partnership firm is adjudged insolvent or commit any criminal activity or act of moral turpitude or detained under any preventive law i.e., TADA, FERA, etc or if the CONTRACTOR/s or servants of the CONTRACTOR/s are convicted of any offence under the State of West Bengal Prohibition Act. West Bengal Opium Smoking Act and/or the Narcotic Drugs and Psychotropic substances Act, or fails to observe any of the provisions of this contract or any of the terms and conditions governing the contract, the contract shall, forthwith, stand terminated.

50.0 PAYMENT UPON TERMINATION:

Upon termination of the contract under Clause 49.1 or 49.2. the amount of performance security will be forfeited by the Employer. The Engineer will arrange joint measurement or in absence of the contractor ex-party measurement of the works already executed which are considered acceptable but not paid within a reasonable time. The contractor will be entitled to receive payment for the unpaid works as stated above. If liquidated damages has to be recovered under terms of contract, the same shall be separately recovered from the dues of the contractor and /or from the amount of retention money at hand. Retention should otherwise be refunded to the contractor as per terms of contract.

51.0 DISPUTES AND RESOLUTION ARISING OUT OF INTERPRETATION OF CONTRACT CONDITIONS:

In case of disputes or differences of opinion arising out of interpretation of contract conditions the decision of the Vice-Chairman shall be final and binding on the CONTRACTOR. The contractor shall be given reasonable opportunity to represent his case before the Vice-Chairman.

52.0 PRICE ADJUSTMENT

- 52.1 Contract price shall be adjusted for increase or decrease in price of Steel Component comprising Mild Steel/Tor Steel reinforcement bars and Mild Steel Structural works and Cement in accordance with the following Principles :-

- 52.1.1 The price adjustment shall apply for the work done from the date of commencement as mentioned in the contract up to stipulated date of completion or extensions granted but, shall not apply to the work carried out beyond the stipulated time for reasons attributable to the contractor.

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- 52.1.2 Adjustment amount shall not exceed 10% of the Bid amount.
- 52.1.3 Contract price wherever appears under price adjustment clause shall mean value of executed work at contract rates.
- 52.2 Price Adjustment in respect of construction materials –Steel Components as defined in sub-clause 52.1 and Cement.
- 52.2.1 **Price Adjustment for Steel components** (as defined in sub-clause 52.1)

Price adjustment for increase or decrease in price of Steel component will be calculated in the manner as follows :

- (i) For percentage rate tender $V_S = R_1 \times (S_1 - S_0) / S_0 \times Q_S \times C$
 (ii) For item rate tender $V_S = R_1 \times (S_1 - S_0) / S_0 \times Q_S$

Where,

- V_S = Adjustment to the contract price on account of increase or decrease of price of Steel components during the period under consideration.
- R_1 = Basic price of Steel Components as indicated in Schedule of Rates for Building works of Public Works Dept., Govt. of West Bengal effective from 01.08.2010 with latest Corrigendum (4th Corrigendum, dt.10.12.12).
- S_1 = Wholesale price index (monthly average) for Iron & Steel published by the Office of the Economic Adviser, Ministry of Commerce & Industry, Government of India, during the period under consideration.
- S_0 = Wholesale price index (monthly average) for Iron & Steel published by the Economic Adviser, Ministry of Commerce & Industry, Government of India, in the month which contains date of calling of Notice Inviting Tender.
- Q_S = Quantity of Steel components consumed on items of work (supported by related delivery orders & challans showing price details) as per Contract during the period under consideration excluding involvement of Steel components on items of work under the contract whose rates are derived on the basis of market rate of Steel components prevailing at the time of execution of work.
- C = $(100 \pm P) / 100$ (applicable for percentage rate tender only), where
- P = Contractual rate in percentage above or below Estimated amount put to tender (where (+) for above and (-) for below) in case of percentage rate tender.

52.2.2 **Price Adjustment for Cement component :-**

- (i) For percentage rate tender $V_c = R_1 \times [(C_1 - C_0) / C_0] \times Q_c \times C$
 (ii) For item rate tender $V_c = R_1 \times [(C_1 - C_0) / C_0] \times Q_c$

Where,

- V_c = Adjustment to the contract price on account of increase or decrease of price of Cement.

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- R_1 = Basic price of Cement as indicated in Schedule of Rates for Building works of Public Works Dept., Govt. of West Bengal effective from 01.08.2010 with latest Corrigendum (4th Corrigendum dated 10.12.12).
- C_1 = Wholesale price index (monthly average) for Cement published by the Office of the Economic Adviser, Ministry of Commerce & Industry, Government of India, during the period under consideration.
- C_o = Wholesale price index (monthly average) for Cement published by the office of the Economic Adviser, Ministry of Commerce & Industry, Government of India, in the month which contains date of calling of Notice Inviting Tender.
- Q_c = Quantity of Cement consumed on items of work (supported by related delivery orders & challans showing price details) as per Contract during the period under consideration excluding involvement of Cement on items of work under the contract whose rates are derived on the basis of market rate of Cement prevailing at the time of execution of work.
- C = $(100 \pm P) / 100$ (applicable for percentage rate tender only), where
- P = Contractual rate in percentage above or below Estimated amount put to tender (where (+) for above and (-) for below) in case of percentage rate tender.
- 52.3 Any rebate / or discount over Bid amount will be incorporated in the formulae applying corresponding multiplication factor.
- 52.4 If at any time the current indices are not available, provisional indices as determined by the Engineer will be used, subject to subsequent correction of the amounts paid to the contractor when the current indices become available.
- 52.5 On completion of the works and before final payment, contractor shall give a certificate that he has made full disclosure to the Engineer of every increase or decrease in price obtained by him on all times affected by this clause.

53.0 SUBSEQUENT LEGISLATION

- 53.1 If, after the date 28 days prior to the latest date for submission of tenders for the Contract there occur in the country in which the Works are being or are to be executed changes to any National or State Statute, Ordinance, Decree, or other Law or any regulation or bye-law of any local or other duly constituted authority, or the introduction of any such State Statute, Ordinance, Decree, law, regulation or bye-law which causes additional or reduced cost to the Contractor, in the execution of the Contract, the Contractor will bear the cost of or benefit from such additional or reduced cost.

54.0 JOINT AND SEVERAL LIABILITY :

If the Contractor is a joint venture of two or more persons, all such persons shall be jointly and severally bound to the Employer for the fulfillment of the terms of the Contract and shall designate one of such persons to act as a leader with authority to bind the joint venture. The composition or the constitution of the joint venture shall not be altered without the prior consent of the Employer.

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55.0 DETAILS TO BE CONFIDENTIAL:

- 55.1 The Contractor shall treat the details of the Contract as private and confidential, save insofar as may be necessary for the purposes thereof, and shall not publish or disclose the same or any particulars thereof in any trade or technical paper or elsewhere without the previous consent in writing of the Employer or the Engineer, If any dispute arises as to the necessity of such publication or disclosure for the purpose of the Contract the same shall be referred to the decision of the Employer whose award shall be final.

56.0 MONTHLY PAYMENTS :

- 56.1 The contractor shall submit a statement in triplicate to the Engineer through the Resident Engineer at the end of each month in a tabulated form approved by the Engineer showing the amounts to which the contractor considers himself to be entitled up to the end of the month in respect of :

- (a) Value of Permanent Works executed at the unit rates and prices quoted by him.
- (b) Actual value certified for payment for works executed upto the end of previous month at unit rates and prices quoted by him.
- (c) Estimated contract value at unit rates and prices quoted by him for the month in question obtained by deducting (b) from (a).
- (d) Complete measurements based on approved drawings or deviation as per Engineering norms along with quality certification.
- (e) The value of any variation/supplementary works executed upto the end of the month in question less the amount certified in the previous interim payment certificate.
- (f) Amounts reflecting price adjustment pursuant to clause 52
- (g) Amounts to be deducted as repayment to Advance under provision of clause 10
- (h) Any other sum to which the contractor may be entitled under the contract.

- 56.2 The said statement shall be scrutinized by the Resident Engineer and approved or amended by the Engineer in such a way that, in the Engineer's opinion, it reflects the amounts due to the Contractor in accordance with the Contract, after deduction, of any sums which may have become due and payable by the Contractor to the Employer. In cases where there is a difference of opinion as to the value of any item, the Engineer's view shall prevail. Within a reasonable time of receipt of the monthly statement, the Engineer shall determine the amounts due to the Contractor and shall issue to the Employer and the Contractor a certificate herein called "Interim Payment Certificate", certifying the amounts due to the Contractor.

- 56.3 Notwithstanding the terms of this Clause or any other Clause of the Contract, no amount will be certified by the Engineer for payment until the performance security has been provided by the Contractor and approved by the Employer.
Provided that normally the Engineer shall not be bound to certify more than once in a month unless any payment under this Sub-Clause if the net amount thereof, after retentions and all deductions, would be less than 1% of the value of contract as stated in the Appendix to bid.

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56.4 Only under valid circumstances more than one payment in a month even if the net value of the same falls below 1% of the value of contract may be made.

57. REGISTRATION AND COLLECTION OF CESS UNDER THE BUILDING AND OTHER CONSTRUCTION WORKERS' (RECS) ACT, 1996 AND THE BUILDING & OTHER CONSTRUCTION WORKERS' WELFARE CESS ACT, 1996.

Successful tenderer will have to produce Registration Certificate as required under the Building and Other Construction Workers' (RECS) Act, 1996 and the Buildings & Others Construction Workers' Welfare Cess Act, 1996 and the Rules made there under.

Statutory deduction towards cess @1% of the cost of construction will be made from the bill of the construction in addition to I.T., S.T. etc.

58.0 THIRD PARTY QUALITY CONTROL ENGAGEMENT

58.1 METHODOLOGY OF APPOINTMENT

The Engineer in consultation with the Employer will deploy suitable third party Supervision and Quality Control professionals/sub-professionals/support personnel from one or more consulting firms by evaluating their curriculum vitae and through interactive assessment on their suitability for the required assignment who will be deemed to be delegated representatives of the Engineer and supervise execution of works, check quality of works and materials, assist in taking joint measurement of works and carry out any other jobs for execution of the project as directed by the Engineer. The deployment of personnel will be made through agencies selected by the process of tender.

59.0 TIME OF PAYMENT

59.1 The amount due to the Contractor under any Interim Payment Certificate issued by the Engineer pursuant to this Clause, or to any other term of the Contract, shall, be paid by the Employer to the Contractor an amount of 75% of the bill within 7 days and the remaining amount within 45 days, after the Contractor's monthly statement has been certified by the Engineer and delivered to the Employer or in the case of the Final Certificate pursuant to Clause 45.0, the full payment to be made within 56 days after the agreed Final Statement and written discharge have been submitted by the Engineer after certification to the Employer for payment.

60.0 CORRECTION OF CERTIFICATES

60.1 The Engineer may by any Interim Payment Certificate make any correction or modification in any previous Interim Payment Certificates which has been issued by the Engineer, and shall have authority, if any work is not being carried out to the satisfaction of the Engineer, to omit or reduce the value of such work in any Interim Payment Certificate.

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61.0 STATEMENT AT COMPLETION

61.1 Not later than 30 days after the issue of the Taking-Over Certificate in respect of the whole of the Works, the Contractor shall submit to the Engineer 6(six) copies of a Statement at Completion with supporting documents showing in detail, in the form approved by the Engineer,

(a) the final value of all work done in accordance with the Contract up to the date stated in such Taking-Over Certificate;

(a) any further sums which the Contractor considers to be due: and

(b) an estimate of amounts which the Contractor considers will become due to him under the Contract.

Estimated amounts shall be shown separately in such Statement at Completion. The Engineer shall certify payment in accordance with conditions of contract.

62.0 FINAL STATEMENT

62.1 Not later than 30 days after the issue of the Defects Liability Certificate pursuant to Clause 46.0, the Contractor shall submit to the Engineer for consideration 6(six) copies of a draft final statement with supporting documents showing in detail, in the form approved by the Engineer,

(a) the value of all work done in accordance with the Contract: and

(b) any further sums which the Contractor considers to be due to him under the Contract or otherwise.

62.2 If the Engineer disagrees with or cannot verify any part of the draft final statement, the Contractor shall submit such further information as the Engineer may reasonably require and shall make such changes in the draft as may be agreed between them. The Contractor shall then prepare and submit to the Engineer the final statement as agreed (for the purposes of these Conditions referred to as the "Final Statement").

62.3 If, following discussions between the Engineer and the Contractor and any changes to the draft final statement which may be agreed between them, it becomes evident that a dispute exists, the Engineer shall issue to the Employer an Interim Payment Certificate for those parts of the draft final statement which are not in dispute. The dispute shall then be settled in accordance with Clause 39.0. The Final Statement shall be agreed upon on settlement of the dispute.

63.0 DISCHARGE

63.1 Upon submission of the Final Statement, the Contractor shall give to the Employer, with a copy to the Engineer, a written discharge confirming that the total of the Final Statement represents full and final settlement of all monies due to the Contractor arising out of or in respect of the Contract. Provided that such discharge shall become effective only after payment due under the Final Payment Certificate issued pursuant to Clause 64.0 has been made and the performance security referred to in Clause 6.0 has been returned to the Contractor.

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64.0 FINAL PAYMENT CERTIFICATE

Within 30 days after receipt of the Final Statement, and the written discharge, the Engineer shall issue to the Employer (with a copy to the Contractor) a Final Payment Certificate stating

- (a) the amount which, in the opinion of the Engineer, is finally due under the Contract or otherwise, and
- (b) after giving credit to the Employer for all amounts previously paid by the Employer and for all sums to which the Employer is entitled, the balance, if any, due from the Employer to the Contractor or from the Contractor to the Employer as the case may be.

65.0 CESSATION OF EMPLOYER'S LIABILITY

65.1 The Employer shall not be liable to the Contractor for any matter or thing arising out of or in connection with the Contract or execution of the Works, unless the Contractor shall have included a claim in respect thereof in his Final Statement and (except in respect of matters or things arising after the issue of the Taking-Over Certificate in respect of the whole of the Works) in the Statement at Completion referred to in Clause 61.0.

66.0 ENGINEER AT LIBERTY TO OBJECT

The Engineer shall be at liberty to object to and require the Contractor to remove forthwith from the Works any person provided by the Contractor who, in the opinion of the Engineer, misconducts himself, or is incompetent or negligent in the proper performance of his duties, or whose presence on Site is otherwise considered by the Engineer to be undesirable and such person shall not be again allowed upon the Works without the consent of the Engineer. Any person so removed from the works shall be replaced as soon as possible.

67.0 SHEDS, STORES, YARDS

The Contractor shall at his own expense provide sheds, store-houses and yards in such situations and in such numbers as in the opinion of the Engineer are necessary for carrying on the works and the Contractor shall keep at each of such sheds, store-houses and yards sufficient quantity of materials and plant in stock as not to delay the carrying out of the works with due expedition. The Engineer and the Engineer's representatives shall have free access to the said sheds, store-houses and yards at any time for the purpose of inspecting the stock of materials and plant so kept in hand. Any materials or plant which the Engineer may object to shall not be brought upon or used in the Works, but shall forthwith be removed from the sheds, store-houses or yards by the Contractor. The Contractor shall at his own expense provide and maintain any other land, space, plant or equipment necessary for execution of works.

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68.0 ROADS AND WATER COURSES, ACCESS TO PREMISES AND SAFETY OF PUBLIC

- i. Existing road or water courses shall not be blocked, cut through, altered, diverted or obstructed in any way by the Contractor, except with the permission of the Engineer. All compensation claimed for any unauthorized closure, cutting through, alteration, diversion or obstruction to such roads or water courses by the Contractor or his agent or his staff shall be recoverable from the Contractor by deduction from any sums which may become payable to him in terms of the Contract, or otherwise according to law.
- ii. During progress of work in any street or thoroughfare, the Contractor shall make adequate provision for the passage of traffic, for securing safe access to all premises – approached from such street or thoroughfare and for any drainage, water supply or means of lighting which may be interrupted by reason of execution of works and shall erect and maintain at his own cost barriers, lights and other safeguards as prescribed by the Engineer for the regulation of traffic, and provide watchman necessary to prevent accidents. The works shall in such cases be prosecuted day and night if so ordered by the Engineer and with such vigour that the traffic is impeded for as short a time as possible.
- iii. The Contractor shall be responsible for taking all precautions to ensure safety of the public, whether on public or Employer's property and shall post such look out men as may, in the opinion of the Engineer, be necessary to comply with the regulations appertaining to the work and to ensure safety.

69.0 CARE OF WORKS

The Contractor shall take full responsibility for the care of the works, materials and plats for incorporation therein from the commencement date until the date of issue of the Taking Over Certificate for the whole of the works.

70.0 FORCE MAJEURE

If, at any time during the currency of the Contract, the performance in whole or in part by either party of any obligation under this Contract shall be prevented or delayed by reason of any war, hostilities, invasion, acts of public or foreign enemies, rebellion, revolution, insurrection, civil commotion, sabotage, large scale arson, floods, earthquake, large scale epidemics, nuclear accidents, any other catastrophic unforeseeable circumstances, quarantine restrictions, any statutory rules, regulations, orders or requisitions issued by a Government department or competent authority or acts of God (hereinafter referred to as "event") then, provided notice of the happening of such an event is given by either party to the other within 21 days of the occurrence thereof.

- a. Neither party shall by reason of such event be entitled to terminate the Contract or have claim for damages against the other in respect of such non-performance or delay in performance.

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- b. The obligations under the Contract shall be resumed as soon as practicable after the event has come to an end or ceased to exist.
- c. If the performance in whole or part of any obligation under the Contract is prevented or delayed by reason of the event beyond a period mutually agreed to if any, or 90 days, whichever is more, either party may at its option terminate the Contract.
- d. In case of doubt or dispute, whether a particular occurrence should be considered an “event” as defined under this clause, the decision of the Engineer shall be final and binding.
- e. Works that have already been measured shall be paid for by the Employer even if the same is subsequently destroyed or damaged as a result of the event. The cost of rebuilding or replacing any work that has been measured, shall be borne by the Employer.
- f. If the Contract is terminated under this Clause, the Contractor shall be paid fully for the work done under the Contract, but not for any defective work or work done which has been destroyed or damaged before its measurement. The Employer shall have the option to take over any plant and materials lying at site, at rates provided for in the Contract, failing that, as per rates which are determined to be fair and reasonable by the Engineer.

71.0 TEMPORARY WORKS

All temporary works necessary for the proper execution of the works shall be provided and maintained by the Contractor at his cost and subject to the consent of the Engineer shall be removed by him at his expense when they are no longer required and in such manner as the Engineer shall direct. In the event of failure on the part of the Contractor to remove the temporary works, the Engineer will cause them to be removed and cost as incurred for removal, supervision and other incidental charges, shall be recovered from the Contractor. No temporary huts or any other form of accommodation can be provided by the Contractor on the Employer’s land for labour engaged by him for the execution of the works. The Contractor shall arrange for such accommodation by himself.

72.0 LABOUR CAMP

72.1 PROVISION OF LABOUR CAMP

The Contractor, shall, at his own expense, make adequate arrangements for the housing, supply of drinking water, canteen and provision of latrines and urinals, for his staff and workmen employed on the Work., directly or through petty contractors or sub-contractors and for temporary creche (Bal-mandir) where 50 or more women are employed at a time. All camp sites shall be maintained in a clean and sanitary condition, by the Contractor, at his own cost.

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72.2 COMPLIANCE WITH RULES FOR EMPLOYMENT OF LABOUR

The Contractor shall comply with all laws, bye-laws, rules and regulations, for the time being in force, pertaining to the employment of local or imported labour, and shall take all necessary precautions to ensure and preserve the health and safety of all staff, employed on the Works directly or through petty contractors or sub-contractors.

72.3 SANITARY ARRANGEMENTS

The Contractor shall obey all sanitary rules, and carry out at his cost all sanitary measures that may from time to time be prescribed by the Local Medical Authority, and "permit inspection of all sanitary arrangements at all times by the Engineer, the Engineer's Representative or the Medical staff of the Employer and the staff of the local municipal or other authorities concerned. Should the Contractor fail to make adequate sanitary arrangements, these will be provided by the Employer, and the cost thereof recovered from the Contractor.

72.4 MEDICAL FACILITIES AT SITE

The Contractor shall, at his own cost, provide First Aid and medical facilities, at the Site as may be prescribed by the Engineer, on advice of Medical Authority in relation to the strength of the Contractor's staff and workmen employed on the Works, directly or through petty contractors or sub-contractors.

73.0 INDEMNITY

73.1 DAMAGE TO PERSONS AND PROPERTY

The Contractor shall, except if and so far as the Contract provides otherwise, indemnify the Employer against all losses and claims in respect of:

- (a) death of or injury to any person, or
- (b) loss of or damage to any property (other than the Works),

which may arise out of or in consequence of the execution and completion of the Works and the remedying of any defects therein, and against all claims, proceedings, damages, costs, charges and expenses whatsoever in respect thereof or in relation thereto, subject to the exceptions defined in Sub-Clause 73.2.

73.2 EXCEPTIONS

The "exceptions" referred to in Clause 73.1 are:

- (a) the permanent use or occupation of land by the Works, or any part thereof,

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- (b) the right of the Employer to execute the Works, or any part thereof, on, over, under, in or through any land,
- (c) damage to property which is the unavoidable result of the execution and completion of the Works, or the remedying of any defects therein. in accordance with the Contract,
- (d) death of or injury to persons or loss of or damage to property resulting from any act or neglect of the Employer, his agents, servants or other contractors, not being employed by the Contractor, or in respect of any claims, proceedings, damages, costs, charges and expenses in respect thereof or in relation thereto or, where the injury or damage was contributed to by the Contractor, his servants or agents, such part of the said injury or damage as may be just and equitable having regard to the extent of the responsibility of the Employer, his servants or agents or other contractors for the injury or damage.

73.3 INDEMNITY BY EMPLOYER

The Employer shall Indemnity the contractor against all claims, proceedings, damages, costs, charges and expenses-in respect of the matters referred to in the exceptions defined in Sub-Clause 73.2.

73.4 ACCIDENT OR INJURY TO WORKMEN

The Employer shall not be liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or any Subcontractor, other than death or injury resulting from any act or default of the Employer, his agents or servants. The Contractor shall indemnify and keep indemnified the Employer against all such damages and compensation, other than those for which the Employer is liable as aforesaid, and against all claims, proceedings, damages, costs, charges, and expenses whatsoever in respect thereof or in relation thereto.

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**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM**

PACKAGE - 1

TENDER DOCUMENTS

(NIP NO. HRBC/PL. & DN./20 of 2012-2013, dt: 08.03.2013)

BOOK – 1

VOLUME II

HOOGHLY RIVER BRIDGE COMMISSIONERS

(A Statutory Organisation under Government of West Bengal)

TRANSPORT DEPARTMENT

MUNSHI PREMCHAND SARANI

(ST. GEORGE'S GATE ROAD)

KOLKATA – 700 021

NOVEMBER 2013

**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM**

PACKAGE – 1

**Volume II
Technical Specification**

HOOGHLY RIVER BRIDGE COMMISSIONERS
(A Statutory Organisation under Government of West Bengal)
TRANSPORT DEPARTMENT
MUNSHI PREMCHAND SARANI
(ST. GEORGE'S GATE ROAD)
KOLKATA – 700 021

NOVEMBER 2013

TECHNICAL SPECIFICATION

Preamble

The works of **“Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum”** are to be carried out in accordance with the Technical Specifications, Vol. II of tender documents and the Specifications for PWD (WB) schedule of rates for Building and S&P Works(effective from 01.08.2010) with the latest corrigendum (4th Corrigendum dated 10.12.12) and as per directions of the Engineer or his representative. For items in the Bill of Quantities, whose technical specification are not available in the above schedule, those shall be adopted from respective specification outlined in the relevant PWD (Roads) SOR for Road and Bridge Works (effective from 14.11.2008) with the corrigendum (7th corrigendum dated 30.04.12) PWD (Roads) NH SOR for Road and Bridge Works(effective from 01.07.2011) or CPWD specification with latest corrigendum.

All electrical works are to be carried out in accordance with the Specifications for PWD schedule of rates for Electrical Works (Volume-I August, 2008) and Enhancement order (effective from 18.07.2012) vide Memo No. 284/AM(I)/P3 dated 24.07.2012 issued by Office of SE, Electrical Resource Circle, PWD or CPWD specification with latest corrigendum.

For items in Bill of Quantities, specification of which are neither available in this document nor in specification books mentioned above should be followed in accordance with good engineering practices.

TECHNICAL SPECIFICATION

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TECHNICAL SPECIFICATION CIVIL/INTERIOR WORKS

1.0 CARRIAGE OF MATERIALS

1.0 GENERAL The carriage and stacking of materials shall be done as directed by the Engineer-in-Charge. Any tools and plants, required for the work shall be arranged by the Contractor. The carriage of materials includes loading within a lead of 50 metres, unloading and stacking within a lead of 50 metres.

1.1 RESPONSIBILITY FOR LOSS OR DAMAGE Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to the materials. In case of any loss or damage, recovery shall be effected from the Contractor at twice the Departmental issue rates of the materials. If the departmental issue rates of the materials are not available then the recovery shall be effected at twice the prevailing market rates as determined by the Engineer-in-Charge.

1.2 MODE OF CARRIAGE Depending upon the feasibility and economy, the Engineer-in-Charge shall determine the mode of carriage viz. whether by mechanical or animal transport or manual labour.

1.3 LEAD 1.3.1 All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and as approved by Engineer-in-Charge alongwith reasons in writing.

1.3.2 Carriage by manual labour shall be reckoned in units of 50 metres or part thereof.

1.3.3 Carriage by animal and mechanical transport shall be reckoned in one km unit. Distances of 0.5 km or more shall be taken as 1 km and distance of less than 0.5 km shall be ignored. However, when the total lead is less than 0.5 km, it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km by mechanical/ animal transport.

2.0 Earthwork

2.1 Excavation

Excavation for trenches over areas and for pits, etc. shall be done to widths, lines and levels as shown in drawings or to such lesser or greater widths lines and levels as directed. The bottom and side of excavation shall be trimmed to required levels, profile, etc. watered and thoroughly rammed. Where the Contractor excavated below required level in good ground inadvertently or carelessly they shall make up the void in concrete (1:5:10) at his own expense. During excavation the Contractor shall take necessary precaution to retain earth (viz sal ballah piling, shoring etc) so that the earth will not slide or fall down to avoid any accident and hamper the progress of work at his own risk , responsibilities and cost . They will take necessary step to prevent the damage the adjacent structure or existing services. They shall repair and make good any such damage at their own expense to the satisfaction of the Engineer - in - Charge. A suitable path for men and materials around the excavated pit should be maintained throughout the work.

2.2 Shoring

The sides of excavation should be supported in such a way as is necessary to secure these from falling in and the shoring shall be maintained in position as long as necessary. The Contractor shall be responsible for the proper design of the shoring to be approved by the Engineer - in - Charge to hold the sides of the excavation in position and ensure safety of persons and properties. The shoring shall be removed as directed after the items for which it is required are completed. Unless otherwise mentioned in the schedule of quantities, no extra payment will be made for shoring.

2.3 Dewatering

All water which may get accumulated in excavations during the progress of work from whatever cause or source, shall be bailed or pumped out as necessary. The rates for excavation shall be deemed to include for the same.

2.4 Disposal of excavated materials

All materials excavated shall be removed from the site of excavation and disposed off during excavation with prior written permission of ENGINEER - IN – CHARGE from the site in an approved manner with the approval of local authority. No extra claim on any account will be entertained. The Contractor must also secure the approval of the Engineer - in - Charge regarding the quantity of surplus materials to be removed prior to commencement of this item of work.

2.5 Back filling

All shoring and form work shall be removed after their necessity ceases and trash of any sorts shall be cleaned out from the excavation. All space between foundation masonry or concrete and sides of excavation shall be refilled to the original surface with approved excavated materials in layers of 15 cm in thickness, watered and rammed. The filling shall be done after concrete or masonry is fully set and done in such a way as not to cause undue thrust on any part of the structure. Where suitable excavated materials is to be used for refilling, it shall be brought from the place where it is temporarily stacked and used in refilling. No excavation of foundation shall be filled up or covered until all measurements of excavation, masonry, concrete and other works below ground level has been jointly recorded. Black cotton soil shall not be used for back filling or in plinth filling under any circumstances.

2.6 Measurements

Measurements for all excavation, filling, carting away and earthwork shall be in solid measure. The rates quoted by the tenderers are thus for solid measure units. The following factors shall be applied to obtain quantities of solid measure.

Excavation : No reduction in volume (as per drawing area).

Filling : Volume shall be determined and consolidated by levels taken before and in layers after compacted filling and by measuring the length and breadth as required.

The mode of measurement for various types of excavations shall be as under:-

- a) In case of trenches, pits and areas, measurements shall be on the basis of size of foundation & the depth of bottom of foundation (bottom of bed concrete if provided) formation. Surface dressing shall be measured in plan projection only.

In case of pipe trenches and drains, measurement of width of trench shall be diameter of the pipe plus an allowance of 50 cms. to allow for collars, flanges etc.

3.0 SURFACE DRESSING.

3.1 Surface dressing shall include cutting and filling upto a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth upto 30 cm measured at a height of one metre above the ground level and removal of rubbish and other excavated material upto a distance of 50 metres outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depression filled upto the required level with the excavated earth so as to give an even, neat and tidy look.

3.2 Measurements

Length and breadth of the dressed ground shall be measured correct to the nearest cm and the area worked out in square metres correct to two places of decimal.

3.3 Rates

The rates shall include cost of labour involved in all the operations described above.

4 ANTI-TERMITE TREATMENT

4.0 Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Tenderer's Signature and Stamp

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite 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. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

4.2 Materials 2.28.1.0 Chemicals: Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used: (i) Chlorphiphos emulsifiable concentrate of 20% (ii) Lindane emulsifiable concentrate of 20%

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. For example, to dilute chemical of 20% concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

Engineer-in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers, chemical shall be kept in the custody of the Engineer- in-Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

4.3 Measurements: Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different types and concentration shall be measured separately.

4.4 Rate: The Rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

4.5 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 labelled 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 through skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact 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 cleanclothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the 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 that they are not allowed to contaminate wells or springs which serve as source of drinking water.

4.6 Anti-Termite Treatment: Constructional Measures The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building. (i) Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50 mm in brick masonry for providing apron floor around the periphery.

(ii) Brick on edge masonry in cement mortar shall be laid on the plinth wall. Dry brick shall be placed on the inner side of plinth wall for getting anticipated offset space for coarse sand and on the other side for installing anti-termite masonry groove. In the case of intermediate walls, dry bricks are placed on either side of the brick on edge masonry for getting offset space for coarse sand layer.

(iii) The dry brick for the anti-termite groove shall be taken out and dense cement concrete 1:3:6 (1 cement : 3 sand : 6 coarse aggregate by volume) sub-floor carpet shall be laid casting the anti-termite groove in position. In case of internal partition walls, the cement concrete sub-floor shall be laid on either side over the dry bricks to sufficient extent for getting staggered vertical joints over the joint of plinth wall and earth filling.

(iv) Superstructure masonry shall be raised over the dense cement concrete sub floor carpet and over-head jobs completed.

(v) The dry brick for coarse sand layer shall be removed and graded sand (of size 3 to 5 mm) layer at least 100 mm thick shall be compacted over the earth filling and underneath the partially laid dense cement concrete sub-floor carpet

(vi) Dense cement concrete (1:3:6 mix.) sub-floor at least 75 mm thick shall be laid over the sand filling. Necessary finish may be provided to the cement concrete sub-floor carpet.

(vii) Dry brick provided for apron floor shall be taken out and 600 mm wide formation of earth in 1:30 slope shall be made. Over the formation, 75 mm thick lime concrete 1:3:6 (1 lime:3 sand: 6 coarse aggregate, by volume) shall be laid.

(viii) Over the 75 mm thick like concrete bed at least 25 mm thick cement concrete topping 1:2:4 (1 cement: 2 sand: 4 fine aggregate, by volume) shall be laid and 12 mm thick cement plaster shall be applied on foundation and plinth.

The final recommendations incorporating the constructional details given above (i to viii) are shown in

4.7 Anti Termite Treatment : Treatment for Existing Building: Post Construction Treatment 2.28.4.1 Material

(i) Chemicals : Any one of the following chemicals conforming to relevant Indian Standards in water emulsion may be used for soil treatment in order to protect a building from termite attack.

Chemical with Percent Relevant Indian Standards Concentration by weight (Active ingredient) Chlorpyrifos 20EC IS 8944 1.0 Lindane 20EC IS 632 1.0

These chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemicals should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20% concentration, 19 parts of water shall be added to one part of chemical for achieving 1% concentration. Oil or kerosene based solution of chlorpyrifos 20 EC or Lindane 20 EC, 1.0 percent (by weight) concentration is useful for treatment of wood. Engineer-in-charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized representative. Chemical shall be kept in the custody of the Engineer-in-charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-charge or his authorized representative.

(ii) Measurements : Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different types and concentration shall be measured separately.

(iii) Rate : The rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.

(iv) Safety Precautions : Chemical used for antitermite 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 carrying out chemical soil treatments should familiarize themselves and exercise due care when handling the chemicals whether in concentrated or in diluted form. After handling the concentrates or dilute emulsion, worker shall wash themselves with soap and water and wear clean clothing especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the 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.

The use of chemical shall be avoided where there is any risk of wells or other water supplies becoming contaminated.

4.8 Treatment (i) Once the termites have an ingress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against termites. Anti termite measures described below are necessary for the eradication and control of termites in existing building. 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 in existing building shall be done as per IS 6313 (Part III). Treatment shall be got done only from the approved specialized agencies using the chemical procured directly by the Engineer-in-Charge from reputed and authorized dealers.

(ii) Treatment along outside of foundations: The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 litres per square metre of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 litres per running metre of the channel. Rodding with 12 mm diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 litre per running metre shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre.

In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along with external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 litres/sqm. of the vertical surface of the structure. To facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams upto a depth of 300 mm or upto the bottom of the plinth beams, if this level is less than 300 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

(iii) Treatment of Soil under Floors : The points where the termites are likely to seek entry through the floor are the cracks at the following locations: (a) At the junction of the floor and walls as result of shrinkage of the concrete; (b) On the floor surface owing to construction defects; (c) At construction joints in a concrete floor, cracks in sections; and (d) Expansion joints in the floor.

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-charge.

(iv) Treatment of Voids in Masonry : The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at 300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.

(v) Treatment at Points of Contact of Wood Work : The wood work which has already been damaged beyond repairs by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6 mm holes at a downward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.

Infested wood work in chaukhats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3 mm diameter with a downward slant to the core of the wood work on the inconspicuous surface of the frame. These holes should be at least 150 mm centre to centre and should cover in entire frame work. Chemicals shall be liberally infused in these holes. If the wood is not protected by paint or varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

4.9 Measurements : All dimensions shall be measured correct to a cm. The measurements shall be made of the surface actually provided with anti-termite treatment. Measurements shall be done separately for treatment of foundations, soils under floors, voids in masonry and wood work as detailed below: (i) Treatment along outside of foundations : The measurements shall be made in running metres taking length along the plinth of the building. (ii) Treatment of soil under floors : The measurements shall be made in square metres, inside clear dimensions of rooms, verandah etc. shall be taken. (iii) Treatment of voids in masonry : The measurements shall be made in running metres along the plinth of the building. (iv) Treatment of wood work : The measurements shall be made in running metres for chowkhats, joints, purlins, beams etc.

4.10 Rates The rate shall include the cost of labour and all other inputs (except concentrated chemical) involved in all the operations described above including drilling, refilling and making good the holes.

4.11 Treatment of Electrical Fixtures If infestation in electrical fixture (like switch boxes in the wall) is noticed, covers of the switch boxes shall be removed and inside of such boxes shall be treated liberally with 5 per cent Malathion dusting powder. The covers of the switch boxes shall be refixed after dusting.

5.0 Filling

Filling under floors or other places indicated shall be done by fine sand or silver sand brought from outside by the Contractor. The material should generally be good quality. Filling shall be done in layers not exceeding 15 cms. thick and each layer shall be fully inundated and consolidated properly by using 8 to 10 T Roller or otherwise. For filling under floors Consolidation shall be done by hand rollers and pneumatic / plate vibrator followed by hand rammer. The surface of the filling shall be finished true to lines and levels as required. The compaction shall be such that minimum compacted density obtained on testing is 95% of the maximum dry density. In general test shall be performed for every 1000 M2 of compacted area. The filling of final level after compaction and ready to take up soling work under the floor item, shall be checked by ENGINEER - IN - CHARGE. .

CONCRETE WORKS

6.0 Controlled Cement Concrete – Plain & Reinforced

6.1 General

Concrete and reinforced concrete work shall be carried out generally in conformity with the latest Indian Standards IS : 456 except for provisions indicated herein below. All work is to be carried out with utmost precision and upto date scientific know-how and the Contractor shall employ thoroughly competent staff to achieve the highest standards.

6.2 Cement

Cement for the work shall be either of ordinary Portland Cement conforming to the latest Indian Standards IS:8112 – 1989 for 43 grade and IS 12269 -- 1987 for 53 grade or Portland Pozzolana Cement conforming to IS 1489 (Part 1) 1991- specification (fly ash based) IS 1489 (Part 2) 1991, - specification (Calcined clay based) and of the best normal setting quality unless a quick setting quality is expressly instructed in the specifications or otherwise during the course of the work by ENGINEER - IN - CHARGE. If directed the Contractor shall purchase Portland cement as fresh as possible after manufacture and where there is reason to believe the cement has been long stored, ENGINEER - IN - CHARGE may demand a Laboratory Test Certificate regarding the character of cement and the Contractor shall furnish the same at no extra cost. ENGINEER - IN - CHARGE shall reject any cement which in its opinion does not meet the required standards.

The list of manufactures for cement as per the list of BOQ or as instructed in writing by ENGINEER - IN - CHARGE.

Any field or laboratory test for cement, if asked for by ENGINEER - IN – CHARGE shall be carried out at the risk and cost of the Contractor as per provision of relevant IS codes.

All bags and containers in which cement is packed shall be stored in a dry, weather-tight, properly ventilated structure with adequate provision against prevention and absorption of moisture. The Contractor shall at all times maintain for the inspection of ENGINEER - IN - CHARGE, a log book indicating the receipt of cement, brand and agent from whom obtained and the age of cement. Cement which has caked or perished by being wet or otherwise, shall on no account be used on the work. Cement shall be consumed on the works in the same sequence as that of their receipt at site. Cement reclaimed from cleaning of bags or from spillage from containers or otherwise shall on no account be used. The cement is to be stacked in an orderly and accessible way to permit ENGINEER - IN – CHARGE physical verification of existing stock at all points of time. The Contractor has to ensure furnishing a copy of manufacturer batch test certificate along with every lot of supply.

If so felt, ENGINEER - IN – CHARGE may instruct the Contractor for further testing of cement in Govt. laboratories/testing houses has been detailed in the relevant clause of GCC, over and above the / as submission of test certificates at the risk and cost of the Contractor.

6.3 Fine Aggregate

Fine aggregate shall generally conform to latest Indian Standards (IS:383). Sand shall be natural sand, crushed gravel sand or crushed stone sand at the discretion of ENGINEER - IN - CHARGE. Use of sea sand is prohibited. It shall be composed of hard siliceous material and shall be clean and of sharp angular grit type. Sand shall be properly graded minimising all voids.

Its grading shall fall within the limit of grading zone I, II for non-plastering work and Zone III for plastering work, of Table 1 (Ref clause no 3.1.4.3 of PWD specifications 1996, revised to 2000 vide page no 33).

Allowance for bulking of sand shall be made. Silt content shall not be more than 5%. Laboratory equipment such as measuring jars etc. are to be kept at site for time to time checking of bulking and silt content.

For sand testing periodicity may be given at the rate of every 150 cum of concrete work of all kinds (apart from RMC) and part thereof. For plastering work however, a separate periodicity of testing in term of every 500 SQM of plastering of any thickness irrespective of number of coats and part thereof is to be adopted. For brick masonry one test for 100 cum or part thereof for masonry may be adopted. The tests so mentioned shall have to be carried out through reputed Central/State Government registered testing house/ laboratory and not from site testing facilities.

All tests, to carry out field as well as laboratory tests shall be borne by the Contractor.

6.4 Coarse Aggregate

Coarse aggregate shall be approved hard aggregate generally conforming to latest Indian Standards : IS - 383. The following tests should be carried out for every new lot of supply :---

- Crushing value
- Impact value
- Sieve analysis
- Deleterious material
- Flakiness index

For every 150 CUM of concrete work of all kinds (apart from RMC) and part thereof one test shall be carried out.

All costs to carry out field as well as laboratory tests shall be borne by the Contractor.

6.5 Water

Water conforming to IS 456 - 2000 for all concrete work shall be clean, free from deleterious matter such as oils, acids, alkalies, sugar and vegetable matter. Every attempt shall be made to use water which is fit for drinking purposes. Water storages facilities provided by the Contractor shall be maintained properly to preclude contamination of water by any of the harmful substances. ENGINEER - IN - CHARGE may instruct the Contractor to carry out test of water sample as per provision of relevant IS code in Govt. laboratories and the Contractor shall comply the same at his risk and cost. The quantity of water to be added to concrete for mixing shall be such as to afford workability consistent with strength. Water/cement ratio shall be recorded in every batch of concrete. Arrangement for slump cone test shall be kept at site to arrive workability whenever ENGINEER - IN - CHARGE wants to check at site. The periodicity of testing may be conducted as once in every batch of concrete and part thereof.

6.6 Types of concrete, strengths etc.

The strength requirement of both controlled and ordinary concrete where ordinary Portland cement or Portland blast furnace slag cement is used shall be conforming to IS: 456.

Where ordinary Portland cement or Portland blast furnace slag cement is used, the compressive strength requirements for various grades shall be as given in Table II. It shall be the contractor's responsibility to obtain specified strength for the various grades of concrete.. Where rapid hardening Portland cement is used, 28 days compressive strength requirement specified in Table II shall be met at 7 days.

Strength requirements of concrete specified in volumetric proportions like 1:2:4 etc. will be corresponding to the following grades of concrete.

Concrete Mix	Corresponding Grade of Concrete
1: 2:4 M-15	
1: 1.5 : 3	M-20
1: 1:2 M-25	

MINIMUM CEMENT CONTENT SPECIFIED FOR DIFFERENT GRADES OF CONCRETE

M aximum free water Cement ratio	Grade of Concrete	Minimum Cement content (Kg/Cum)
0.55	M-20	300
0.50	M-25	300
0.45	M-30	320
0.45	M-35	340
0.40	M-40	360

STRENGTH REQUIREMENTS OF CONCRETE

Comprehensive strength of 15 cm x 15 cm cubes at 7 days and 28 days curing, (works test only) conducted in accordance with IS:516-1959 with all value in kg/sq.cm.

Grade	Preliminary Test (7 Days) (Minimum)	Mark Test (28 Days) (Minimum)
M-10	70	100
M-15	100	150
M-20	135	200
M-25	170	250
M-30	200	300
M-40	270	400

In case, the test results obtained from testing of sample cubes fail to attain specified strength of concrete, it will be considered as a result of negligence on the part of the contractor and in such cases the acceptance of work shall be in following manner.

REDUCTION IN STRENGTH

PART RATE TO BE PAID

Upto 5%	6/7 th of contract rate
5% to 10%	5/7 th of contract rate
Above 10%	To be rejected

Sufficient number of cube mould should be kept ready at site.

The type of concrete for any particular situation or work shall be as per instructions given to the Contractor by ENGINEER - IN - CHARGE notwithstanding anything contained in the foregoing clauses.

6.7 Tests for determination of strength of Reinforced concrete

As will be apparent from the Bill of Quantities, the strength of concrete specified is the criterion and the Contractor shall make every effort to obtain the specified strengths by good quality control. In case of concrete which does not obtain the specified strength at 28 days, such work shall be demolished and reconstructed to obtain the requisite strengths all as directed by ENGINEER - IN - CHARGE. To determine whether concrete in any particular part of the work is of the requisite strength or not, test cubes (works test cubes) shall be made from samples collected from the concrete being poured for the particular part and determined as per acceptance criteria detailed hereinafter. The salient features for the collection of samples is as indicated below :

The size of cubes to be prepared and tested shall be 15 x 15 x 15 cm.

All costs for sampling and field as well as laboratory testing shall be borne by the Contractor.

6.7.1 Number of tests

The number of cube tests in a work shall be entirely at the discretion and as directed by the Controlling Officer of the work. Cubes shall generally be collected for various structural members and also for works at various levels. It shall also be collected whenever the usual quality for a particular strength is in suspect. The number of cubes may at most be twelve or even more as instructed by ENGINEER - IN - CHARGE and as per provisions of relevant IS code on any given day in a particular work. However, in case other important casting works are running in parallel with a major concreting work, additional cubes in the range of six or twelve shall be taken for each of them as well.

6.7.2 Preparation and Testing of Cubes

Casting of cubes, preparation of moulds for the same, processing and curing the cubes and pressure testing the same shall be as per detailed instructions which will be issued to the Contractor from ENGINEER - IN – CHARGE from time to time or as per relevant Indian Standard as amended upto date as directed. All costs to be borne by the Contractor .

6.7.3 Equipment modules, testing etc.

It is the entire responsibility of the Contractor to prepare and get the cubes tested and provide for all material, labour, modules, equipment, facility and charges for sampling , testing etc. The Contractor's rate for concrete work shall be deemed to include for these and no extra whatsoever is admissible on this account.

6.7.4 Criteria for acceptance of work

The test and acceptance criteria shall comply to relevant IS codes including IS: 456
Part or element of concrete work shall be deemed to be acceptable, provided the three cubes tested for 28 days strength conform to the following:

Average of the three cubes strengths shall not be less than the specified strength.

No individual cube strength shall be less than 90% of the specified strength.

If any individual cube strength exhibits more than 133% of the specified strength, such cube shall be classified as freak and criteria above, shall be applied for the remaining two cubes only and the acceptability determined. Reference is drawn to Clause 2.3.5 in this connection incases of failure.

6.7.5 Quantum of cubes and testing

The decision of ENGINEER - IN - CHARGE in this regard shall be final and binding.
Cube testing shall be done at site regularly and at least 20% of this testing shall be carried out in the reputed laboratory.

Testing machine with valid calibration certificate to be kept at site for crushing of cubes. The testing shall be duly witnessed and approved by ENGINEER - IN - CHARGE.

All costs to carry out tests at field as well laboratory shall be borne by the Contractor.

7.0 Formwork

7.1 Materials and Design

The method and design of form work to be adopted by the Contractors is to be produced for approval of the same by ENGINEER - IN – CHARGE before any form work is taken up.

The form work shall be of approved 12 mm. thick water proof ply surface to be in contact with concrete, to be planed smooth. In every case joints of the shuttering are to be such as to prevent the loss of liquid / water from concrete. In ply shuttering the joints shall be perfectly close and lined.

Steel shuttering using hydraulic jacks shall preferably be used in all possible cases and as directed by ENGINEER - IN - CHARGE.

If any particular materials, or materials be specified in the schedule of quantities for form work such particularly specified material or materials shall be used in work. The form work shall be so constructed as to remain sufficiently rigid during placing of the concrete. All shuttering and forming must be adequately stayed and braced to the satisfaction of ENGINEER - IN – CHARGE for properly supporting the concrete during the period of hardening. The forms shall have sufficient strength and rigidity to hold concrete and withstand the pressure of remaining and vibration without excessive deflection from the prescribed lines and more so when the concrete is vibrated. The surface of all forms in contact with concrete shall be clean, rigid, watertight and smooth. Suitable devices shall be used to hold corners, adjacent ends and edges of panels of other forms together in accurate alignment.

The form work shall conform to the shape, lines and dimensions to suit the R.C.C. members as shown on drawings and be so constructed. Form work shall be adequately designed to support the full weight of workers, fresh placed concrete without yielding settlement or deflection, and to ensure good and truly aligned concrete finished in accordance with the construction drawings. A camber in all directions of 6mm for every 5 M span in all slab and beam centering shall be given to allow for unavoidable sagging due to compression or other causes , unless otherwise specifically instructed in writing by ENGINEER - IN - CHARGE.

The form work shall be as designed that the sides of the beams retain its position and does not get bulged these however should be so designed that the sides of the beams can be first struck leaving the soffit of beams and the supporting props in position. Props shall be designed to allow accurate adjustment and to permit of their being struck without jarring the concrete. No bamboo propping shall be used . Bulged section shall not be accepted and need to be rectified or rebuilt as per instruction of ENGINEER - IN - CHARGE. No extra claim , in any case shall be entertained by ENGINEER - IN - CHARGE.

Temporary openings shall be provided at the base of columns forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is deposited.

7.1.1 Vertical Shuttering

The vertical shuttering shall be carried down to such solid surface and is sufficiently strong to afford adequate support and shall remain in position until the newly constructed work is able to support itself. Props shall be securely braced against lateral deflection. Where timber props are used like bullies, they shall be a minimum diameter of 10cm. and shall be straight and adequately strong. The spacing of such struts shall be designed to carry to carry loads imposed on it without undue deflection of the members supported by the props. The spacing of props shall be approved by ENGINEER - IN - CHARGE and any alterations suggested by him shall be carried out at Contractor's expense. Bracing shall be provided as directed without extra cost. Contractor shall allow in his rates for providing props and struts for any height shown in the working drawings issued to Contractor from time to time.

7.1.2 Curve & Circular shuttering

Unused and new waterproof ply of 6 mm thick supported by good quality wooden batten shall be used. Repetition of the material will be same as stated above for the other shuttering.

7.2 Water Tightness

It is the Contractor's responsibility to ensure that the forms are checked for water tightness just before concreting operation starts and to make good any deficiencies.

7.3 Cleaning and Treatment of Forms

All rubbish, particularly chippings, shavings and saw dust, shall be removed from the interior of the forms before the concrete is placed and the form work in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition. Care shall be taken that such approval composition is kept out of contact with the reinforcements. Interior of all moulds and boxes must be thoroughly washed out with a hose pipe or otherwise so as to be perfectly clean and free from all extraneous matter previous to the deposition of concrete.

Prior approval of the form work should be taken from ENGINEER - IN - CHARGE before placing reinforcements on form work. No concrete shall be commenced until ENGINEER - IN - CHARGE has inspected the form work and until his approval is obtained. A notice of at least 24 hours shall be given to the opinion of ENGINEER - IN - CHARGE any materials is not accordance with the specification or the form work, is wrongly done or otherwise defective the Contractor shall immediately remove such materials from site and replace the same and rectify any other defects in accordance with the instruction of ENGINEER - IN - CHARGE and to his entire satisfaction.

The lines , levels, form work, reinforcement etc shall be checked by the Contractor with subsequent approval / checking by ENGINEER - IN - CHARGE prior to allowing of concreting , by ENGINEER

- IN - CHARGE. However, the cost, labour etc for such checking shall be borne by the Contractor and this will not relieve any of the obligations under this contract.

7.4 Stripping

Forms shall be left in place and removal shall be done as per norms laid down in IS codes and is authorized by ENGINEER - IN – CHARGE and shall then be removed with care so as to avoid injury to concrete. In no circumstances shall forms be struck until the concrete reaches a strength of at least twice the strength as to which the concrete may be subjected at the time of striking. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions, and cured under conditions of temperature and moisture similar to these existing on the work. Where possible, the form work should be left longer as it would assist the curing. Exposed surfaces of concrete which are indicated/ required to be plastered shall be roughened with wire brushes and hacked out closely immediately after removal of formwork by free of cost.

Any honeycomb , appeared after removal of form work shall be mended as per procedures laid down in IS codes including pressure grouting required , if any, as instructed by ENGINEER - IN - CHARGE.

7.4.1 Stripping Time

In normal circumstances (generally where temperature are above 20°C) and where ordinary cement is used, forms shall be struck after expiry of the following periods and as per relevant IS code unless otherwise directed at site by ENGINEER - IN - CHARGE.

7.5 Form Work in Lift for Continuous Surfaces

Where forms for continuous surface are placed in successive units, (as for example in columns or walls) the forms shall fit tightly over the completed surface so as to prevent leakage of slurry from the concrete and to maintain accurate alignment of the surface.

7.6 Procedure While Removing the Form Work

All form work shall be removed without such shock or vibration as would damage the reinforced concrete. Before the soffit and strata are removed the concrete surface shall be exposed where necessary in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occur with all cements in the cold-weather.

7.7 Tolerances

The following shall be the maximum permissible tolerance :-

- a) On general setting out dimensions upto 4 M. in length a tolerance upto 3mm will be allowed.
- b) On lengths of more than 4 M. tolerance of not more than 5mm will be allowed.
- c) On the cross sectional dimensions of columns, beams, slabs, faces, chajjas, mullions, grills, fins, louvers, and such other members tolerance more than 2mm will not be allowed.
- d) The top surface of concrete floor slab will be within plus/minus 3mm of the level and line shown on the drawings.
- e) Columns and walls and other vertical members shall not be more than 3mm out of plumb in their storey height and not more than 6 mm out of plumb in their full height.
- f) If work is not carried out within the tolerance set out above (a) to (d) the cost of all rectification measures of dismantling and reconstructing as decided by ENGINEER - IN – CHARGE shall be borne by the Contractor. In case of work dismantled, the same shall not be measured and no payment even for cement and reinforcement shall be allowed .

7.8 Openings and inserts

All openings and inserts which are designated in due time or as required for services, will be exactly provided by the Contractor. The Contractor should also fix the anchors or such items which may be supplied by the Proprietor in exact position and in perfect lines and levels. Inserts apply to such items as timber, dowels, bolts, loop, brackets, suspension irons, hooks, screws, plates, pipe of various types and diameter etc. etc. Openings in concrete or masonry must be provided in exact location to correct shape, size and depth or slightly bigger, if directed so, as shown in drawings or as instructed. It must be clearly understood that the provisions of inserts and openings as contemplated in this contract are to be carried out with "utmost precision" and any deviation of the same from that as shown in drawing or instructed, have to be rectified by the Contractor at his own cost and responsibility. The Contractor should make provision of openings to deep beams and their members at bottom or at lower level as necessary for cleaning purpose prior to concreting.

8.0 Reinforcement

High strength deformed steel bars produced by Thermo Mechanical Treatment process (TMT steel bars of grade Fe 500) shall be used for reinforcement work unless otherwise mentioned.

This shall conform to the standard and quality in accordance with IS:1786 (Latest edition) and other relevant IS Codes. Bending and cutting of reinforcing steel bars shall conform to IS: 2502. Lapping of bars where necessary shall be done as per IS specifications.

8.1 Storage

The reinforcement shall not be kept in direct contact with the ground but stack on top of an arrangement of timber sleepers or the like. Reinforcement shall be coated with cement wash before stacking to prevent scale and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion corrosion and deterioration.

8.2 Quality

All steel shall be of Grade I quality unless specifically permitted by the Engineer. Re-rolled material is generally not permitted. However, only approved / authorized re-rolling manufacturer can be allowed to supply only at the discretion of Engineer. With each lot, contractor shall submit the manufacturer's test certificate for steel. Random tests on steel supplied by Contractor may be performed by owner as per relevant Indian Standards. All cost incidental to such tests shall be at "Contractor's Expense". Steel not conforming to specification shall be rejected.

All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All bars shall be thoroughly cleaned before being fabricated. Pitted and defective bars shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer. If welding is approved, the work shall be carried out as per IS-2751 and according to best modern practices and as directed by the Engineer. In all cases of important connections, strength of bars welded Special precautions, as specified by the Engineer shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

8.3 Laps

Laps and splices for reinforcement shall be as shown on the drawings. Splices in adjacent bars shall be staggered and the locations of all splices, except those specified on the drawings, shall be approved by the Engineer. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

8.4 Bending

All bars shall be accurately bent according to the sizes and shapes shown on the approved detailed working drawings / bar bending schedules. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and rebend in a manner that will injure the material,

crack or split. Bar of over 25 mm in diameter shall be bent cold, except bar specifically approved by the Engineer. Bars, which depend for their strength on cold working, shall not be bent hot. Bars bent hot shall not be heated beyond red colour (not exceeding 645°C) and after bending shall be allowed to cool slowly without quenching. Straightening and rebending be such as shall not in the opinion of Engineer injure the material. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially, embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

8.5 Fixing

Reinforcement shall be accurately fixed by any approved means and maintained in the correct position shown in the drawings by the use of blocks, spacers and chairs as per I.S. 2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing point shall be securely bound together at all such points with 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that main bars do not perceptibly sag between adjacent spacer bars.

8.6 Inspection

Erected and secured reinforcement shall be inspected and approved by Engineer prior to placement of concrete.

8.7 Sampling & Testing

Sampling & testing for following physical test of steel shall be carried out as per relevant IS Codes.

- i. Tensile strength / Proof Stress.
- ii. Nominal Mass
- iii. Bend / Rebend Test
- iv. Elongation Test

The frequency of testing shall be as per relevant code or as directed by Engineer depending on the source of materials, previous test results etc.

8.8 Add for plaster drip course/ groove in plastered surface or moulding to R.C.C. projections in the direction of Engineer-in-charge.

9.0 Batch Mixed Concrete

Concrete shall always be mixed in a mechanical mixer unless specially approved by Engineer. Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable container freely suspended from a scale or other suitable load-measuring device and equipped with a suitable discharging Mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached the material may be added at controllable rate and shut off precisely within the weighing tolerances as specified. The weighing hoppers for cement, mineral admixtures aggregate shall be capable of receiving their rated load, without the weighed material coming into contact with the loading mechanism. Where the rated capacity of a batching plant, mixing cycle is less than 2.0 m³, additional precautions shall be taken to ensure that the correct number of batches are loaded into the truck mixer. The weighing hoppers shall be constructed so as to discharge efficiently and prevent the buildup of materials. A tare adjustment, up to 10 percent of the nominal capacity of the weigh scale, shall be provided on the weighing mechanism so that the scale can be adjusted to zero at least once each day. Dust seals shall be provided on cement hoppers between the loading mechanism and the weigh hopper, and shall be fitted so as to prevent the emission of cement dust and not affect weighing accuracy. The hopper shall be vented to permit escape of air without emission of cement dust. Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used, the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.

Concrete shall be handled from the place of mixing to the place of final deposit as quickly as practicable, by method which will prevent the segregation or loss of any of the ingredients. If segregation occurs during transport, the concrete shall be remixed before use. The concrete shall be placed in position and compacted before the initial set of cement has commenced and shall not be subsequently disturbed. Concrete shall not be dropped into position from a height greater than 1.50 metre.

9.1 Slump

If in the opinion of ENGINEER - IN - CHARGE, slump cone tests are required to be performed to establish workability the same shall be carried out at free of cost. Slump tests are however, to serve as guide only.

9.2 Transporting, Placing and Compaction of Concrete

No mixing of concrete shall be started unless the situation where they are to be poured are prepared and kept ready. Concrete shall be poured immediately on preparation. Transporting of concrete shall be done as speedily as possible and also in a manner to prevent segregation of aggregates. No retempered concrete shall be allowed to be used on the works. No concrete shall be allowed to fall through a height more than 1.20 M. where the concrete to be placed from more height it should be done through chute as per specification and relevant IS as directed by ENGINEER - IN - CHARGE.

Before fresh concrete is placed against an already cast and hardened section, such surfaces shall be roughened, swept clean, moistened with water and treated with cement slurry. Fresh concrete shall then be poured as required. Under no circumstances, concrete mixed more than stipulated initial setting time as per IS code shall be used. Dewatering of excavations for concreting where necessary shall be carried out by the Contractor as directed and the rates quoted by the Contractor are deemed to be inclusive of such dewatering. No concreting shall be done in adverse weather condition, except exigencies with proper precautions or prior approval from ENGINEER - IN - CHARGE.

9.3 Transportation by Mixer Trucks

These are essentially revolving drums mounted on truck chasis. Truck mixers used in the job shall be labeled permanently to indicate the manufacture specifications for mixing like:

- Capacity of drum.
- Total number of drum revolutions required for complete mixing.
- Mixing speed
- Maximum time limit before completion of discharge and after cement has entered the drum.
- Reduction in time period of discharge.
- Due to warm weather or other variables.
- All above information shall only form guidelines for the manufacture/producer of concrete.

Fulfillment of the stipulated number of revolutions or elapsed time shall not be acceptable criterion. As long as the mixing water limit is not exceeded and the concrete has satisfactory plastic physical properties and is of satisfactory consistency and homogeneity for satisfactory placement and consolidation and is without initial set, the concrete shall be acceptable.

When the concrete is totally mixed in transporting trucks or in case of .shrink-mix concrete, volume of concrete being transported shall not exceed 63% of the rated capacity of the drum. In case the concrete is totally mixed in the central batching plant, the transporting truck may be loaded upto 80% of the rated capacity of the drum. In this case the drum shall be rotated at charging speed during loading and reduced to agitating speed after loading is complete.

When transporting concrete by truck mixers, delivery time shall be restricted to 1.50 hours from the time cement has entered the mixer to completion of discharge.

9.4 Transportation by Agitating/non-agitating Trucks

Transporting ready mix concrete by this method shall consist of truck chasis mounted with open top bodies. The metal body shall be smooth and streamlined for easy discharge. Discharge may be from the rear when the body is mechanically tilted. Body of the truck shall have a provision of discharge gate. Mechanical vibrators shall be installed at the discharge gate for control of discharge flow.

Agitators, if mounted, also aid in the discharging of concrete from the truck in addition to keeping the concrete alive.

Water shall not be added to concrete in transport in this system.

Bodies of truck shall be provided with protective covers during period of inclement weather.

Delivery period, when adopting this system of transporting, concrete shall be restricted to 30 minutes from the moment all ingredients including cement and water enters in mixer to completion of discharge.

9.5 Transportation by Buckets

This method of transportation is very common for transportation of centrally mixed concrete. Buckets of suitable capacities may be fitted with concrete which is totally mixed in central plant and hauled to the job site. Buckets then may be conveyed to the actual point of placement either with the help of crane/ hoist or they may be carted.

As in the case of open truck transportation, water shall not be added to concrete transported in buckets. Concrete shall be protected from inclement weather by necessary covering arrangements. Also, maximum delivery period for this system of transportation from the time cement is introduced into the mixer to completion of discharge shall not exceed 30 minutes.

Before loading concrete in either truck mixer, open bodied trucks or buckets, the containers shall be thoroughly cleaned, washed and dried, so that there is no water or moisture in the container which may effect the designed water content of the concrete.

9.6 Transportation by Pumping

Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly into the desired area is termed as pumped concrete. The method of conveying the concrete through pipe lines is dealt with in these specifications.

Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below: -

- a) Piston type pumps
- b) Squeeze pressure type pumps.

Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin - piston pump. The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concrete into the pipe line to maintain a reasonably steady flow of concrete. Single piston pumps shall not be acceptable.

Inlet and outlet valves shall be any one of the following types.-

Rotating plug type Sliding plate type Guided plunger type Swing type Flapper type or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water.

The receiving hopper shall have a minimum capacity of 1.0 cum and the hopper shall be fitted with remixing rotating blades capable of maintaining consistency and uniformity of concrete. The primary

power for pumps may be supplied by gasoline, diesel, or electric motors. The primary power unit and the pump unit may be truck, trailer or skid mounted.

Squeeze pressure pumps shall consist of a receiving hopper fitted with re-mixing blades. Re-mixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper.

The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum.

The drum shall be maintained under a very high degree of a vacuum during operation. The drum shall be so fitted with hydraulically operation metal rollers, which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

Effective range of pumps to be used in the work shall be decided by the contractors after studying the site conditions. However, the minimum horizontal range shall not be less than 150 metres and minimum vertical range shall not be less than 50 metres.

Selection of pumps based on discharge capacity shall be decided by the contractors after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from the Engineer. As a guide line figure the contractors may assume a discharge capacity of 15 cubic metre / hour / pump.

9.7 Consolidation and processing of concrete

Concrete for all works shall be compacted by means of suitable vibrating equipment. One or more spare vibrators which are in complete working condition shall always be kept ready at sites to be put into commission in case of failure of the vibrators under use. The vibrators shall be operated by skilled personnel, thoroughly instructed as regards the mode, frequency, duration etc. regarding vibration. Concrete of low volume/ quantum for a particular work may however, be permitted by ENGINEER - IN - CHARGE at their sole discretion to be consolidated by hand only after prior permission.

9.8 Finish to concrete surfaces

Finish to concrete surfaces at various situations shall be as per directions of ENGINEER - IN - CHARGE. Where form finish is specified, the final surface shall be smooth and even and no-undulations, ridges, spots etc. shall be permitted. They shall be laid to pattern as directed. In case surfaces intended and directed for form finish, exhibit any of the defects above mentioned, the surfaces shall be rubbed with carborundum or plastered and finished all as directed at the risk and cost of the Contractor. The decision as to the acceptability or otherwise of a surface will be notified by ENGINEER - IN - CHARGE and the Contractor will implement the instructions accordingly.

9.9 Cover for reinforcement

Where not specifically indicated in the drawings, concrete cover for reinforcement shall be as per the latest Indian Standards IS 456 - 2000 and as per directions at site from time to time. Proper concrete cover blocks adequately cured to suit various covers as required shall be provided in adequate numbers sufficiently ahead of the work.

9.10 Construction joints

Construction joints in concrete work shall be generally avoided to the maximum extent possible and may only be provided only at predetermined places as per direction and in consultation with ENGINEER - IN - CHARGE. Joints shall be provided as specified in latest Indian Standards or as directed by ENGINEER - IN - CHARGE.

9.11 Curing

It is very important that all cement concrete work shall be cured properly. All concrete work shall be kept continuously in a damp or wet condition by pouring or by covering with a layer of moist sack, canvas, hessian or similar material for a period as stipulated in the relevant IS codes and specifications from the date of concreting. Water used for curing shall also be free from any deleterious substances and shall generally be fit for drinking. The work shall be adequately protected from drying, winds and direct sun rays. The Contractor should arrange at his own cost a temporary water supply line with provision of centrifugal pump, valves etc. for curing and constructional purpose at higher level. A sample sketch is enclosed for the reference purpose.

10.1 Brick Masonry

10.1 Bricks

All bricks shall be table moulded, burnt bricks of crushing strength not less than 75 kg/Sq cm. They shall be hard sound and well burnt with sharp edges and of uniform sizes and shapes. Bricks shall be neither under burnt nor over burnt and shall be free from cracks, stone floats, or other such defects as defined in relevant IS code and PWD specifications. When immersed in water for 24 hours, bricks shall not be absorb more water than 20% of its dry weight. All bricks shall be identical / equal to samples submitted and approved by ENGINEER - IN - CHARGE before the commencement of the work. Metallic sound of brick is also a criteria.

10.2 Cement and Sand

Cement and sand used for masonry and under the heading plastering work shall conform to the specifications laid down under the heading "Plain and Reinforced Concrete" as per clause of 1.3 above and relevant IS code and PWD specifications.

10.3 Additives

Additives, like integral waterproofing compounds, shall be of the approved type from reputed manufacturers and as per instruction in writing by ENGINEER - IN - CHARGE. These shall be used strictly in accordance with the manufacturer's instructions/specification. The additives shall conform to IS : 9103.

10.4 Samples

When demanded by ENGINEER - IN - CHARGE, the Contractor shall produce samples of materials or carry out samples of work for ENGINEER - IN - CHARGE approval. All materials used as also works carried out shall conform to the quality of approved samples. Production of these samples shall be at Contractor's cost. However, approval of samples by ENGINEER - IN - CHARGE shall not relieve the Contractor's obligation of the cost for this.

Testing of bricks shall be carried out in respect of dimension, crushing strength, water absorption and efflorescence in a standard sample size of six bricks. The periodicity of testing may be taken as once for every 50 CUM of brick masonry of nominal thickness not less than 250 mm and part thereof and for half brick masonry, once for every 500 SQM and part thereof. These tests shall be guided as per relevant IS code and PWD specification at the risk and cost of the Contractor.

10.5 Laying

Brick shall be soaked in clear water for at least six hours in a vat before use. Bricks shall be laid in English bond unless specified otherwise. No half or quarter brick shall be used except as closers. Brick shall be accurately raised to plumb.

Brick work shall be raised uniformly all round and no part shall be raised more than 1 metre above another at any time, and the work shall be properly toothed and raked back. In case of 125 mm. thick brick walls, wire mesh shall be provided in every third course as per relevant specification and as

instructed by ENGINEER - IN - CHARGE. The wire mesh shall be properly bedded in mortar, as directed.

Joints in brick work shall not be more than 10 mm. thick. Brick work shall not be raised more than 10 courses a day. The work shall be kept watered thrice a day for 10 days and afterwards twice a day for 3 weeks. All joints shall be thoroughly flushed with mortar at every course. Care shall be taken to see that bricks are properly bedded and all vertical joints completely filled to the full depth. The jointed of brick work shall be raised out to a depth not less than 10mm. as the work proceeds. The surface of brick work shall be cleaned down and watered properly before the mortar sets.

10.6 Half Brick Masonry

Specification of half brickwork is same as that mentioned above except that all the bricks shall be laid stretch wise breaking joints with those in the upper and lower course. Mix for mortar shall be as specified in the schedule of quantities and / or shown On drawings.

10.7 Curing

All brick works shall be kept continuously wet for at least 7 days from the date of laying.

10.8 Brick Soling

Where brick soling is required to be provided, it shall conform to the following specifications:-

It shall be flat of the bricks touching each other as per item. Soling shall be closely packed leaving no interstices or gaps. The interstices to be filled with fine sand and shall be sprayed with water. If crevices appeared between two bricks after spraying with water it shall be mended again by spreading fine sand.

10.9 Reinforcement Bars

The mild steel reinforcing bars shall conform to specification as laid down herein. Two bars of 6 mm diameter shall be used longitudinally at every third course of the brickwork. The first reinforcement shall be placed on the top of the bottom most courses.

The bars shall be fully embedded in the mortar and the ends shall be properly anchored to the mortar of main brickwork of the main wall to which half brickwork is joined. Laps shall be provided with a minimum length of 45 d. For unsupportable length of half brickwork exceeding 3.5 m, 115 x 200 mm wide RCC mullion (M-15, nominal mix) shall be provided @ 3.5 m and Horizontal RCC band of 115 x 150 mm at lintel level for heights of half brick work more than lintel level to be provided for which payment will be made separately under relevant item.

11.0 Granite Stone

It shall be of any colour and size as directed by Engineer-in-Charge. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

11.2 SIZES AND TOLERANCES

Sizes of Marble Blocks, Slabs and Tiles

	<i>Length</i>	<i>Width</i>	<i>Thickness</i>
1. Blocks	30 to 250	30 to 100	30 to 90
2. Slabs	70 to 250	30 to 100	2 to 15
3. Tiles	10 to 60	10 to 60	0.8 to 2.4

Notes:

- (1) All dimensions are in centimetre.
- (2) The length and width, of the blocks shall be in multiple of 30 cm.
- (3) Length and width of slab shall be in multiple of 10 cm. and thickness in multiple of 1 cm.
- (4) Tiles shall be square cut and linear dimensions in multiple of 10 cm.
- (5) Only slabs and tiles shall be machine cut and factory made.
- (6) For 8 mm thick tiles, special precautions will be required for fixing them like using special adhesive as per manufacturer's specifications. Such tiles are not suitable for outside veneering work exposed to rains/sun if used in large areas in continuous stretches. For tiles of thickness 20 mm and above cramps may be provided if approved by Engineer-in-Charge.

Tolerance

The following tolerances shall be allowed in the dimension of blocks, slabs and tiles: Tolerance

Blocks

- (a) Length + 2 per cent
- (b) Width + 2 per cent
- (c) Thickness + 2 per cent

Slabs

- (a) Length + 2 per cent
- (b) Width + 2 per cent
- (c) Thickness + 3 per cent

Tiles

- (a) Linear dimension + 3 per cent
- (b) Thickness + 1 per cent

The sizes other than those mentioned above may be provided as directed by the Engineer-in-Charge and nothing extra shall be payable on this account.

11.3 PHYSICAL PROPERTIES

11.3.1 Physical Properties of Marble & Granite Marble Granite

Characteristic Marble Requirements Method of test Granite Requirement Method of test

- (1) Moisture absorp- Max. 0.4% IS 1124 Max. 0.50% IS 1124
tion after 24 hrs by weight immersion in cold water
- (2) Hardness Min. 3 Mhos scale — —
- (3) Specific Gravity Min. 2.5 IS 1122 Min. 2.6 IS 1122

11.3.2 Approval of Sample

Before starting the work, the contractor shall get samples of marble approved by the Engineer-in-Charge. Approved samples shall be kept in the custody of the Engineer-in-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

11.4 SAMPLING

In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot

Sample Size and Criteria for Conformity

<i>Number of Blocks slabs/Tiles in the lot</i>	<i>Number of blocks slabs/ Tiles to be selected in sample</i>	<i>Permissible number of defectives</i>	<i>Sub sample size in no.</i>
(1)	(2)	(3)	(4)
Up To 25	3	0	2
26 to 100	5	0	2
101 to 200	8	0	3
201 to 500	13	0	4
501 to 1000	20	1	5

Note: The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

Tenderer's Signature and Stamp

Explanation 1 : All the blocks/slabs/tiles, selected in the sample, shall be examined for dimensions/workmanship and general requirements. Any block/slab/tile failing in any one or more of the above requirements shall be considered as defective. A lot shall be considered as conforming to these requirements if the number of defectives obtained is not more than permissible no. of defectives.

Explanation 2 : The lot having been found satisfactory with respect to dimensions, workmanship and general requirement shall be tested for physical properties of the marble. For this purpose a sub sample of the size given in Col. 4 of Table 8.3 shall be selected at random. These blocks/slabs/tiles in the subsample shall be tested for moisture absorption, hardness and specified gravity. The lot shall be considered having satisfied the requirements of the physical properties if none of the blocks/slabs/tiles tested for the requirements fails in any of these tests.

12.0 Doors

12.1 Wood Work

The work consists of supply of materials, fabrication, joinery, carpentry, delivery and erection at site on wooden door and window, flush doors as specified in Bill of Quantities. The measurements, materials etc shall be guided by relevant IS code and PWD specification.

12.1.1 Materials

Timber shall be best quality teak locally available or well seasoned Sal wood (as per BOQ) uniform in texture, free from large, loose dead or cluster knots, waves injurious open shakes, discolouration, soft or spongy spots. It shall have uniform colour, reasonably straight grains and shall be free from all defects.

All samples of wood work shall be got approved by ENGINEER - IN - CHARGE before bringing in bulk quantity at site and the samples shall be kept at site for future reference. Samples of wood may be sent for testing in Govt. laboratories / testing houses, if instructed by ENGINEER - IN - CHARGE at the risk and cost of the Contractor. The tests shall be governed by relevant IS codes and PWD specifications. Necessary test certificates shall have to be submitted, if asked for by ENGINEER - IN - CHARGE irrespective of further testing of samples as detailed above.

Wood work abutting against or embedded in masonry or concrete shall be painted with a coat of solignum paint before being placed in position. No wood work shall be painted prior to checking and subsequent approval by ENGINEER - IN - CHARGE.

12.1.2 Fixing/erection in position of door frames

Before the frames are fixed in position, these shall be inspected and passed by ENGINEER - IN - CHARGE. The frames shall be placed in proper position and fixed to the walls with suitable holdfasts/clamps as per PWD and IS specification as shown in drawing.

In case the door frames without sills the vertical members shall be buried in floor 50 mm. deep at least. Sills shall be provided where so directed. The door frames without sills while being placed in position shall be provided with temporary wooden bracings well wedged between the styles at the sill level. The sills shall be retained to keep the frames from warping during construction. These frames shall also be protected from damages during construction.

12.1.3 Shutters (Block Board)

Flush doors shall be solid core type with commercial or decorative faces. All flush door shall be obtained from approved manufacturer. This should be solid core with 1 mm thk. decorative laminates on both sides of approved shade & quality as desired by ENGINEER - IN - CHARGE and as mentioned in the approved list of materials with teak wood lipping all around and bonded with phenol formaldehyde synthetic resin as per IS specification. The specification generally should conform to I.S.2202/1966. Necessary test certificates shall have to be submitted by the Contractor, if asked for by ENGINEER - IN - CHARGE. Samples shall be approved well in advance prior to bringing in bulk quantities at site. Rejected materials shall be removed from site within 48 hours.

12.1.4 Tolerance

Tolerance on width and height shall be + 2mm and on thickness it will be + 1.2mm. The thickness of shutter shall be uniform throughout with a variation not exceeding 0.8 mm. when measured at any two points.

12.1.5 Adhesives

Only synthetic resin adhesives conforming to IS No.IS-851/1964 or latest amendment shall be used for bonding core members to one another including core frame and other exposed parts. The adhesive used for bounding cross band to core and face veneers to cross band shall conform to IS:848/1957 (Phenolic and Aminoplastic), or equivalent IS standards with latest amendment .

12.1.6 Fittings

Fitting shall be of Stainless Steel made of approved manufacturer. These shall be of the following types according to the material used.

The sample of fittings to be actually provided in a particular work shall however be approved by ENGINEER - IN – CHARGE prior to bringing in bulk quantities at site. Approved samples shall be kept at site for any reference .

Screws used for fittings shall be of the same metal.

The rate quoted for doors shall include all necessary hardware and screws as generally required to complete the job , as specified in the relevant items of BOQ and as per PWD and IS specifications .

12.1.7 Measurement

The rates quoted by the Contractor under each item in the Bill of Quantities for a complete finished item of and no claims by the Contractor in this regard shall be admissible. Supplying and fixing of all the fittings and iron mongery shall be deemed to have been included in Contractor's rates and consequently shall not be paid for separately.

13.0 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 25 mm. 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.

- 14.0 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 headless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401-1982.

- 14.1** Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only. Mullions and glazing bars shall be stubtenoned to the maximum depth which the size of the member would 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.

15.0 FITTINGS

15.0 Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

- (a) **Aluminium Fittings** : These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Appendix Hattached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge. Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures. Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

15.1.1.1 Sampling and Criteria for Conformity : The number of butt hinges to be selected from a lot shall be depend on size of lot and shall be in accordance with Table 9.11 below. Butt hinges for testing shall be selected at random from at least 10 per cent of the randomly selected packages subjected to minimum of three equal number of hinges being selected from each package. All butt hinges selected shall be checked for dimensions and tolerance requirements. Defects in manufacture and finish shall also be checked and lot shall be considered conforming to the requirement of this specifications, if the number of defective hinges among those tested does not exceed the corresponding number given in

Scale of Sampling and Criteria for Conformity

Sl. No.	Lot size	Sample Size	Permissible No. of Defective hinges
(1)	(2)	(3)	(4)
1	Up To 150	5	0
2	151 to 300	20	1
3	301 to 500	32	2
4	501 to 1000	50	3
5	1001 and above	80	5

15.1.3 Extruded Aluminium Alloy : These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205.

15.1.4 Sampling and Criteria for Conformity : The number of butt hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.12. Butt hinges for testing shall be taken at random from at least 10 per cent of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number

Scale of Sampling and Criteria for Conformity

<i>Sl. No.</i>	<i>Lot size</i>	<i>Sample size</i>	<i>Permissible No. of defective hinges</i>
1	Upto 200	15	0
2	201 to 300	20	1
3	301 to 500	30	2
4	501 to 800	40	2
5	801 and above	55	3

Note: Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

15.2 Parliament Hinges

15.2.1 These shall be of mild steel cast brass or as specified, and shall generally conform to IS 362. The size of parliament hinges shall be taken as the width between open flanges. Mild steel parliament hinges shall be copper oxidised (thick finish) or as specified. The brass parliament hinges shall be finished bright, chromium plated or oxidised or as specified.

15.2.2 The hinge pin shall be made of mild steel in the case of brass hinges. The hinge pin shall be mild steel (galvanised) in the case of aluminium alloy hinges. The hinge pin shall be firmly rivetted and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake. All screw holes shall be clean and counter sunk to suit the counter sunk head of wood screws specified.

15.2.3 Sampling Criteria for and Conformity : The number of parliament hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.13. Parliament hinges for testing shall be taken at random. All hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 9.13.

TABLE 9.13

<i>Lot Size</i>	<i>Sample Size</i>	<i>Permissible No. of Defective hinges</i>
Upto 150	13	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

15.7 Sliding Door Bolts (Aldrops) **15.7.1** These shall be of mild steel, cast brass, aluminium or as specified, and shall be capable of smooth sliding action.

15.7.4 Aluminium Sliding Door Bolts : These shall be made of aluminium alloy and shall generally conform to IS 2681. Aluminium sliding door bolts shall be anodized. All screw holes shall be countersunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminium fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole. The leading dimensions of the sliding door bolts are illustrated.

15.7.5 Sampling and Criteria for Conformity : The number of sliding door bolt to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.15. For testing shall be taken at random from at least 10 percent of the package subject to a minimum of three, equal number of doorbolts being selected from each package. All door bolts selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirement of this specification if the number of defects sliding door bolts among those tested does not exceed the corresponding number given in Table 9.15.

TABLE 9.15

<i>Lot Size</i>	<i>Sample Size</i>	<i>Permissible No. of Defective hinges</i>
Upto 150	5	0
151 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	81	5

15.8 Tower Bolts

15.8.0 These shall generally conform to IS 204 (Part. I) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth. The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.9 metre.

15.8.1 Tower bolts shall be of the following types:

- (a) Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and rivetted at the back.
- (b) Brass tower bolts with cast brass barrel and rolled or cast brass bolt or piece.

15.8.2 Unless otherwise specified bolt shall have finish as given below :

- (a) Aluminium alloy tower bolts (type 6) Bolt and barrel anodized. The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

15.8.3 Sampling and Criteria for Conformity : It shall be same as specified in clause 9.15.1.4.

15.9 M.S. Locking Bolt with Holes for Pad Locks

15.9.1 This shall conform to IS 7534.

15.9.2 This shall be of mild steel polished bright or copper oxidised batch electrogalvanised or stove enamelled. In case of stove enamelled locking bolts, the bolt may be finished bright.

15.10 Pull Bolt Locks

15.10.1 These shall be of M.S. cast brass or aluminium as specified. M.S. pull bolt locks shall be copper oxidized (black finish) or as specified.

15.10.2 Brass pull bolt locks shall be finished bright, chromium plated or oxidised as specified. Aluminium pull bolt locks shall be anodised and the anodic coating shall not be less than grade A.C. 10 of IS 1868. The bolt shall be 10 mm in diameter and the fixing plate 3 mm thick. The stop block shall be screwed to the fixing plate by a small ball and spring over which the bolt shall slide.

15.10.3 The fixing plate shall have four holes for fixing it to the door leaf, two of which shall be square to receive 6 mm dia. bolts with round heads, the remaining two shall receive machine screws with locknuts. The receiving plate shall be of the same width and thickness as the fixing plate and shall have 3 counter sunk holes. Where the bolt slides into wooden members, like the chowkhat, which have a rebate, the receiving plate shall also be correspondingly shaped so as to fit into the rebate. The screws and bolts shall have the same finish as the main bolt. The leading dimensions of pull bolt locks are given in the drawing. The denoting size of the pull bolt locks shall be length of the fixing plate between guides plus the thickness of the guides.

15.11 Door Latch

15.11.1 This shall be of mild steel, cast brass, or as specified and shall be capable of smooth sliding action. In case, of mild steel latch, it shall be copper oxidized (black finish) or as specified and in case of brass, it shall be finished bright, chromium plated or oxidized or as specified. The size of door latch shall be taken as the length of the latch. CPWD SPECIFICATIONS 2009 334

15.12 Indicating Bolt (Vacant/Engaged)

These shall be of cast brass finished bright chromium plated, or oxidized or as specified. The shape and pattern shall be approved by the Engineer-in-Charge.

15.13 Mortice Lock and Latch

15.13.0 This should generally conform to IS 2209.

15.13.1 The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 65 mm, 75 mm and 100 mm as specified. The measured length shall not vary more than 3 mm from the length specified.

15.13.2 Non-interchangeable Keys : Testing of non-interchangeable keys shall be as per IS 2209.

15.13.3 The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body suitably by counter sunk head screw. The latch bolt shall be of specified material and of section not less than 12 x 16 mm for all sizes of locks. If made of two piece construction both parts shall be rivetted. Ordinary lever mechanism with not less than two levers shall be provided. False levers shall not be used. Lever shall be fitted with one spring of phosphor bronze or steel wire and shall withstand the tests as provided in IS 2209.

15.13.4 Locking bolts, spring and strike plate shall conform to IS 2209.

15.13.5 Handles : These shall conform to IS 4992.

15.13.6 Keys : Each lock shall be provided with two keys.

15.13.7 Sampling, Criteria for Conformity : It shall be the same as specified in clause 9.15.1.4.

15.13.8 Tests : The finally assembled locks shall be tested as prescribed in Appendix 'G' of Chapter 9.

15.14 Mortice Latch (with Locking Bolt)

15.14.1 These are generally used in doors of bath rooms, WC's and private rooms.

15.14.2 Mortice latch shall, in respect of shape, design and mechanism of the latch and its components parts, generally conform to IS 5930. The material used for the different component parts of the latch shall comply with Tables 1 and 2 of IS 5930, unless otherwise specified.

15.14.3 The size of the latch shall be denoted by the length of the body towards the face and shall be 65 mm, 75 mm or 100 mm as specified. The depth of the body shall not be more than 15 mm.

15.14.4 The latch shall be of size 10 × 18 mm of shape as shown in Fig. 1 of IS 5930. The locking bolt shall be of section not less than 8 x 25 mm for all size of locks. The mechanism of the latch bolt, its spring, striking plate etc. shall be as described in IS 5930.

15.14.5 The handles provided shall conform to IS 4992.

15.14.6 Sampling, criteria for conformity shall be same as per clause 9.15.1.4.

15.15 Mortice Lock and Latch (Rebated)

15.15.1 These are slightly different from mortice lock described in 9.15.14 and are designed for use in double leaved doors. These should generally conform to IS 6607.

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15.15.2 Handles, Keys, Sampling, Criteria for Conformity and Test : These shall be same as specified in clause 9.15.14.

15.16 Mortice Night Latch

15.16.1 This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

15.16.2 This should generally conform to IS 3847.

15.16.3 It shall be cast or sheet brass, cast or sheet aluminium alloy or Mild steel as specified and of best quality of approved make. These shall be bright finished or copper oxidised (black) finish as specified. Nominal size of the latch shall be denoted by the length of the face over the body in millimetres. These shall have not less than two levers. False (Dummy) levers shall not be allowed.

15.16.4 Keys : Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

15.17 Cupboard or Wardrobe Lock

This should generally conform to IS 729. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. This shall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidised or as specified. The size of the lock shall be denoted by the length of the face across the body in mm.

These locks shall be fitted with four, five or six levers as specified. False (dummy) levers shall not be used.

15.18 Kicking Plates

15.18.1 This shall be of brass (finished bright or chromium plated or oxidised) bronze, stainless steel, aluminium or as specified. Aluminium kicking plates shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5mm in case of stainless steel. Shape of the plate shall be as specified. This shall have bevelled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of the plate. The shape and pattern shall be according to the drawings and as approved by the Engineer-in-Charge.

15.19 Door Handles (Doors and Windows)

15.19.1 These should generally conform to IS 208. The door handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

15.19.2 Door handles shall be of the following types according to the material used:

(a) **Cast or Sheet Aluminium Alloy Handles :** These shall be of aluminium of specified size, and of shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood screws of designation No.6. Aluminium handles, shall be anodized and the anodic coating shall not be less than grade AC 15 – IS1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.

(b) **Cast Brass Handles:** These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidised or as specified.

(c) **Mild Steel Handles :** These shall be of mild steel sheet, pressed into oval section. The size of the handles will be determined by the inside grip of the handle. Door handles shall be 10 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6., Iron handles shall be copper oxidised (black finish) or stove enamelled black or as specified.

15.19.3 Sampling and Criteria for Conformity : The number of handles to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 9.16. Handles for testing shall be selected at random for at least 10 percent of packages. Subject to a minimum 3, equal number of door handles being selected from each such package. All door handles shall be checked for dimensional requirement and finish. Any door handle which fails to satisfy the requirement of dimensions or finish or both shall be considered as defective. A lot shall be considered as conforming to requirement of this specification, if the number of defective handles among those tested does not exceed the corresponding number of defectives is greater than or equal to rejection number given in column 4 of Table 9.16, the lot shall be deemed as not meeting the requirements of this specification.

TABLE 9.16

Scale of Sampling and Criteria for Conformity

<i>Lot size</i>	<i>Sample size</i>	<i>Acceptance no.</i>	<i>Rejection no.</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>
Upto 50	8	0	1
51 to 90	13	1	2
91 to 150	20	1	2
151 to 280	32	2	3
281 to 500	50	3	4
501 to 1200	80	5	6
1201 and above	125	7	8

15.20 Floor Door Stopper

9.15.20.1 The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

15.20.2 Sampling and Criteria for Conformity : The number of floor door stoppers to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table 9.17. These stoppers shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of stoppers being selected from each such package.

All the floor stoppers selected shall be checked for dimensional requirement, material, manufacture and finish. Any of door stopper which fails to satisfy any one or more of these requirements shall be considered as defective door stopper. A lot shall be considered as conforming to the requirements of this specification if the number of defective floor door stoppers among these tested does not exceed the corresponding number given in col. 3 of Table 9.17. Otherwise it shall be considered as not conformity to the requirements of this specification.

TABLE 9.17

Scale of Sampling and Criteria for Conformity

<i>Lot Size</i>	<i>Sample Size</i>	<i>Permissible No. of Defective hinges</i>
Upto 100	5	0
101 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

TABLE 9.18

Requirements for Rubber for Use in Floor Door Stoppers

<i>Particulars</i>	<i>Requirements</i>	<i>Testing Procedure</i>
Relative density Max.	1.3	IS 3400 (Part IX)
Hardness	60 + 5	IS 3400 (Part 2)
Ageing for 24 hours at 100% + 1°C	(a) <u>Change in initial hardness</u> (b) Shall not develop brittleness + 5, - 0	<u>IS 3400 (Part II)</u> -do-

15.21 Hanging Rubber Door Stopper

15.21.1 These shall be of cast brass, finished bright, chromium plated or as specified. Aluminium stopper shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

15.22 Universal Hydraulic Door Closer (Exposed Type)

15.22.1 These shall be made of cast iron/aluminium alloy/zinc alloy and of shape and pattern as approved by the Engineer-in-Charge.

15.22.2 These shall generally conform to IS Specifications for door closers (Hydraulically regulated) IS 3564.

15.22.3 The door closers may be polished or painted and finished with lacquer to desired colour. Aluminium alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be pickled, scrubbed and rinsed to remove grease, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphating treatment in accordance with IS 3618.

15.22.4 The nominal size of door closers in relation to the weight and the width of the door size to which it is intended to be fitted shall be given in

TABLE 9.19
Type and Designation of Door Closers

<i>Designation of closers</i>	<i>Mass of the door (kg)</i>	<i>Width of the door (mm)</i>	<i>Remarks</i>
1.	Upto 35	Upto 700	For light doors such as double leaved and toilet doors.
2.	36 to 60	701 to 850	Interior doors, such as of bed rooms, kitchen and store
3.	61 to 80	851 to 1000	Main doors in a building, such as entrance doors

15.22.5 Sampling and Criteria for Conformity :

All the door closer of the same nominal size and shape and from the same batch of manufacture, in one consignment shall constitute a lot. The number of door closers to be taken at random from a lot shall depend upon the size of the lot. (Table 9.20). The sample shall be tested for construction, finish, dimensions, interchange ability of parts and performance in accordance of Table 9.20. Any door closer failing in any one or more of these characteristics shall be considered as defective. If in the first sample, the number of defective door closer is less than or equal to corresponding acceptance number, the lot shall be declared as conforming to the requirement of these characteristics. If the number of defective door closer is greater than or equal to the rejection number, the acceptance number but less than the rejection number, lot shall be deemed as not meeting with requirements of these characteristics. If the number of defectives is greater than the acceptance number, but less than the rejection number, a second sample of the size equivalent to that of the first shall be taken to determine the conformity or otherwise of the lot. The number of defective door closers found in the first and the second sample shall be combined and if the combined number of defectives thus obtained is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements of these characteristics.

Endurance Test- Two door closer in case of lot size 280 or less and five door closers in case of lot size more than 280 shall be selected from those already found satisfactory. These door closers shall be tested for the endurance test. If all the door closers tested for endurance test satisfy the requirement of this standard, the lot shall be deemed as having satisfied the requirements of endurance test, otherwise not.

TABLE 9.20

<i>No. of door closers in the lot</i>	<i>Sample</i>	<i>Sample size</i>	<i>Commulative sample size</i>	<i>Acceptance Number</i>	<i>Rejection Number</i>
Upto 50	First	8	8	0	2
	Second	8	16	1	2
51 to 90	First	13	13	0	2
	Second	13	26	1	2
91 to 150	First	20	20	0	3
	Second	20	40	3	4
151 to 280	First	32	32	1	4
	Second	32	64	4	5
281 to 500	First	50	50	2	5
	Second	50	100	6	7
501 to 1200	First	80	80	3	7
	Second	80	160	8	9
1201 to 3200	First	125	125	5	9
	Second	125	250	12	13
3201 and above	First	200	200	7	11
	Second	200	400	18	19

15.22.6 Performance Requirements : After being fitted in its position when the door is opened through 90°, the same should swing back to angle of $20^{\circ} \pm 5^{\circ}$ with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final position the door smoothly negotiates with the latch.

15.23 Casement Brass Stays (Straight Peg Type)

15.23.1 These shall be made of mild steel, cast brass, aluminium (extruded section) or plastic (Polypropylene) as specified. Mild steel casement stays shall be a copper oxidised (black finish) or as specified. Cast brass stays shall be finished bright or chromium plated or as specified. Aluminium stays shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminium and M.S. stays shall be made from channel section. The stays shall not weigh less than that indicated below:

200 mm	0.24 kg each
250 mm	0.28 kg each
300 mm	0.33 kg each

15.23.2 The shape and pattern of the stays shall be approved by the Engineer-in-Charge. The size of stays shall be determined by its length as shown in the plate. The plastic (Polypropylene) stays shall conform to IS 6318.

15.24 Quadrant Stays 300 mm

These shall be made of cast brass and finished bright or chromium plated or as specified. The shape and pattern shall be approved by the Engineer-in-Charge. It shall not weigh less than 0.20 kg each.

15.25 Hasp and Staple Safety Type

15.25.1 This shall be made of mild steel, cast brass or aluminium as specified. This shall generally conform to IS 363. M.S. Hasp and staples shall be finished black enamelled, or copper oxidised (black finish) or as specified. Brass hasp and staples shall be finished bright chromium plated or oxidised or as specified. Aluminium hasp and staples shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868.

15.25.2 M.S. hasp and staples shall be manufactured from M.S. sheet and brass hasp and staples by casting and Aluminium hasp and staples shall be made from dye section. The hinge pin which in all cases shall be of mild steel, shall be firm and its rivetted heads well formed. The movement of hasp shall be free, easy and square and shall not have any play or shake.

The hasp shall fit, in the staple correctly. The size shall be determined by the length of the bigger of the hasp.

15.25.3 The staple except in the case of cast one, shall be rivetted properly to its plate. The ends of the hinge pin for the safety type hasp shall be rivetted and properly finished. All screw holes shall be clean and counter sunk to suit counter sunk wood screw. All edges and corners shall be rounded.

16.0 Glass Panels : Glass panelling (Glazing) shall be done as specified in 9.2.6. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. Frosted glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

16.1 Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

16.2 Finish : Panels of shutters shall be flat and well sanded to a smooth and level surface.

16.3 Glazing

16.3.1 Specifications described in para 16.0 shall apply. The glass panes shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. In doors, windows and clerestory windows of bath, WC and lavatories frosted glass panes shall be used which shall weight not less than 10.00 kg/m².

16.3.2 Glazing shall be provided on the outside of the frame unless otherwise specified. Putty of approved make conforming to IS 419 shall be used for fixing glass panes. Putty shall be applied between glass panes and glazing bars. Putty shall then be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the back rebate to enable the painting to be done upto the sight line to seal the edge of the putty to the glass. The oozed out putty shall be cleaned and from putty cut to straight line. Quantity of putty shall not be less than 185 gm/ metre of glass perimeter. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its cracking.

Note: Putty may be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to the 18 kg paste.

16.3.3 Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

Note: Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

16.3.4 Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading. Size of M.S. beading shall be 10 x 10 mm box section manufactured from 1.6 mm thick sheet unless otherwise specified in the item. Where metal beading is specified, extra payment shall be made on this account.

17 HOLD FASTS

17.0 These shall be made from mild steel flat 40 × 5 mm size conforming to IS 7196 without any burns or dents. 5 cm length of M.S. flat at one end shall be bent at right angle and one hole 11 mm dia shall be made in it for fixing to wooden frame with 10 mm dia nut bolt. The bolt head shall be sunk into the wooden frame, 10 mm deep and plugged with wooden plug. At the other end 10 cm length of the hold fast flat shall be forked and bent of length as specified at right angle in opposite direction and embedded in cement concrete block of size 30 x 10 x 15 cm of mix 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate, 20 mm nominal size) or as specified

17.1 Measurements

Measurements for the hold fasts shall be in number.

17.2 Rate

It includes the cost of labour and material involved in all the operations described above including fixing bolt and cement concrete blocks.

18 PVC DOOR FRAME

Solid PVC door frame and shutter shall be as per para 9.19.

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18.1 Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheethaving density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneershade as approved by the Engineer-in-Charge. The weight per running metre of the door frame includingreinforcement should be a minimum of 1.5 kg./sq. mtr. The depth of the rebate of door frame shall be 10mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts ofthe door frame are to be joined to each other using solvent adhesive conforming to IS 14182. A toleranceof + 3 mm shall be permitted in the specified dimension of PVC section in the door frames. (Fig. 9.21)The solid PVC door frames shall be fabricated in factory as per nomenclature of the item anddirections of the Engineer-in-charge.

18.2 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 frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames 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. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. 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 center. 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.

18.3 Measurements

The outer length of the vertical and horizontal members of UPVC door frame shall be measured in running metres including embedded length in floor corrected upto a cm.

18.4 Rate

The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately

19 PANEL PVC DOOR SHUTTER

19.1 Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. TheSolid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plaincolour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The shuttersshall 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

19.2 Sampling and Criteria for Conformity

19.3.1 General Precautions

19.3.1.1 The test specimens shall not have been exposed to a temperature below 40°C 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.

19.3.1.2 If any 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.

19.3.2 Sampling

9.19.3.2.1 Sampling criteria for conformity shall be in accordance with IS 4020 (Part –I)

19.3.2.2 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 form a lot.

19.3.2.3 The number of shutters to be selected at random from a lot shall depend upon its size and shall be in accordance with Col. 1 and Col. 2 of Table 9.23.

TABLE 9.23

No. of Sample and Criteria for Conformity

<i>Sl. No.</i>	<i>Sample size</i>	<i>Permissible No. of Defects</i>
<i>(1)</i>	<i>(2)</i>	<i>(3)</i>
26 to 50	8	1
51 to 100	13	1
101 to 150	20	1
151 to 300	32	1
301 to 500	50	2
501 and above	80	2

Note : For lot size 25 or less, number of samples to be taken for testing shall be as agreed to between the manufacturer & Engineer-in-Charge.

Number of Tests : The samples selected as in column 2 of Table 9.23 shall be as agreed to between the manufacturer & Engineer-in-Charge.

19.3.2.4 Criteria for Conformity : The lot shall be considered conforming to the requirements if the number of samples failing to satisfy the requirements of characteristics does not exceed the permissible number mentioned in col. 3.

19.4 Test

19.4.1 The door shutters shall be subjected to the following tests in accordance with IS 4020 (Part 1 to 16).

(a) *Dimension and Squareness Test :* Door shutters when tested in accordance with IS 4020 (Part 2) the dimensions of nominal width and height will be within a limit of + 5 mm. The door shutter shall not deviate by more than 1 mm on a length of 500 mm. The thickness of the door shutter shall be uniform throughout with the permissible variation of not more than 0.8 mm between any two points. The nominal thickness of the shutter shall be within a limit of + 1.5 mm.

(b) *General Flatness Test :* Door shutter, when tested in accordance with IS 4020 (Part 3) the twist, cupping and warping shall not exceed 6 mm.

(c) *Local Planeness Test :* Door shutters, when tested in accordance with IS 4020 (Part 4), the depth of deviation measured at any point shall not be more than 0.5 mm.

(d) *Impact Indentation Test :* Door shutters, when tested in accordance with IS 4020 (Part 5), shall have no defects such as cracking, tearing or delamination and the depth of indentation shall not be more than 0.2 mm.

(e) *Edge Loading Test :* Door shutters, when tested in accordance with IS 4020 (Part 7) the deflection of the edge at the maximum load shall not be more than 5 mm. On removal of the loads, the residual deflection shall not be more than 0.5 mm, failing which the test may be repeated on the other edge in the reverse direction. Also there shall be no lateral buckling by more than 2 mm during loaded condition and no residual lateral buckling after removal of the load.

(f) *Shock Resistance Test :* Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 8) , there shall be no visible damage in any part of the door after twenty five blows on each end.

(g) *Buckling Test* : Door shutters, when tested in accordance with IS 4020 (Part 9), shall not show any deterioration and any residual deformation more than 5 mm after 15 min. of unloading and the initial deflection also shall not be more than 50 mm.

(h) *Slamming Test* : Door shutters, when tested in accordance with 2.1 of IS 4020 (Part 10), shall not have any damage in any part of the door at the end of successive impacts.

Door shutters, when tested in accordance with 3.1 of IS 4020 (Part 10), shall not have any visible damage in part of the door at the end of 100 successive impacts.

(i) *Misuse Test* : Door shutters, when tested in accordance with IS 4020 (Part 11), there shall not be any permanent deformation of the fixing or any other part of the door set in hindering its normal working after the test.

(j) *Screw Holding Test* : Door shutters, when tested in accordance with IS 4020- Part 16, the load shall not be less than 1000 N.

19.5 Fixing of Shutters

PVC door shutter 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.

19.6 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.

19.7 Fittings

Fittings shall be provided as per schedule 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.

19.8 Measurements

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

19.9 Rate

The specified rate include the cost of the door shutter and labour involved in fixing of the shutter. Fittings & fixtures on the door shutter except hinges & screws shall be paid extra as provided.

20.0 Providing and fixing 12 mm thick frameless toughened glass door shutter of approved brand and manufacturer, including providing and fixing top & bottom pivot & spring type fixing arrangement and making necessary holes etc. for fixing required door fittings, all complete as per direction of Engineer-in-charge (Door handle, lock and stopper etc.to be paid separately).

21.0 Providing and fixing fire resistant door frame of section 143 x 57 mm having built in rebate made out of 16 SWG G.I. sheet (zinc coating not less than 120 gm/sqm) duly filled with vermiculite based concrete mix, suitable for mounting 60 minutes fire rated door shutters. The frame is fitted with intumescent fire seal strip of size 10x4 mm (minimum) around the frame and fixing with dash fastener of approved size and make, including applying a coat of approved brand fire resistant primer etc. complete as per direction of Engineer-in-charge (Dash fastener to be paid for separately).

22.0 Providing and fixing 50 mm thick glazed fire resistant door shutters 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, made out of 16 SWG G.I.sheet (zinc coating not less than 120 gm/sqm) etc. complete as per direction of Engineer-in-charge (Dash fastener to be paid for separately).

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gm/m²) duly filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make, including applying a coat of approved fire resistant primer etc. all complete as per direction of Engineer-in-charge (panneling to be paid for separately).

23.0 Providing and fixing glazing in fire resistant door shutters, fixed panels, ventilators and partitions etc., with G.I. beading of appropriate size, made out of 20 SWG G.I. sheet (zinc coating not less than 120 gm/m²), fire resistant sealant, including applying a coat of approved fire resistant primer on G.I. beading etc., complete all as per direction of Engineer-in-charge. With clear fire resistant glass panes 6mm thick of approved brand, having minimum 60 minutes fire resistance

24.0 Providing and fixing panic bar / latch (Double point) fitted with a single body, Trim Latch & Lock on back side of the Panic Latch of reputed brand and manufacture to be approved by the Engineer-in-charge, all complete.

25.1 Steel

25.1.1 Supply of Material : General requirements relating to supply of structural steel shall conform to IS 8910.

25.1.2 Grades : There shall be nine grades of steel as given in Tables 10.1 and 10.2. While placing the order the steel should be designated by 'Designation' (See Table 10.1 and 10.2).

25.1.3 Manufacture : The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier. If required, secondary refining may follow steel making, as also normalizing rolling/controlled rolling during manufacturing of sections or as per the agreement between the purchaser and the manufacturer/supplier.

25.1.4 Freedom from Defects

25.1.4.1 All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/jagged and imperfect edges and all other harmful defects.

25.1.4.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 percent may be made subject to mutual agreement between the purchaser and manufacturer/supplier.

25.1.4.3 Subject to agreement with the purchaser, surface defects which cannot be dealt with as in 10.1.1.4.2 may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that :

(a) After complete removal of the defects and before welding, the thickness of the item is not to be reduced by more than 20 percent at any place.

(b) Welding is carried out by procedure APPROVED by competent authority with approved electrodes and the welding is ground smooth to the correct nominal thickness; and

(c) Subsequent to the finish grinding, the item may be required to be normalized or otherwise heat treated at the purchaser's discretion.

25.1.4.4 Welding as mentioned in 10.1.1.4.3 is not permissible for grade designation E 250 material.

25.1.5 Chemical Composition : Ladle Analysis the ladle analysis of the steel, when carried out by the method specified in the relevant part of IS 228 or any other established instrumental /chemical method, shall be as given in Table 10.1. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier.

25.1.2 Rivets

Rivets shall be made from rivet bars of mild steel as per IS 1148.

25.1.3 Bolts

These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts is adopted. They shall conform to IS 1367 – Technical supply conditions for threaded steel fasteners.

25.1.4 Electrodes

The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814.

26 STEEL WORK WELDED IN BUILT-UP SECTIONS FOR HAND RAIL USING M.S. TUBULAR/ERW TUBULAR PIPES AND G.I. PIPES

26.1 General specifications to be same as for steel work welded in built-up section as mentioned in para 10.4.

26.2.1 Hot finished welded (HFW) Hot finished seamless (HFS) and electric resistance welded tube shall conform to IS 1161.

26.2.2 G.I. pipes used for Hand rail to be conforming to IS 1239-Part I for medium grade. GI pipes to be screwed and socketed type and of required nominal bore.

26.2.3 Galvanising of GI pipes shall conform to IS 4736.

26.2.4 All screwed tubes and socket of GI pipes shall have pipe threads conforming to the requirements of IS 554.

26.2.5 The fittings for GI pipes to be conforming to IS 1239 (Part-II).

26.2.6 Measurement of Hand Rail of M.S. Tubular/E.R.W Tubular Pipes

The work as fixed in place shall be measured in running metres correct to a centimeter and their weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified.

27.0 Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.).

28 ROLLING SHUTTERS

10.8.1 Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for 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 or operated with mechanical device supplied by the firm. Shutters upto 10 sq. metre shall be of push and pull type and shutters with an area of over 10 sq. metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

28.1.1 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 0.90 mm for the shutters upto 3.5 m width. 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. 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.

28.1.2 Spring : The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part I .

28.1.3 Roller and Brackets : The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter upto 6 metre width and height not exceeding 5 metre, steel pipes of 50 mm 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 upto a 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 3.5 m and upto 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.

28.1.4 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 bearing with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.

28.1.5 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.

28.1.6 Guide Channel : The width of guide channel shall be 25 mm the minimum depth of guide channels shall be as follows:

Clear width of shutters Depth of guide channel

<i>Clear width of shutters</i>	<i>Depth of guide channel</i>
Upto 3.5 m	65 mm
3.5 m upto 8 m	75 mm
8 m and above	100 mm

28.1.7 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.

28.1.8 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 fore embedding in the walls.

28.1.9 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.

28.1.10 Cover : Top cover shall be of mild steel sheets not less than 0.90 mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

28.1.11 Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

28.2 Fixing

The arrangement for fixing in different situations in the opening shall be as per IS 6248.

28.2.1 Brackets shall be fixed on the lintel or under the lintel as specified with rawl. Plugs and screwsbolts etc. The shaft along with the spring shall then be fixed on the brackets.

28.2.2 The lath portion (shutter) shall be laid on ground and the side guide channels shall be boundwith ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts andnuts. The side guide channels and cover frames shall then be fixed to the walls through the plate weldedto the guides. These plates and bracket shall be fixed by means of steel screws bolts, and rawl plugsconcealed in plaster to make their location invisible. Fixing shall be done accurately in a workmen likemanner that the operation of the shutter is easy and smooth.

28.3 Measurements

Clear width and clear height of the opening for rolling shutter shall be measured correct to a mm.

The clear distance between the two jambs of the opening shall be clear width and the clear distancebetween the sill and the soffit (bottom of lintel) of the opening shall be the clear height.

The area shall be calculated in square metres correct to two places of decimal.

28.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described aboveincluding cost of top cover and spring except ball bearing and mechanical device of chain and crankoperation, which shall be paid for separately.

29.0 Structural Steel Work

29.1 General

29.1.1 Application of Specification

For this purpose, the contractor has to complete the erection work in certain sections on priority basis and take-up other sections as per the requirements of areas planned and approved for execution by the Owner/Consultants. This aspect is to be kept in mind by the Contractor and fully ascertain the working conditions.

29.1.2 Keeping Works free from Water

The Contractor shall provide and maintain at his own cost labour, and all equipment to keep the site free from water to do so until the completion of the work.

29.1.3 Bench Marks and Ground Water Ganges

The Contractor shall protect surveyor's bench marks and ground water ganges, zero line marks and base line marks from damage or movement during work.

29.1.4 Secrecy of Information

The Contractor shall not divulge any information that he may obtain regarding the project to any other party.

29.1.5 Work Included

The Contractor shall furnish labour, materials, equipment and tools so as to complete the work as specified herein and/or as shown in drawings and/or bill of quantities. The work shall include :-

- a. Preparation of shop drawings
- b. Supplying structural steel and all other materials unless otherwise provided in the contract.
- c. Fabrication of structural steelwork and painting as prescribed and delivery of the fabricated steelwork at site of erection.
- iv) Loading/handling of steel to fabrication site.
- v) Erecting the structural steelwork, including aligning, leveling and grouting.
- vii) Providing painting as specified on all structural steel work after erection.

29.2 Fabrication

29.2.1 Standards

All fabrication of structural steelwork shall be in accordance with Indian Standards unless otherwise stated herein. The tolerances of fabrication of steel structures shall be in accordance with IS:7215 unless specified otherwise.

29.2.2 Type of Construction

All structural steel work will be generally of welded construction unless otherwise shown in the design drawings. All shop connections will be of welded construction. Site connection shall be generally bolted or welded with erection bolts. The above connections are applicable in general unless other shown in the design drawings. Where erection bolts are used, the holes for erection bolts are to be plug welded after welding at site.

29.2.3 Storing Materials

All materials shall be stored properly on skids, above the ground. It shall be kept clean and properly drained. Structural steel shall be stored and handled so that members are not subjected to excessive stresses and damage. Girders and beams shall be placed upright and stored. Long members such as columns shall be supported on closely space skids to prevent injury from deflection

29.2.4 Workmanship

29.2.4.1 General

All workmanship shall be equal to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part of the work and all similar parts shall be strictly interchangeable. Rolled material before being laid off or worked must be straight. If straightening or flattening is necessary it shall be done by methods that will not injure the material.

29.2.4.2 Templates

Templates used throughout the work shall be of steel or steel bushed in such cases as may be considered necessary by the Engineer. In cases where actual materials have been used as templates for drilling similar pieces the Engineer will decide whether they are fit to be used as parts of the finished structures.

29.2.4.3 Straightening

All materials shall be straight and if necessary before being worked shall be straightened and/or flattened by pressure unless required to be of curvilinear form and shall be free from twists. Decoiling and straightening in case of thinner sheets/plates, if supplied in coil is also included.

29.2.4.4 Clearance

The erection clearance for cleared ends of members connecting steel to steel should be not greater than 2mm at each end. The erection clearance at ends of beams without web cleats should not be more than 3, at each end, but where for practical reasons greater clearance is necessary, suitably designed seatings shall be provided.

29.2.4.5 Shearing, Flame cutting and Planning

Shearing and flame cutting may be used at the Contractor's option provided that a mechanically controlled cutting torch shall be used for the flame cutting and that the resulting edge shall be reasonably clean and straight. Care shall be taken to ensure a full bearing of the stiffeners at the supports and at other points where concentrated load is applied.

1.15.7.4.6 Making holes :
Holes for bolts shall not be more than 1.5mm or 2.0mm (as the case may be depending on whether the diameter of the bolts is less than or more than 25mm), in diameter larger than the nominal diameter of the bolts, unless otherwise specified. All holes, except as stated hereunder shall be drilled to the required size or sub punched 3mm less in diameter and reamed thereafter to the required size. Thickness of the material for sub punching shall not be greater than 16mm. All matching holes for bolts shall register with each other so that a gauge of 1.5mm or 2.0mm as the case may be, less in diameter than the hole can pass freely through the members assembled for bolting in the direction at right angle to such members

29.2.4.6 Assembly

All parts assembled for bolting shall be in close contact over the whole surface and all bearing stiffeners shall bear tightly at both top and bottom without being drawn or caulked. The component parts shall be so assembled that they are neither twisted nor otherwise damaged.

29.2.4.7 Bolting

All site connections shall be with site weld or black bolts and all the holes shall be 1.5mm larger in diameter. All such bolts shall be provided with washers having a hole of 1.5mm larger in diameter than the barrel of the bolt and thickness not less than 6mm so that the nut, when tightened, shall not bear on the unthreaded body of the bolt.

Additional joints, wherever required, in case the length of the member is short of length, is to be done by the Contractor at no additional cost to the Employer. However, prior permission of the Engineer has to be taken for such cases.

29.3 Welding

29.3.1 General

The welding and the welded work shall conform to IS:816 and IS:823 unless otherwise specified. As much work as possible shall be welded in shops and the layout and sequence of the operations shall be so arranged as to eliminate distortion and shrinkage stresses.

29.3.2 Plant and Equipment

The equipment shall be of sufficient capacity to suit the welding procedure laid down and be capable of depositing the particular type or types of electrodes to be used under the conditions of current and voltage specified by the electrode manufacturer. All equipment, accessories and connections shall be maintained in proper working order.

Tenderer's Signature and Stamp

29.3.3 Preparation of Joints

The edges shall be prepared with automatically controlled flame cutting torch correctly to the shape, size and dimensions of the groove, prescribed in the design and shop drawings. In case of U-groove joint, the edges shall be prepared with an automatic flame cutting torch in two phases following a bevel cut with a gauging pass or by machining. The welding surface shall be smooth uniform and free from fins, tears, notches or any other defect which may adversely affect welding and shall be free of loose scale, slag, rust, grease, paint, moisture, or any other foreign material.

29.3.4 Welding Procedure

The welding procedure shall be arranged by the Contractor to suit the details of the joints as indicated on the drawings and the position at which welding has to be carried out. Welding procedure shall cover the following :-

- i) Type and size of electrodes;
- ii) Current and (for automatic welding) arc voltage;
- iii) Length of run per electrode; or (for automatic welding) speed of travel;
- iv) Number and arrangement of runs in multirun welds
- v) Position of welding;
- vi) Preparation and set up of parts;
- vii) Welding sequence;
- viii) Pre or post heating;

29.3.5 Minimum leg length and Throat Thickness in Fillet Welds

The minimum leg length of a fillet welds as deposited shall be not less than the specified size. In no case shall a concave weld be deposited unless specifically permitted, where permitted, the leg length be increased above that specified, so that the resultant throat, thickness is as great as would have been obtained by the deposition of flat faced weld of the specified leg length.

29.3.6 Deslagging

After making each run of welding all slag shall be thoroughly removed and the surface cleaned.

29.3.7 Quality of Welds

The weld metal as deposited (including tack welds if to be incorporated) shall be free from cracks, slag inclusions, porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without undercutting or overlapping at the toes of the weld. The surface of the weld shall have a uniform consistent contour and regular appearance.

29.3.8 Weather Conditions

Welding shall not be done under such weather conditions which might adversely affect the efficiency of the welding.

29.3.9 Qualification and Testing of Welders

The Contractor shall satisfy the Engineer-in-charge that the Welders are suitable for the work upon which they will be employed and shall produce evidence to the effect that welders have satisfactorily completed appropriate tests as described in IS:817. The Engineer-in-charge may at his own discretion order periodic tests of the welders and/or of the welds produced by them. Such tests shall not be at the expense of the Contractor.

The Contractor shall employ competent welding supervisor to ensure that the standard of workmanship and the quality of the materials comply with the requirements laid down in this specification.

29.4 Crane Rails

The rail shall be reasonably free from twist and the camber shall not exceed 0.2 percent of the length. The rails shall be straight and deviation from straightness shall not exceed + 1.5mm.

Rail joints shall overlap the joints of the gantry girder by a minimum distance of 300mm. Joint in one crane rail shall be staggered to the joint in the opposite crane rail.

29.5 Inspection and Testing

The Engineer-in-charge shall have free access at all reasonable times to the Contractor's works where the fabrication of steel work is carried out and shall be afforded all reasonable facilities by the Contractor for satisfying himself that the fabrication is being undertaken in accordance with the provisions of the specification and drawings.

The Contractor shall continually inform the Engineer-in-charge of the progress in fabrication and as to when individual pieces will be ready for inspection.

Unless directed otherwise, inspection shall be made at the place of manufacture prior to despatch. Should any structure or part of a structure be found incomplete any of the provisions of this specification, it shall be liable for rejection. No structure or part of the structure, once rejected shall be resubmitted for inspection/test, except in cases where the Engineer considers the defect as rectifiable.

Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the Engineer. All gauges and templates necessary to satisfy the Engineer shall be supplied by the Contractor. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at the Government Test House or elsewhere and should the material so tested be found to be unsatisfactory the costs of such tests shall be borne by the Contractor.

29.5.1 Measurement

Measurement of structural steel work shall be made on the calculated weights of steel work as determined from the dimensions given on the approved drawings or any approved amendment thereto. In the case of mild steel plates the calculated weights shall be based on 78.50 Kg. per sq.m. of metal 1 cm thick and in the case of mild steel standard sections the weight shall be calculated on the basis of weight per metre run specified in IS Hand No.1 .

The weights of all plates and sections shall be calculated using the overall square dimensions, no deduction being made for skewcut and holes.

No additional weight for weld metal deposited shall be allowed in the measurements. No deduction shall be made for bolt holes. No measurements shall however be made for bolts and nuts used in fabrication and erection.

29.6 Erection

29.6.1 General

Erection of structural steelwork shall be carried out in accordance with IS:800 and in an expeditious manner in conformity with the drawings and specifications.

The suitability and capacity of all plant, equipment etc. used for erection shall be to the satisfaction of the Consultant.

29.6.2 Erection Drawings

The approved erection drawings and any approved arrangement drawings, specifications or instructions accompanying them shall be followed in erecting structural steelwork. Erection drawings for structural steelwork shall be prepared by Contractor and shall consist of line diagrams showing every member in position with the respective erection mark.

Erection marks shall appear on the structural steel members as in detail drawing and all steelwork shall be erected with marks in the same relative position as shown on the plan or elevation.

29.6.3 Storing and Handling of Materials

The fabricated materials on receipt at site shall be carefully unloaded, examined for defects, checked, sorted out and stocked securely on skids above level ground. The ground shall be kept clean and properly drained. Girders and beams shall be placed upright and stored. Long members such as columns and chords shall be supported on skids placed near enough to prevent injury from deflection.

The fabricated materials shall be verified with respect to markings on the marking plan or erection drawing supplied by the Contractor. Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be identified by painting in distinct colour. Such materials shall be dealt with as ordered by the Engineer.

The handling and storing of the component parts of a structure shall involve the use of method and appliances not likely to produce injury by twisting, bending or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until the defects are corrected and members seriously damaged in handling shall be rejected.

All small bends or twist received by members shall be rectified before such members are put in place, any serious bends or damage shall be reported at once to the Engineer-in-charge by the Contractor for instructions. The straightening of bend edges of plates, angles and other shapes shall be done by methods not likely to produce fracture or other injury. Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected by the Contractor for evidence of incipient or other fractures. The Contractor shall immediately report to the Engineer, presence of any such evidence and act according to his instructions.

29.6.4 Setting Out

The Contractor shall be responsible for checking the alignment and levels of foundations and correctness of foundation bolt centres, well in advance of starting erection work and shall be responsible for any consequences for noncompliance thereof. Discrepancies, if any shall immediately be brought to the notice of the Engineer-in-charge for his advice.

The Contractor shall assume full responsibility for the correct setting out of all steel work and erecting it correctly as per alignment and levels shown on the Drawings. Notwithstanding any assistance rendered to the Contractor by the Engineer-in-charge, if at any time during the progress of the work any error should appear or arise therein, on being required to do so, the Contractor at his own cost shall remove and amend the work to the satisfaction of the Engineer-in-charge.

29.6.5 Assembly and Erection

Before starting erection the Contractor shall submit to the Engineer-in-charge for his approval the method he proposed to follow and the number and type of equipment and temporary work he proposes to use for the erection. The approval of the Engineer-in-charge shall not be considered as relieving the Contractor from responsibility for the loads which the erection equipment and temporary work will be called upon to carry or support. Adequate allowance and provision shall be made for lateral forces and wind loads. Drawings for such temporary work shall be submitted to the Engineer-in-charge for prior approval, if so desired by him.

The Contractor shall plumb and level all steel work and shall thoroughly brace the structures during erection to keep them plumb and rigid till completion. Erected parts of the structure shall be stable during all stages of erection and the structural elements to be erected shall be strong enough to bear erection loads. The stability of structures subject to the action of winds, dead weight and erection forces shall be obtained by observing specified sequence of erection of vertical and horizontal structural members by installing permanent and temporary bracing. As the work progresses, the steel members shall be securely bolted up to take care of all dead loads, wind and erection stress, including those due to erection equipment or its operation. No permanent bolting, welding or grouting shall be done until proper alignment has been obtained and approved by Engineer-in-charge.

29.6.6 Erection Tolerance

29.6.6.1 Erection Tolerance for Buildings without Cranes

The maximum tolerance for line and level of steel work shall be + 3.0 mm on any part of the structure, the structure shall not be out of plumb more than 3.5mm on each 10 m. section of height but not more than 7.0 mm per 30 m section height. These tolerances shall apply to all parts of the structures unless otherwise stated on the drawings.

29.6.6.2 Erection tolerances for buildings containing cranes :

Component	Description	Variation allowed
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3. Crane & Track.	a) Difference in levels of Girder crane rail measured between the adjacent columns.	6.0 mm
	b) Deviation to crane rail gauge.	+ 6.0mm
	c) Relative shifting or ends of adjacent crane rails in plan and elevation after jointing.	2.0 mm
	d) Deviation of crane rail axis from centre line of web.	+3.0mm

29.6.7 Field Connections

Field connection in the trusses, portals, columns, roof girders, floor girders, crane girders, surge girders, auxiliary girders, column bracings, etc. shall be welded with erection bolts or shall be bolted. Connection of purlins, girts, roof bracings, wind girders, catwalkways, staircases, ladders, hand rails and all other secondary members may be bolted with black bolts, except where welded connections are required. The above connections shall be applicable in general unless otherwise shown in detail drawings. All nuts for securing run-ways and gantries shall be locked against turning after tightening by provision of suitable spring washer.

Holes of erection joints to be bolted (with machine bolts), shall be filled with temporary bolts and plugs, after mounting the structures. The number of temporary bolts and plugs shall not be less than 50% of the total number of holes. In joints where the number of holes is equal to or less than 5, then 3 holes shall be filled.

The number of washers on permanent bolts shall not be more than two (and not less than one) for the nut and one for the bolt head.

29.6.8 Field Welding

All field assembly and welding shall be executed in accordance with the requirements for shop fabrication excepting such as manifestly apply to shop conditions only. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of at least 50mm on either side of the joints.

29.6.9 Bedding and Grouting

Bedding and grouting shall be carried out with mortar grout or cement concrete grout. The Contractor shall provide screed bars or mild steel plates and fix them in mortar. The bedding and grouting shall not be carried out by Civil Contractor until as sufficient portion of steel work including columns, girders, beams, trusses, bracings etc. has been properly aligned, leveled and plumbed and approval of the Engineer-in-charge has been obtained.

Immediately before grouting, the space under the base plate and around bolts shall be thoroughly cleaned and made free from foreign materials. The grout shall be prepared with correct quantity of water to get derived consistency and shall be vibrated and compacted so that the entire grouting space and holes are filled up with dense grout.

Wherever the site connection has to be made, concrete encasing structural member should be cleaned and after erection of new structurals re-encasing at the cut portion has to be made.

29.6.10 Correction of misfits

Correction of minor misfits, a reasonable amount of reaming and cutting of excess will be considered a legitimate part of the erection.

Any error in shop work which prevent the proper assembling and fitting up of parts by the moderate use of reaming and slight chipping, cutting shall immediately be reported to the Engineer-in-charge and his approval for the method of correction is to be obtained.

30 CEMENT CONCRETE FLOORING

30.1 Cement Concrete

Cement concrete of specified mix grade shall be used and it shall generally conform to the specifications

30.2 Base Concrete

30.2.1 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 as 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 6 mm to 10 mm 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.

30.2.2 The flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

30.2.3 If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

30.2.3 Thickness

The thickness of floor shall be as specified in the description of the item.

30.2.4 Laying

30.2.4.1 Panels : Flooring of specified thickness shall be laid in the pattern including the border as given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450 mm in width and the joints in the border 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.

30.2.4.2 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. 4 mm thick glass strips or 2 mm PVC strips or 2 mm 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. Cost of providing and fixing strips shall be paid for separately.

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.

30.2.4.3 Laying of Flooring without Strips : Laying of cement concrete 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 angle 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 under 11.2.4.2. 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.

30.2.5 Finishing

11.2.5.1 The finishing of the surface shall 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.

30.2.5.2 Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 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.

30.2.5.3 The edges of sunk floors shall be finished and rounded with cement mortar 1:2 (1 cement : 2 coarse sand) and finished with a floating coat of neat cement.

30.2.5.4 The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

30.2.5.5 The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

30.2.6 Curing

The curing shall be done for a minimum period of ten days. 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.

30.2.7 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 4°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38° C. 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 offloor.

30.2.8 Measurement

Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

30.2.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on RCC slab or on base concrete including roughening and cleaning the surface but excluding the cost of strips which shall be paid separately under relevant item. Nosing of steps where provided shall be paid for separately in running metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunk floors. In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

31.0 Flooring

31.1 Kotah Stone Flooring , Dado & Skirting

Kotah Stone shall be of selected quality, hard, sound, dense and homogenous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut and shall be of approved colour of even shade as far as permissible. The stones having yellowish strips, dent, black patch and broken edges shall not be used. The slabs shall conform to the sizes of 600 mm. x 600 mm. or as required and shall be laid to pattern as directed. The edges will be perfect vertical and in right angled to each other. Minimum thickness of slabs shall be 20 mm. and the minimum thickness of floor finish including bedding mortar shall be 40 mm or specified in the relevant items of BOQ and PWD and IS specification. The floor surface to be tiled shall be closely picked or hacked and thoroughly watered and cleaned. Mortar for bedding shall be 1 part of cement, 4 parts of sand with a layer of neat cement slurry. The stone slabs shall be laid on this bedding immediately and as each stone is laid it shall be tapped with a wooden mallet and set. Flush joints shall not exceed 1 mm thick and shall be as per pattern indicated by ENGINEER - IN - CHARGE. The joint shall be set close with white cement, stone dust, adhesive and admixture of pigment matching the shade of kota stone. After the work has set, the surface shall be machine polished to the satisfaction of ENGINEER - IN - CHARGE. The final polished surface shall then be washed of all dirt, mortar, etc. by using Oxalic Acid and handed over in a neat condition. Measurement will be taken on finished dimensions. Before the start of kotah laying work, approval should be taken from ENGINEER - IN - CHARGE on the sample work and the approved sample(s) shall be kept at site for ready reference. For dado, 1200mm high, 300mm wide and 20mm thick Kotah shall be fixed in wall, raised from the plastered surface matched with floor joints or as directed by ENGINEER - IN - CHARGE.

Rates to include

- a) All labour , materials and equipments , cleaning the sub-base laying mortar bed and cement grout and fixing marble slabs and making the joints and polishing.
- b) Any cutting and waste if required.
- c) Curing
- d) Cleaning the floor and wall from all stains etc complete .

32.0 Ceramic Tile Flooring and Dado/Skirting

32.1 General

This item relates to the furnishing of materials and installations of ceramic tiles in flooring, dado, etc. Tiles shall conform to IS : 15622 and workmanship shall be per IS : 1443.

32.2 Materials

The ceramic tiles shall be of high quality of approved manufacturers as specified by ENGINEER - IN - CHARGE. The size of tiles shall be as specified or as directed in the drawing and shall be of appropriate minimum thickness as mentioned in the item of ceramic tile flooring & dado in BOQ. No chipped, cracked, crazed or warped tiles shall be used. Glazed rounded corners and cups (convex or concave) shall be provided at corner of walls, edge, junctions of floor and dado etc., if so specified. The mortar shall be in the proportion 1:4. (Cement : Sand)

32.3 Laying

The fixing shall generally conform to IS : 1443.

32.4 Workmanship

The surface to be covered shall be plastered rough to a thickness of 12 mm. Fix 12 mm size stone chips (5 nos. one in each corner and one in the middle of each tile with Adhesive viz., Areldite or equivalent for keying action) or with approved chemical of reputed brand and the tiles shall be soaked in water for at least 2 (two) hours prior to fixing at site. A thin layer of cement paste shall be buttered on the back of the tile and on the side after which the tile shall be pressed and tapped home taking care that the corner tiles are perfectly matching. After the backing coat has set the tile joints shall be grouted with neat, white cement slurry with necessary pigment. All surplus slurry that remains on the surface shall be carefully wiped off before it sets. Care shall be taken to ensure that the finished surface is absolutely plumb and to proper levels without any profusions , waviness or zig- zag. Joints between tiles shall be uniform in straight level lines. After completion of the entire work or part of it , the surface shall be cleared of all stains , cement etc., by washing with oxalic acid (1:10) or any other approved compound.

32.5 Fixing tiles

The dado work, shall be done only after fixing the tiles / slabs on the floor. The approved glazed tiles before laying shall be soaked in water for at least 2 hours. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff.

The back of the tile shall be covered with this layer of cement mortar 1:3 using fine sand (table III, zone IV, IS383-1963), and the edge of the tile smeared with neat white cement slurry. The tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from bottom of wall upwards without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. The tiles shall be jointed with white cement slurry. Any thickness difference in the thickness of the tiles shall be arranged out in cushioning mortar so that all tiles faces are in one vertical plane. The joints between the tiles shall not exceed 1.00 mm in width and they shall be uniform.

While fixing tiles in dado work, care shall be taken to break the joints vertically. The top of the dado shall be touched up neatly with the rest of the plaster above.

After fixing the dado / skirting etc. they shall be kept continuously wet for 7 days.

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 Contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

32.6 Cleaning

After the tiles have been laid in a room or the day fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting over shall be washed thoroughly clean. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When dry, 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.

32.7 Pointing and Finishing

The joints shall be cleaned off with wire brush to a depth of 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement and floor kept wet for 7 days and then cleaned. Finished floor shall not sound hollow when tapped with a wooden mallet.

32.8 Testing of the tiles

The tiles used for dado including border tiles are to be tested as per IS 13630 from Part I to Part 13 whichever is applicable. In the periodicity of the testing shall be one set of tiles for every 300 Sqm of dado area and part thereof. The tiles used for the flooring are to be tested as per IS 13630 from Part I to Part 13 whichever is applicable and in case of it's periodicity of testing may be done as one set of tiles for every 100 sqm and part thereof. The Contractor shall submit the test certificates of the manufacturer (s). Over and above , sample testing shall have to be done as directed by ENGINEER - IN – CHARGE at the risk and cost of the Contractor from Govt. laboratories / testing houses .

33.0 Vitrified Tiles

33.1 Vitrified Tiles in Flooring

The Vitrified tiles wherever shown on drgs / schedule of finishes shall be polished / satin matt finished of sizes 595 x 595 mm not less than 10 mm thick, jointed in neat white cement and pointed in white cement with pigment to Match. The colour / shade of the same shall be as approved by PM nearly matching with colour / shade if specified in drawings. Tiles shall be of first quality of Group B1 a confirming to IS: 13006/EN 176 Group B1a. The tiles shall be laid on 10 mm thick cement mortar (1:3) over 20mm thick PCC (1:2:4 type BO over neat cement slurry @3 kg / sq.m over RCC slab in first and subsequent floors. In the ground floor, the tiles shall be laid on 10 mm thick cement mortar (1:3) over 20mm thick PCC: (1:2:4) type BO over 75 mm thick PCC (1:4:8) type D-2 over rammed earth. Tiles shall be laid as per pattern shown on drawing or as directed by PM.

33.2 Vitrified Tiles in Skirting

Where shown on drawings/Schedule of finishes provide skirting of glazed vitrified tiles of specified size (or nearest available size) & specified thickness and height with shade matching with floor or as approved by PM. The tiles shall be laid over 10mm thick screed of cement mortar (1:3) set and jointed in neat cement slurry and pointed in white cement with pigment to match. Tiles shall be of first quality. The workmanship and laying of tiles shall be all as specified in clause 13.41 of MES Sch 2009 Part-I on page 306.

33.0 CHEQUERED TILE FLOORING

33.1 Chequered Tiles

The tiles shall be of nominal sizes such as 20 × 20 cm, 25 × 25 cm and 30 × 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in-Charge. The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm. The overall thickness of the tiles shall not be less than 30 mm. The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered tiles shall be cement tiles, or terrazo tiles as specified in the description of the item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm. The terrazo tiles shall be given the first grinding with machine before delivery to site. The tiles shall conform to the specifications for plain cement concrete or terrazo tiles in respect of method of manufacture and the mix of the backing and wearing layers.

33.2 Laying, curing, Polishing and Finishing shall be as specified in 11.10.2 and 11.10.3 except that the polishing of the tiles and the chequer grooves, after laying, may be done by hand. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion of the tiles. Cement concrete tiles normally do not require polishing but where polishing is required the same shall be done as described above.

33.3 Measurements

33.1 Terrazo tiles flooring with tiles manufactured from ordinary grey cement without pigment and coloured terrazo tile flooring shall be measured separately according to para 11.6.5 Terrazo tile flooring shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm before laying skirting, dado or wall plaster shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room or courtyard.

33.2 Terrazo tile flooring laid in floor borders and similar band shall be measured under the item of terrazo tile flooring. Nothing extra shall be paid in respect of these and similar bands formed of half size or multiplies of half size standard tiles or other uncut tiles.

33.3 Treads of stairs and steps paved with tiles without nosing, shall also be measured under flooring. Moulded nosing shall be paid in running metre except where otherwise stated, returned moulded ends and angles to mouldings shall be included in the description. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm.

33.4 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above. Where cement mortar bedding is used in place of lime mortar the rate will be adjusted accordingly.

34.0 Granite Floor and Cladding

34.1 Sampling

Granite need for floor & cladding work shall be sampled and criteria for selection shall conform to IS 3376-1974 and IS 14223 (Part-I):1995 and as per PWD specification .

Variation efface dimensions on any granite shall not exceed 1 mm in 900 mm

Total variation of thickness on any granite shall not exceed ± 3 mm

Any bow or twist on finished faces of any stone shall not vary from the plane by a dimension exceeding 1 mm in 1200 mm.

All granite, unless otherwise designed, shall stand up square at all face corners so that any deviation in length or heights dimensions is reasonably uniform.

Water absorption shall be maximum 0.5 with a dry density of 2.60 to 2.68 .

34.2 Cutting, Drilling and Fitting

Provide holes required for anchors, cramps, dowels and other devices requires to support stone and to accommodate other items that connect to or penetrate the stone.

Include all cutting, drilling and fitting of stonework required to accommodate the work of other trades. In cutting and fitting, carefully cut and grind edges to a neat tight fit. Execute cutting in such a manner so as not to impair strength or appearance of stone. Use physical templates from the proper trade for all cutting and drilling of work.

34.3 Treatment of Granite

Mortar mixes, setting beds, leveling screed and joint sealant shall be as specified and to approval.

Where required granite joints shall be sealed with joint sealant.

Where required shall be grouted with Elastiment Grout.

Fabric mesh reinforcement shall be incorporated in the leveling screed exceeding 75 mm thick.

Leveling screed shall be laid to the required thickness as indicated in the Contract Drawings or as required by the Architect.

34.4 Setting Generally

When ready for setting, all stone units shall be clean and free from stains, dirt or dust. If necessary scrub face with mild soap and clean water applied with stiff fibre brushes. Rinse well with clean water.

Keep exposed faces of stone units free of mortar or joint sealant. And mortar or joint sealant that gets on exposed faces shall be immediately removed. To prevent marking of stone masking tape shall be applied to either side of the joint. The materials, labours etc deemed to have been included in the rate quoted by the Contractor and no claim in this regard shall be entertained by ENGINEER - IN - CHARGE.

35.0 Vinyl Sheet Flooring

Providing and installing impregnated Polyurethane reinforced (PUR) Vinyl Sheet Flooring 6. feet (1.83 m) wide, having a nominal total thickness of [0.08 in. (2 mm)]. The nominal thickness of the wear layer would be [0.08 in. (2 mm)]. The wear surface shall consist of . impregnated polyurethane homogeneous mixture of PVC, Plasticizers, Urethane, color pigments and filler calendared to form a sheet.. Colors and pattern detail shall be dispersed throughout the thickness of the wear layer. Vinyl sheet shall conform to the requirements of BS EN 649:1997, "Standard Specification for Vinyl Sheet Floor Covering without backing." Accolade Plus shall conform to Group P of Wear Resistance as per EN 660-2, Fire Resistance of more than 11kV/m² as per ISO 9329-1 Critical Radiant Flux, Slip resistance of R9 as per Oil Wet Ramp test (AS 4586). The sheet can be used in Very High traffic in Commercial and in Heavy traffic in Industrial applications as per EN 685.

35.1 Installation:

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be leveled by self leveling compound. The moisture level present in the subfloor should be less than 8% before installation of the floor. The sheet should be laid using water based adhesive like VC 31 of Pidilite or similar. The installation shall be undertaken as per the manufacturer's installation instructions.

36 KHURRAS

36.0 The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm unless otherwise specified in the description of the item and shall be made of cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

36.1 Laying

36.1.1 A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminium foil of 32 SWG) shall be laid under the khurra and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

36.1.2 The concrete shall be laid to a size greater than the stipulated size of the khurra in such a way that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

36.1.3 The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement : 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the Engineer-in-Charge.

36.1.4 In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the Engineer-in-Charge. Iron gratings, shall be of overall size 20 × 25 cm. with an outer frame of 15 × 3 mm M.S. flat to which 4 Nos Tenderer's Signature and Stamp

M.S. bars of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm. or as directed by the Engineer in Charge.

36.2 Measurements

Khurras shall be counted in numbers.

36.3 Rate

The rate is for each completed khurra of the specified size and is inclusive of the cost of all materials and labour in forming the khurras and outlet opening as described above, except for iron gratings which shall be paid for separately.

37 CEMENT CONCRETE GOLA

37.1 Cement Concrete

The specifications for concrete shall be the same as described in subhead 4.0 of concrete work.

37.2 Gola

A chase of 75 mm wide and 75 mm deep shall be cut in the parapet wall just above the junction of mud phuska or lime concrete with parapet wall and it shall be filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm and down gauge) the external face finish with a slope of 1 : 0.75 and the exposed surface of the gola shall be plastered with cement mortar 1 : 3 (1 cement : 3 fine sand). Expansion joint at every 3.5 to 4.5 metres shall be provided and filled with bitumen filler. The bitumen filler shall be prepared by mixing bitumen, cement and coarse sand in the ratio of 80 : 1 : 0.25 (80 kg of hot bitumen : 1 kg of cement and 0.25 cum of coarse sand).

37.3 Curing

The finished surface shall be cured for at least 7 days.

37.4 Measurements

The length of the finished gola shall be measured at its junction with the wall face correct to a cm. No deduction shall be made in measurements for gaps for water outlets.

37.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including the cost of bitumen filler in expansion joint. The rate includes for all turnings and roundings at all the corners and risers.

38 THERMAL INSULATION FOR ROOFING

38.1 With Cellular Concrete

38.1.1 Types and Grades: Cellular concrete is a light weight concrete formed by producing gas or air bubbles in cement slurry or a cement sand slurry. Cellular concrete shall conform to IS 6598 and shall be of following two types depending on the manner of manufacture.

- (i) Type I: High pressure steam cured (auto-claved) materials in the form of precast blocks.
- (ii) Type II: Materials cured under natural conditions (that is under ambient pressure and temperature) by water. The material may be either cast in situ or may be in the form of precast blocks. Grades - Each of these two types of the material shall have three grades, namely:

Grade A - Light weight cellular concrete;

Grade B - Medium weight cellular concrete and;

Grade C - Heavy weight cellular concrete.

38.1.2 Materials

(a) *Aggregate*: A variety of silicious fines, such as ground quartz sand shale, flyash and granulated slag may be used in the manufacture of cellular concrete.

(b) Water and binder shall conform to para 3.1.1 and 3.1.2 of Specifications.

LIST OF MANDATORY TESTS

<i>Material</i>	<i>Clause</i>	<i>Test</i>	<i>Field/ laboratory test</i>	<i>Test procedure</i>	<i>Min. quantity of material for carrying out the test</i>	<i>Frequency of testing</i>
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>
Water	3.1.1	(i) pH Value (ii) Limits of Acidity (iii) Limits of Alkalinity (iv) Percentage of solids (a) Chlorides (b) Suspended matter (c) Sulphates (d) Inorganic solids (e) Organic solids	Lab Lab Lab Lab Lab Lab	IS 3025	-	Water from each source shall be got tested before the commencement of work and thereafter once in every three months till the completion of the work. Water from municipal source need be tested only once in six months. Number of Tests for each source shall be 3
Cement	3.1.2	(a) Physical Requirement (i) Fineness (ii) Soundness (iii) Setting time	Lab Lab Lab	IS 4031 (Part II) IS 4031 (Part III) IS 4031	Each lot	Every 50 tonnes or part thereof. Each brand of cement brought to site shall be tested as per

	(Initial & Final)		(Part V)		this frequency.
	(iv) Compressive Strength	Lab	IS 4031 (Part VI)		
	(v) Consistency of standard cement paste	Lab	IS 4031 (Part VI)		

(c) *Gassing Agents*: Organic foaming agents based on resin soap, glue, surface active agents, or fine aluminium powder, zinc, dust, calcium carbide, calcium by pocheride etc. may be used for gassing the concrete.

38.1.3 Dimensions : The dimensions of the type I and type II precast cellular concrete block shall be either 50 or 60 cm in length, 20, 25 or 30 cm in width and 7.5, 10, 15, 25 or 40 cm in thickness.

38.1.3.1 Tolerance : A tolerance of ± 3 percent shall be allowed on width and height and ± 1 percent on thickness.

38.1.4 Requirement for Cellular Concrete

TABLE 12.9

S. No.	Characteristics	Grade	Grade	Grade	Test reference
		A	B	C	
1	Density in kg/cum	Upto 320	321 to 400	400 to 500	IS 5688
2	Crushing Strength in kg/sq. cm. (type I) (type II)	7.0 2.5	12.0 4.5	20.0 8.0	-do-
3	Thermal conductivity in kw/cm deg c at 50 deg. c mean temperature	0.7	0.85	1.0	IS 3346
4	Capillary absorption not to exceed 20% in case of type I cellular concrete when tested as per Appendix A of IS 6598.				

38.1.5 Sampling: In a consignment, cellular concrete of the same type and grade and manufactured approximately in the same period shall be grouped to form a lot. If it is in the form of blocks, a lot shall be made up of not more than 1000 blocks. If the material is in situ, not more than 10 tons of materials shall constitute a lot. If the material is transported in lorries and received as such, the material in lorry (or vehicle load) & may conveniently be termed as lot.

Each lot shall be tested for all the requirements separately. If the lot is made up of precast blocks, the number of sample blocks to be tested shall be selected at random as per the following Table 12.10.

TABLE 12.10

<i>Lot Size</i>	<i>Sample size (block to be sampled) (n)</i>	<i>Permissible No. of defectives (visual and dimensional requirements) (a)</i>
Up to 100	5	0
101 to 300	8	0
301 to 500	13	0
501 to 1000	20	1

38.1.6 General : Cellular concrete if done with precast blocks shall be laid on terrace slab after thoroughly cleaning the surface. The blocks shall be laid over a layer of 12 mm average thick cementmortar 1:4 (1 cement : 4 coarse sand) and the joints shall also be filled properly with neat cement slurry. The joints shall be staggered. Thickness of joints shall be as minimum as possible and not more than 5mm.

38.1.7 Measurements : Length and breadth of the roofing insulation shall be measured correct to acm and the surface area worked out in square metre of the finished work. No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

38.1.8 Rate : The rate shall include the cost of all materials and labour required in providing cellular concrete.

39 FALSE CEILING AND PARTITION FRAMES

This work shall be done as specified in 9.3 except that the scantlings need not be planed unless otherwise specified.

39.1 TRUSSES

39.1.1 The work shall be carried out as per detailed drawings and as directed by the Engineer-in-Charge specified timber shall be used. Sawing shall be truly straight and square, and in the direction of the grains. The scantlings shall be accurately planed smooth to the full dimensions and rebate roundings and mouldings shown in the drawings, before the same are framed. Patching or plugging of any kind shall not be permitted. A tolerance of +3 mm and -2 mm shall be allowed in the finished cross sectional dimension.

39.1.2 Joints

Joints shall be simple, neat and strong. All mortise and tenon joints, mitred joints, scarfs etc. shall fit in fully and accurately without wedging or fillings. The joints shall be as per detailed drawings. Holes of correct sizes shall be drilled before inserting screws/bolts. Driving in screws with hammer is prohibited. Holes for bolts shall be of uniform diameter. The screws, bolts and nails shall be dipped in oil before using. The heads of nails and screws shall be sunk and puttied or dealt with as instructed by Engineer-in-Charge. The gauge and length of nails, screws and bolts shall be approved by the Engineer-in-Charge before using on works.

39.1.3 Shaping Form and Cutting

The wood sections, as specified or required, shall be straightened, cut square and to correct lengths. A fine accuracy shall be ensured in the fabrication of various member so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true to shape and free from twist, kinks, buckles or open joints.

39.1.4 Fabrication

As per drawing, a full size truss diagram shall first be drawn on a levelled platform. From this full size diagram, templates of all joints as for tenons, mortises, scarves etc. shall be made for use in the fabrication. The template shall be made to correspond to each member and plate holes for screws and bolts shall be marked accurately on them and drilled. The templates shall be laid on wooden members and the holes for screwing and bolting marked on them. The ends of the wooden members shall also be marked for cutting. The base of columns and the position of anchor bolts shall be carefully set out. Before fabrication of the truss individual members shall be assembled together to ensure close abutting or lapping of the surfaces of the different members and fitted close together as per drawing.

39.1.5 Hoisting and Placing in Position

The trusses shall be hoisted and placed in position carefully, without any damage to itself and other building work and injury to workman. The trusses shall be secured to walls by means of holding down bolts or as directed by the Engineer-in-Charge. The necessary mechanical appliances such as lifting tackle, winch etc. for hoisting the truss shall be used. The trusses shall be stayed temporarily till they are permanently secured in position and connected with each other by means of purlins. Holding down bolts cleats used for purlins and bottom plates used for tie and rafter member shall be paid for separately.

39.1.6 Surface Treatment

Wood work shall not be painted, oiled or otherwise treated before it has been approved by the Engineer-in-Charge. All portions of timber built into or against or close to masonry or concrete or buried in ground shall be given two coats of boiling coal tar. All junctions of rafters, purlins, beams and wall plates shall be painted with approved wood primer.

39.1.7 Measurements

Wood work shall be measured for finished dimensions. No allowance shall be made for dimensions supplied beyond those specified. Length of each piece shall be measured over all nearest to a cm, so as to include projections for tenons, scarves or mitres. Width and thickness shall be measured to the nearest mm. Cubical contents can be worked out in units cubic meters upto 3 places of decimal in whole numbers.

39.1.8 Rate

The rate includes the cost of materials and labour involved in all the operations described above. Unless otherwise specified, iron fixtures such as bolts and nuts, M.S. steel plates, holding down bolts and staining, priming, painting or polishing of the work shall be paid for separately.

40.0 Plastering

Plastering work in general shall proceed from top to bottom. An entire unobstructed area shall be plastered in one operation. The surface to be plastered shall be thoroughly cleaned, watered and roughened to provide key. Joints in brick work shall be raked out and cleaned. The surface shall be watered and well wetted for at least 24 hours before the commencement of work. The entire plastered work shall be truly vertical and to proper lines and levels. All exposed angles shall be carefully flushed to provide neat and even surface. Any work that does not conform to approved samples or is not to the satisfaction of ENGINEER - IN - CHARGE shall be rejected and the Contractor shall be liable to redo the work at his own cost. Cement sand plaster will be used. Sand will be coarse or fine (Zone-III). Where waterproofing compound is specified to be provided in mortar for plaster, approved integral waterproofing compounds shall be used. These shall be used and plastering work shall be carried out strictly as per manufacturer's recommendations.

40.1 Neat Cement Plaster, Skirting and Dado

40.1.1 General

The skirting shall be flushed with wall plaster or projecting out uniformly by 6 mm from the wall plaster, as specified. The work shall be preferably carried out simultaneously with the laying of floor.

40.1.2 Preparation of wall surface

The joints in masonry shall be raked out to a depth of at least 12 mm, while the masonry is being laid. In case of concrete walls, the surfaces shall be roughened by hacking. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced. The wall rendering shall be neatly cut in a straight line parallel to the floor at the height of the top of the skirting and dado before fixing the skirting.

40.1.3 Application

Skirting with specified mortar and of specified thickness of not less than 18 mm shall be laid immediately after the surface is prepared. It shall be laid along with the border or adjacent panels of floor. The joints in skirting shall be kept true, and straight in continuation of the line of joints in borders or adjacent panels and the skirting shall be finished smooth and true with top truly horizontal and vertical joints truly vertical except where otherwise indicated.

40.1.4 Finishing

The finishing of surface shall be done simultaneously with the borders of the adjacent panels of floor. A floating coat of neat cement slurry shall be applied uniformly over the area for smooth finishing at the rate of 2 kg. of cement per litre of water applied over an area of 1 sq.m

40.1.5 Curing

Curing shall be commenced on the next day of finishing when the plaster has hardened sufficiently and shall be continued for a minimum period of 7 days.

40.2 Measurements

40.2.1 General

All the rates quoted by the Contractor shall be for a fully finished item of work and shall include for all material, labour, miscellaneous works like storage, loading / unloading, scaffolding, hoisting gear etc. as also all taxes, duties, overheads, profits, etc. complete. The measurement of all items shall be guided by PWD specification, in general.

40.2.2 Plastering

Accounts on plastering shall be settled on the basis of square metre, as arrived at from pertinent plans and for a particular type of plaster. Accounts shall be settled on the basis of dimensions of raw structure. Grooves, notches, drip notches etc. shall be provided in plaster free of cost, wherever indicated by ENGINEER - IN - CHARGE or shown in drawings. Similarly, no special compensation shall be paid for plastering in recesses, grooves, etc. shall be accounted for under relevant item of work. However, providing cleavage or similar miscellaneous works shall be deemed to have been include in the rates quoted by the Contractor and shall not be separately paid for.

41.0 Painting

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

41.1 Erection

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc.

shall be used. The suitability and capacity of all plant and equipment used for erection shall be upto the satisfaction of the Engineer-in-charge.

41.2 Measurements

The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 10.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower side than permissible variation shall not be acceptable. Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gussets (taking overall square dimension) fish plates, etc. shall be added to the weight of respective items. In riveted work allowance is to be made for weight of rivet heads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivet heads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm. The weight of steel sheets, plates and strips shall be taken from relevant Indian standards based on 7.85 Kg/m² for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

41.3 Rate

Rate includes the cost of labour and materials required for all the operations described above.

42 V- Groove line (12 mm wide, 12 mm deep) in plastered surface

43 Closing gap between door and window frame and jambs with cement mortar (1:3) including removing old mortar (throughout entire surface of contact) and cleaning the joint. (cement 0.012 Cu.m/100 Mtr)

44.0 ALUMINIUM WORK

44.0 TERMINOLOGY

Bar

Any solid section, other than round, with at least one dimension of 10 mm or more.

Rod

Any round solid section with a diameter of 10 mm or greater.

Extruded Round Tube

A circular hollow extrusion of uniform wall thickness not subjected to cold drawing.

Hollow Section

An extruded shape other than round tube, the cross section of which completely encloses a void or voids and which is not subject to cold drawing.

Anodized Aluminium

Aluminium with an anodic coating, produced by an electrolytic oxidation process, in which the surface of the aluminium is covered with a coating, generally an oxide, to give protective and decorative properties.

Tenderer's Signature and Stamp

Pre-laminated Particle Board

A particle board laminated on both surface by synthetic impregnated base papers under the influence of heat and pressure with finished foil under the pressure or pressure and heat depending on type of binder used.

Floor Spring (Hydraulically Regulated)

A device used to close the door so as to slow down its speed before it reaches its closed position.

Single Action Floor Spring (Hydraulically Regulated)

A device used to close the door in one direction only so as to slow down its speed before it reaches to its closed position.

Double Action Floor Spring (Hydraulically Regulated)

A device used to close the door in both directions so as to slow down its speed before it reaches its closed position.

Shoe

The device fixed to the bottom of the door leaf in order to hoist it to the floor spring.

Top Centre Pivot

The device to secure the upper portion of the door leaf and the door frame above.

Right Hand Floor Spring

A floor spring suitable for use on an anticlockwise door; an anticlockwise door is one which when viewed from above, rotates in anticlockwise direction about its hinge while opening.

Left Hand Floor Spring

The floor spring suitable for use on clockwise door a clockwise door is one which, when viewed from above, rotates in clockwise direction about its hinge while opening.

Sash

It is a complete window unit whether fixed or open type.

Composite Window

Window unit having two or more sashes joined together with one or more coupling members.

Centre – Hung Ventilator

A ventilator horizontally pivoted at the centre on both sides. Top half opens inwards and bottom half opens outwards.

44.1 ALUMINIUM

44.1.1 Aluminium Sections

Aluminium sections used for fixed/openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in-Charge for technical, structural, functional and visual considerations. The aluminium extruded

sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304. The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows. Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in-Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in-Charge and nothing extra shall be paid on this account.

44.1.2 Anodising

Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensure uniform coating in uniform colour and shades. The extrusions are anodized up to 30 micron in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard.

44.1.3 Powder Coating

21.1.3.1 Material: The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer-in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

44.1.3.2 Pre-treatment: Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coatings supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer-in-Charge. The metal surface after the conversion coating pre-treatment and prior to the application of the coating shall be free from dust or powdery deposits.

44.1.3.3 Process: The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

44.1.3.4 Thickness: The thickness of the finished polyester powder coating measured by micron meters shall not be less than 50 micron nor more than 120 micron at any point.

44.1.3.5 Performance Requirements for the Finish

(i) *Surface appearance:* The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

(ii) *Adhesion:* When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

44.1.3.6 Protection of Powder Coated / Anodizing Finish : It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

44.1.3.7 Measurement: All the aluminium sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

44.1.3.8 Rate: The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

44.2.3 Float Glass

44.2.3.1 The glass shall be clear float glass and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900.

44.2.3.2 Thickness : The thickness of float glass shall depend on the size of panel. The tolerance in thickness shall be as under:

TABLE 21.2

Nominal Thickness (in mm)	Tolerance (in mm)
4.0	± 0.3
5.0	± 0.3
6.0	± 0.3
8.0	± 0.6

44.2.3.3 Allowable Defects: The allowable defects shall be as per Table 21.3 below:

TABLE 21.3

Sl. No.	Defects	Central	Outer	Remarks
1	Gaseous inclusion. Max size, mm	3.0	6.0	Separated by at least 30.0 cm
2	Opaque gaseous inclusion. Max size. mm	3.0	6.0	Separated by at least 60.0 cm
3	Knots, dirt and stones, Max size. mm	1.0	1.0	Separated by at least 30.0 cm
4	Scratches, Rubs and Crush	Faint	Light	Separated by at least 30.0 cm
5	Bow, percent. Max	0.5	0.5	See 21.2.4.3
6	Reams, Strings and lines	Light	Light	See 21.2.4.3
7	Waviness	Nil	Nil	See 21.2.4.3
8	Sulphur stains	Nil	Nil	
9	Corner breakage and chip	Not more than nominal thickness of float glass		

44.2.3.4 Allowable Cluster of Defects: The allowable cluster of defects mentioned under Sl. No. 1, 2 & 3 of Table 21.3 shall be as per IS 14900.

44.2.4 Tests

44.2.4.1 Thickness: The thickness of float glass shall be measured with micrometers or a caliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.

44.2.4.2 Scratches, Rubs and Crush : Place the sample of float glass in a vertical position approximately 50 cm from the viewer's position and look through it using either day light without direct sunlight or a background light suitable for observing each type of defect.

<i>Intensity of Scratches, Rubs, Crush</i>	<i>Intensity Distance Limit</i>
Faint	Shall not be detectable beyond 50 cm
Light	Detectable between 50-100 cm and not beyond 100 cm.

44.2.4.3 Bow : Depending on the side on which bow is present, stand the sample vertically on a wooden plank. Stretch a thread edge to edge. Measure the longest perpendicular. Distance from the thread to the surface of float glass facing the thread and express it as percentage of the length of float glass from edge along the thread.

44.2.4.4 Reams, Strings and Lines : Focus a light projector with a 500 W lamp and an objective lens with an approximate 5 cm aperture and about 30 cm focal length on a flat white projection screen placed about 760 cm from the light source in a dark room. Place the float glass in a vertical position parallel to the screen between the light and the screen. Move the glass slowly towards the screen with a vertical oscillating motion. The shadowgraph read out is the distance at which the distortion just blends with the general shadow of the glass on the screen.

TABLE 21.4

<i>Intensity of Reams, Strings and Lines</i>	<i>Intensity Distance Limit</i>
Light	7.5 cm
Medium	5.0 cm
Heavy	2.5 cm

44.2.4.5 Perspective Distortion: When tested as per test procedure described below it shall not give distorted vision of straight stripe pattern.

Test Procedure for Perspective Distortion

Perspective distortion shall be examined by looking through the specimen glass which may be placed at about 4.5 m distance in such a direction that the incident angle to it is 50 degree (4 mm or above) and by observing a screen set up perpendicularly to the line of vision about 4.5 m further ahead of the specimen over the total width of about middle part of the specimen from the horizontal direction. The specimen glass shall be kept with the drawn direction at manufacture vertical and, on the surface of the screen, the strip pattern of white and black parallel straight lines of 25 mm width and inclined 45 degrees from the vertical shall be provided and its surface shall be luster less.

44.3 EPDM- GASKETS

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 contractor 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 21.5 below:

TABLE 21.5

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 0 _o CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

44.4 SEALANT

21.4.1 The sealants of approved grade and colour shall only be used. The silicone for perimeter joints(between Aluminium section and RCC/Stone masonry) shall be of make approved by the Engineer inCharge.

44.4.2 Method of Application

Surface Preparation : Clean all joints and glazing pockets by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.

44.4.3 Masking

Areas adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall not be allowed to touch clean surfaces to which the silicone sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

44.4.4 Application

Install backer rod of appropriate size and apply silicone sealant in a continuous operation using a positive pressure adequate to properly fill and seal the joint. The silicone sealant shall be tooled with light pressure to spread the sealant against backing material and the joint surfaces before a skin forms. A tool with convex profile shall be used to keep the sealant within the joint. Soap or water shall not be used as a tooling aid. Remove masking tape as soon as silicone joint is tooled.

Tolerance: A tolerance of + 3 mm shall be allowed in the width of silicone joints. The depth of the joints at throat shall not be less than 6 mm.

44.5 REFLECTIVE GLASS

44.5.1 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 Efficacy Constant (Ke)** indicates a window's relative performance in rejecting 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-value):** 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.

44.5.2 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.

44.5.2.1 Types of Coatings: There are two types of reflective glass, Pyrolytic (Hard) coated and vacuum(soft) coated.

(i) **Pyrolytic** : It is a coating applied during glass manufacture. The coating is fused into the glass at 1200°C.

(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 pyrolytic products.

44.5.2.2 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

44.5.2.3 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) **Lab. Test:** In the lab, the reflective glass shall be tested for the parameter specified in 21.5.2.2 above.

44.5.2.4 Fixing of glass shall be done as specified.

45 Sealant

The gaps between the Aluminium member and the perimeter and also any gaps in the door and window sections themselves shall be raked out as directed and filled with silicon sealant or any other sealant as specified of approved make and colour and make to ensure complete water-tightness.

The silicon sealant shall be of such colour, and composition that it would not stain the masonry/concrete work, shall receive paint without bleeding, will not sag or run and shall not set hard or dry out under any condition of weather. Silicon sealant shall be applied with a special gun as per manufacturers recommendation.

45.0 Aluminium Composite Panel Cladding

Cladding shall be non-toxic composite aluminium panels of adequate strength with approved aluminium details. The panels shall be 4mm thick composite units finished with PVDF (Polyvinylidene difluoride) coating overall 35 micron thick of approved metallic colour. The resin content of the PVDF (Polyvinylidene difluoride) coating shall be 75% to 80%. The back of the panel shall be chromatised 3-4 micron thick, compatible with adhesives for stiffeners if any or given a polymer coating.

The fabrication and installation of the cladding systems shall be carried out as per manufacturer's instructions with invisible/concealed fastenings, aluminium sub-structure, silicon sealants properly tooled etc.

All cladding panels of one kind shall be obtained in one lot from the manufactures.

Each panel shall be guaranteed for a flatness of ± 1 mm from the true face after installation under no-wind conditions. Deviations from the true alignment of adjoining panels shall not be cumulative. Full load deflections shall be kept to the minimum possible. Each panel shall be capable of withstanding 300 Kg/Sq.m wind pressure without any permanent deformation.

The cladding system shall be adequately ventilated. The air-gap between the cladding panels and the concrete /block –wall shall be at least 50 mm to allow proper ventilation of the rain screen system. The cavity shall be closed by a perforated bird/vermin-proof closer at bottom and by a flashing at top or any other method as mentioned in the drawing. The wall behind should be treated with approved water proof paint applied over plastered surface as directed by the ENGINEER - IN - CHARGE.

The fabrication processes including cutting, grooving, benching, folding, root-in as well as installation shall be performed as per manufacturer's instructions. The panels shall be backed by approved aluminium support framework, fixed to wall with aluminium/galvanized steel brackets. Cross warranty attaching the warranty of the manufacturer shall be submitted by the Contractor to ENGINEER - IN - CHARGE in approved form and manual .

The composite Aluminium panels shall satisfy the following fire codes requirements:

BS476	part6	Class	0
ASTM E-84	Flame Spread Index		0
Smoke developed	Index		<15

UBC 26-9 & NFPA for 30 minute Intermediate scale Multi-story Apparatus. Test to prove no flame spread beyond the area directly exposed to fire source.

Sample approval from ENGINEER - IN – CHARGE shall have to be got done by the Contractor prior to bringing the material in bulk at site. Necessary test certificate with warranty from the manufacturer shall have to be submitted by the Contractor. Over and above the submission of test certificate, ENGINEER - IN – CHARGE its discretion may ask for sample testing further in Govt. laboratories / test house at the risk and cost of the Contractor.

46.0 WATER PROOFING TREATMENT

46.0 TERMINOLOGY

Water Bars

Water bars are preformed strips of impermeable materials which are embedded in the concrete during construction.

Low Partition Walls

Parapet walls of height less than 45 cm.

Expansion Joints

Joints provided in the structure to allow for thermal expansion/construction.

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Blended Cement

Cement mixed with water proofing compound in liquid or powder form.

46.1 INTEGRAL CEMENT BASED TREATMENT FOR WATER PROOFING ON HORIZONTAL SURFACE OF UNDER-GROUND STRUCTURE AT ALL DEPTH

46.1.1 Water Proofing of Horizontal Internal Surfaces of Under-ground Structure

(i) Preparation of Surface

The Water Proofing Treatment over the lean concrete/levelling course surface should adhere to the surface firmly, the surface of levelling course should be roughened properly when the concrete is still green. In case the surface is not made rough before the concrete is set, the work of water proofing should not be executed till proper key is provided for the base layer of Cement Mortar 1:3.

(ii) Blending Cement/Water with Water Proofing Compound

The required quantity of cement bags to be used for a particular portion of work should be emptied on a dry platform. Water proofing compound bearing ISI mark and conforming to IS 2645 should then be mixed properly with the cement. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement. The quantity of cement and water proofing compound thus mixed should be thoroughly blended and the blended cement should again be packed in bags. For the water proofing compound in liquid form, the blending is to be done with water. This can be done by taking the just required quantity of water to be mixed in the particular batch of dry cement mortar.

The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water proofing compound from sealed tins with ISI mark. The water thus mixed with water proofing compound shall be thoroughly stirred so that the water is blended with water proofing compound properly.

(iii) Rough Kota Stone 22 to 25 mm Thick

The stone slabs to be used for this item shall be in thickness of 22 mm to 25 mm. Larger size of stone slabs i.e. 550 mm x 550 mm or 550 mm x 850 mm shall be used to minimise the number of joints. General requirement of Kota stone shall be as laid down in CPWD Specifications of Kota Stone flooring.

(iv) Preparation of Cement Slurry

Cement slurry shall be prepared by using 2.2 kg of blended cement per sqm. area. Each time only that much quantity shall be prepared which can be covered on the surface and the surface in turn would be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained unused for more than half an hour shall be totally rejected.

(v) Preparation of Cement Mortar

Cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be prepared with cement/ water duly blended as explained in clause 22.1.1 (ii). Only that much quantity of cement mortar which can be consumed within half an hour, shall be prepared. Any cement mortar that is prepared and remains unused for more than half an hour shall not be used in the work and shall be rejected.

(vi) Laying Water Proofing Course

Before laying the base course of cement mortar 1:3, the lean concrete surface shall be cleaned neatly with water. Cement slurry prepared as per clause 22.1.1 (ii), shall be applied only on the area of the concrete surface, that can be covered with the cement mortar (1:3) base course within half an hour. The cement slurry should cover every spot of the surface and no place shall remain uncovered. Just after the application of cement slurry on the surface, the cement mortar prepared as per clause 22.1.1 (v) should be used for laying the base course. Base Course should be laid to a perfect level with wooden/aluminium straight edge of at least 2 mtrs. long. The top surface of cement mortar should be finished neatly and later scratched when green with a suitable instrument before the base course dries and gets hard that is just before the base course takes up initial set. When the 25 mm thick base course is just getting set the cement

slurry prepared as per clause 22.1.1 (iv) should be spread over the base course upto the area that shall be covered with just two to three stone slabs. The cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap or dry spots. Immediately on applying cement slurry on the base course the Rough Kota Stone slab shall be laid over the base course and pressed gently so that the air gap can be removed. The slurry applied on the surface which gets spread when the stone slab is pressed shall get accumulated in the joints of adjacent stone slabs and if any gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry. For laying the stone slabs in perfect level, two stone slabs at adjacent concerns/ends shall be fixed firmly to the required level and a string stretched over the two slabs, the intermediate slabs shall then be set to the level of the string.

After filling all the joints of the Rough Kota stone Slabs with cement slurry the area of stone slab shall be laid with cement mortar 1:3. The surface of stone slabs shall be cleaned and lightly watered. Cement mortar 1: 3 prepared as per clause 22.1.1 (iv) shall be used for laying this course. For laying this course 25 mm high wooden strips shall be used and the top surface shall be finished smooth without using additional cement or slurry.

After laying 3rd course and before the mortar layer takes the initial set, Stone aggregate of 10 mm to 12 mm nominal size shall be uniformly spread and lightly pressed into the finished surface @ 8 cumm./sqm. The aggregates shall not be embedded totally inside the mortar and shall be visible on the top surface. In cases where slope is to be provided for the water proofing layer, grading with additional cement concrete/cement mortar shall be provided and then the water proofing layer shall be laid on the graded surface. Extra payment shall however be made for the grading course.

(vii) *Curing*

Immediately after completing the fourth layer, arrangements shall be made for the top RCC slab as quickly as possible and in the mean time till the top slab is casted the water proofing treatment shall be kept wet continuously. In case the concreting of slab gets delayed for more than 2 weeks the curing can be stopped after 14 days.

(viii) *Measurement*

Length and breadth shall be measured along the finished surface correct to a cm and the area shall be worked out to nearest 0.01 sqm.

(ix) *Rate*

The rate shall include the cost of all labour & materials involved in all the operations described above. The cost of grading with cement concrete / cement mortar shall be paid for separately.

46.1.2 Water Proofing of Internal Horizontal Surfaces of Under-ground Structure

Same as in 46.1.1 above except that water proofing courses will be laid on R.C.C. Slab.

46.2 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT ON THE VERTICAL SURFACE OF UNDER GROUND STRUCTURES

(i) *Preparing the Surface*

The surface of the structure to be treated shall be roughed either by raking of joints in case of brick/ stone masonry or by hacking the cement concrete surface with a specifically made hacking tool just after removing shuttering. Alternately, the surface should be roughened by providing spatter dash key as explained under clause 22.1.1 (i). While doing water proofing to vertical faces from inside, it shall be ensured that water proofing treatment of floor slab is not damaged. Preferably, water proofing of vertical surface shall be done before that of horizontal surface.

(ii) *Blending Cement/Water with Water Proofing Compound*

Same as under clause 46.1.1(ii).

(iii) *Rough Kota Stone Slab*

Same as explained under clause 46.1.1(iii).

(iv) Preparation of Cement Slurry

Same as explained under clause 46.1.1(iv).

(v) Preparation of Cement Mortar

Same as explained under clause 46.1.1(v).

(vi) Laying Water Proofing Course

Same as explained under clause 46.1.1(vi). Further rough kota stone are not sufficiently rough to remain in vertical position held by cement slurry. Therefore, the grip for the stone slab has to be increased and this can be done by planting 12 mm to 15 mm nominal size stone aggregate fixed with araldite on surface of each sand stone slab.

(vii) Curing

Same as explained under clause 46.1.1(vii). Further till the water proofing work on vertical face is in progress, the water proofing work done on floor slab shall be kept wet for a minimum period of 14 days. Immediately after completion of water proofing on vertical faces of side walls, the water tank shall be gradually filled with water for testing.

(viii) Measurement

Same as explained under clause 46.1.1(viii).

(ix) Rate

Same as explained under clause 46.1.1(ix).

46.3 WATER PROOFING TREATMENT TO VERTICAL AND HORIZONTAL SURFACE OF DEPRESSED PORTION OF WC, KITCHEN AND THE LIKE

46.3.1 Before the Water Proofing Treatment

Before the water proofing treatment, the internal plaster of ceiling and walls of WC block leaving the portion for dado/skirting should be completed. Grooving / chasing for doing the concealed work of GI/CI pipes/Electrical conduits should be completed. Cleaning the depressed/sunken portion of WC of all debris, extra mortar sticking to the vertical and horizontal surface etc. Necessary holes for 'P' trap /Nhani trap/Water escape pipe etc should be completed.

46.3.2 Preparing Surface and Fixing Pipes and Fittings

Before the water proofing treatment work, proper key in the concrete surface should be provided. The depressed/sunken portion should be hacked by a hacking tool, after the concrete slab is cast and when this concrete is still green. The vertical surfaces of the depressed /sunken portion should be hacked with a hacking tool just after the shuttering is removed.

In case of old work, the water proofing treatment on such surfaces shall be permitted after making proper spatter dash key.

Fixing the 'P' trap in position and all other pipes work including the water escape pipe shall be fixed properly and the holes should be plugged carefully before taking up the water proofing work.

46.3.3 1st Course

Cement duly blended with water proofing compound as explained in clause 22.1 shall be used for preparing the cement slurry.

The consistency of the slurry should be such that 4.4 kg. of blended cement with water proofing compound is used per sq. metre area of surface to be treated. The slurry should be started from the vertical faces towards the bottom of the floor as shown in Fig. 22.4. Particular care should be taken to see that the slurry is applied to corners without leaving any gap.

46.3.4 2nd Course

Immediately on applying the blended cement slurry on the surface to be treated cement plaster 20 mm thick in CM 1:3 (1 blended cement: 3 coarse sand) shall be applied both on vertical and horizontal surfaces
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taking particular care to complete the entire depressed/ sunken portion of WC within a day so that the plaster can be done without any joint. Junctions shall be properly rounded. The surfaces of the plaster shall be left rough but finished in one plain and cured for a week. On completion of the curing period both horizontal and vertical surfaces shall be cleaned properly and gently and allowed to dry.

46.3.5 3rd Course

Only after the surface is completely dried the blown or residual bitumen shall be applied @ 1.7 kg. of bitumen per sqm area.

46.3.6 4th Course

PVC sheet 400 micron thick shall be spread evenly without any kink immediately, so that the PVC sheet sticks to the surface firmly. PVC sheet shall be continued to be laid over the main slab upto 100 mm.

Overlapping of PVC sheet should be done with a minimum overlap of 100 mm, duly pasting the overlapped sheet with an application of bitumen @ 1.7 kg./ sqm.

The projections of pipes and 'P' trap outlet etc. inside the depressed/sunken portion of WC shall also be cladded with water proofing treatment layer upto a height of 150 mm, using a coat of bitumen with PVC sheet complete. The surfaces of depressed/sunken portion of WC shall not be left without covering with specified filling material and base concrete, otherwise the PVC sheet layer may be tampered by the labour working in the vicinity. Fixing up of WC pan, filling specified material and the top base concrete should be done as early as possible and the top horizontal layer of water proofing may be taken up later i.e. just before laying the floor tiles.

46.3.7 Measurement

Length and breadth shall be measured along the finished surface correct to a cm. and area shall be worked out to nearest 0.01 sqm. No payment however shall be made for the 100 mm overlap of PVC Sheet over the roof slab.

46.3.8 Rate

The rate shall include the cost of labour and materials involved in all the operations described above.

.46.4 WATER PROOFING TREATMENT IN SUNKEN PORTION OF WCs, BATHROOMS ETC.

46.4.1 Preliminaries to be Attended

The preliminaries shall be attended as described in clause 46.3.1.

46.4.2 Preparing Surface, Fixing Pipes and Fittings

In this case, unlike as described in clause 46.3.2, no hacking of surface need be made, but only extra mortar sticking to the surface should be removed and the surface should be cleaned thoroughly. Fixing 'P' trap etc. shall be done as described in Clause 46.3.2.

46.4.3 Providing and Laying of Slurry for First Layer

The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application.

The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

46.4.4 Providing and Laying of Slurry for Second Layer

The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. cement + 0.126 kg. water proofing compound + y litres of water per sqm. Area and the required quantity of slurry thus prepared should only be used for second application. The

application of 2nd layer of slurry is same as for first layer as detailed in clause 46.5.3. The applied surface shall be allowed to air cure for 4 hours and thereafter water curing shall be done for full 48 hours. In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer for which separate payment shall be made to the contractor.

46.4.5 Measurement

Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

46.4.6 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above. The cost of plastering shall be measured and paid for separately.

47.7 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT WITH BRICK BAT COBA

47.7.1 Before taking up the work the preliminaries to be attended shall be exactly same as described in clause (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 tack the fibre 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) .

47.7.2 Preparing the Surface

The surface of the slab should be roughened by scrapping when the slab concrete is still green, however, the surface need not be hacked. In case the slab is already cast and surface fairly finished, the same shall be cleaned neatly of all mortar droppings, loose materials etc with brooms/cloth.

47.7.3 Providing and Laying of Slurry under Base Coat

The quantity of water required to prepare the slurry with 2.75 kg. of blended cement to be painted over an area of 1 sqm. shall be calculated exactly as described in clause(**Providing and Laying of Slurry for First Layer**) The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application. The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.)

Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement.

The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc. The application of the slurry should continue upto a height of 300 mm on the parapet wall and also the groove. The slurry should also be applied upto a height of 150 mm over pipe projections etc.

47.7.4 Laying Base Coat 20 mm thick

Immediately after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5 (1 blended cement : 5 coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

47.7.5 Laying Brick Bat Coba

Brick bat of size 25 mm to 115 mm out of well burnt bricks shall be used for the purpose of brick bat coba. The brick bats shall be properly dampened for six hours before laying. Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15-25 mm gap between two bats. Cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be poured over the brick bats and joints filled properly. Under no circumstances dry brick bats should be laid over the base coat. The haunches/gola at the junction of parapet wall and the roof shall be formed only with brick bat coba. In case the brick bat coba is laid on the base coat immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba. However, if the brick bat coba is to be laid on the subsequent day, cement slurry prepared as described in clause **(Providing and Laying of Slurry under Base Coat)**

The quantity of water required to prepare the slurry with 2.75 kg. of blended cement to be painted over an area of 1 sqm. shall be calculated exactly as described in clause (The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application. The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours).

Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement.

The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc. The application of the slurry should continue upto a height of 300 mm on the parapet wall and also the groove. The slurry should also be applied upto a height of 150 mm over pipe projections etc.) shall be applied over the top surface of the base coat, then only the brick bat coba shall be laid.

47.7.6 Application of Slurry over Brick Bat Coba

After two days of curing of brick bat coba cement slurry prepared as per clause **(Providing and Laying of Slurry under Base Coat)** The quantity of water required to prepare the slurry with 2.75 kg. of blended cement to be painted over an area of 1 sqm. shall be calculated exactly as described in clause **Providing and Laying of Slurry for First Layer)** The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application.

The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.). Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement. The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc. The application of the slurry should continue upto a height of 300 mm on the parapet wall and also the groove as shown in. The slurry should also be applied upto a height of 150 mm over pipe projections etc.) shall be applied on the surface of brick bat coba. The application of slurry shall be the same as described in clause **(Providing and Laying of Slurry for First Layer)** The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per

manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application. The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours. 22.5.3 which should cover the haunches/gola, and the remaining small portion of parapet wall and also inside the groove.

47.7.7 Laying Finishing Layer (Protective Coat)

Immediately on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green, the fibre glass cloth as specified in clause 22.6.4 shall be spread evenly on the surface without any kink & pressed to see that no air spaces exist. The fibre glass cloth shall be taken up to a height of 300 mm on parapet walls & tucked in the groove specially prepared at that height. 20 mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended cement: 4 coarse sand) over the entire fibre glass cloth including the haunches/gola and the small portion on the parapet wall. The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove. The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry

prepared as per clause 22.7.3. The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the entire surface.

47.7.8 Curing and Testing the Treatment

The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.

47.7.9 Measurement

The measurement shall be taken along the finished surface of treatment including the rounded and tapered portion at junction of parapet wall. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. No deduction in measurement shall be made for openings or recesses or chimney stacks, roof lights or khurras of area upto 0.40 sqm., nor anything extra shall be paid for making such openings, recesses etc. For areas exceeding 0.40 sqm., deduction will be made in the measurements for the full openings and nothing extra shall be paid for making such openings.

47.7.10 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

48 Foot Rests

All manholes deeper than 0.8 m shall be provided with M.S. foot rests. These shall be embedded 20 cm deep in 20 x 20 x 10 cm blocks of cement concrete 1:3:6 (1 cement: 3 coarse sand 6 graded stone aggregate 20 mm nominal size). The concrete block with M.S. foot rest placed in its centre shall be cast in situ along with the masonry and surface finished with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth.

TABLE

Sizes of drain Top of channel at the centre Depth of benching at side walls
above bed concrete above bed concrete

mm	cm	cm
100	15	20
150	20	30
200	25	35
250	30	40
300	35	45
350	40	50
400	45	55
450	50	60

Foot rests which shall be of 20×20 Sq. M.S. bars as shown in Fig. 19.8 shall be fixed 40 cm apart vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top foot rest shall be 45 cm below the manhole cover.

Foot rests shall be painted with coal tar, the portion embedded in the cement concrete block being painted with thick cement slurry before fixing.

49.0 PILE WORK

49.0 TERMINOLOGY

Allowable Load: It is load which is applied to a pile after taking into account its ultimate load capacity, pile spacing, Overall bearing capacity of the ground, the allowable settlement, negative skin friction including reversal of loads.

Bearing Pile: A pile formed in the ground for transmitting load of a structure to the soil by the resistance developed at its tips and or along its surface. It is either vertical or batter pile. It may be 'End bearing pile' or friction pile if it supports the load primarily along the surface.

Board Compaction Pile: It is bored cast-in-situ with or without bulb. In this compaction of surrounding ground and freshly filled concrete in pile, bore is simultaneously achieved by suitable method. A pile with a bulb is called a "under-reamed bored compaction pile". Under-reamed pile with more than one bulb is called Multi-under-reamed pile.

Constant Rate of Penetration (CRP) Test: The ultimate bearing capacity of preliminary piles and piles which are not used as working piles.

Constant Rate of Uplift (CRU) Test: The ultimate capacity in tension of preliminary piles and piles which are not used as working piles.

Cut of Level: It is the level where the installed pile is cut off to support the pile caps or beams.

Datum Bar: A rigid bar placed on immovable supports.

Draft Bolt: A metal rod driven into hole bored in timber, the hole being smaller in diameter than the rod.

Drop of Stroke: The distance through which the driving weight is allowed to fall for driving the piles.

Factor of Safety: It is the ratio of the ultimate load capacity of a pile to the safe load of a pile.

Follower Tube: A tube which is used following the main casing tube and it requires to be extended further. The inner diameter of the follower tube should be the same as the inner diameter of casing. The follower tube shall preferably be an outside guide and should be water tight when driven in water bearing strata or soft clays.

Initial Test: This test is carried out with a view to determine ultimate load capacity and safe load capacity.

Raker or Batter Pile: The pile which is installed at an angle to the vertical. Raker piles are normally provided where vertical piles cannot resist the required applied horizontal forces. The maximum rake to be permitted in piles shall not exceed – 1 in 8 for cast-in-situ piles of large diameter viz. 750 mm dia., and above. 1 in 5 for smaller dia. cast-on-situ piles.
1 in 4 pre-cast piles.

Routine Test: It is carried out with a view to check whether pile is capable of taking the working load assigned to it.

Safe Load: It is the load arrived at by applying a factor of safety to the ultimate load capacity of the pile.

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Set: The net distance by which the pile penetrates in the ground due to stated number of blows of the hammer.

Spliced Pile: A pile composed of two or more lengths secured together, end to end to form one pile.

Test Pile: A pile which is selected for load testing and which is subsequently loaded for that purpose. This pile may form working pile itself if subjected to a routine load test with up to one and half time the safe load.

Total displacement (Gross): The total movement of the pile under a given load.

Total Elastic Displacement: This is the magnitude of the displacement of the pile due to rebound caused at the top after removal of given test load. This comprises two components as follows:

- (a) Elastic displacement of the soil participating in load transfer; and
- (b) Elastic displacement of the pile shaft.

Trial Piles: These are installed initially to assess the load carrying capacity, it is either tested to ultimate bearing capacity or twice the estimated safe load.

Ultimate Load Capacity: The maximum load which a pile can carry before failure of ground (when the soil fails by shear) or failure of pile materials.

Working Load: It is a load assigned to a pile as per design.

Working Pile: It is a pile forming part of foundation of a structural system.

49.2 BORED CAST-IN-SITU REINFORCED CONCRETE PILES

49.2.1 General

The piles are formed within the ground by excavating or boring a pile within it with or without the use of temporary casing and subsequently filling it with plain or reinforced concrete. When the casing is left permanently it is termed as cased pile and when the casing is taken out it is termed as uncased pile.

49.2.2 Equipment

The equipment and accessories used for bored cast-in-situ piles shall depend on subsoil strata, ground water conditions, type of founding material and penetration etc. General requirements of boring equipment are as per Appendix 'D'. The equipment is applicable for bored piles without the use of bentonite.

49.2.2.1 Boring operation shall be done by rotary percussion type drilling rigs using direct mud circulation or reverse mud circulation methods to bail out the cuttings or as specified. In soft clays and loose sand, bailer and chisel method should be used with caution to avoid the effect of suction. Rope operated grabbing tool Kelly mounted hydraulically operated grab are also used. This method of advancing the hole avoids suction. The size of cutting tool shall be as per [IS 2911 (Part I Section 2)] and not less than the diameter of pile by more than 75 mm.

49.2.2.2 Use of drilling mud is stabilizing sides of bore hole where specified shall have properties as defined in Appendix A. Permanent casing where specified shall be used to avoid aggressive action of water.

49.2.3 Boring for installing Pile

49.2.3.1 Installation of Piles: Installation of piles shall be as accurate as possible and as per design and drawings. The vertically or the required batter should be correctly maintained. Particular care shall be taken in respect of installing either single pile or piles in two pile groups.

49.2.3.2 Deviation /Tolerance

- (i) The deviation/tolerance should be as per IS 2911 (Part 1/Sec.1). The piles should not deviate more than 75 mm or D/4 whichever is less (75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm) from their designed position at the working level.
- (ii) In case of a single pile under a column, the positional deviation should not be more than 50 mm or D/4 whichever is less (100 mm in case of piles having diameter more than 600 mm). Greater tolerance may be prescribed for piles driven over water and for raking piles.

49.2.3.3 Procedure of Driving Pile Bore

- (i) Bored cast-in-situ concrete piles are installed by making a bore into the ground and removing out the material.
- (ii) The ground shall be roughly leveled and position of pile marked. The boring shall be done with or without the use of temporary casing. The sides of bore hole; shall be stabilized with the aid of temporary casing or with the aid of drilling mud of suitable consistency.
- (iii) The equipment and accessories shall depend upon the type of bored pile chosen for the job, consideration of sub-soil strata, ground water condition, type of founding material. Boring operation normally are done by rotary or percussion type drilling rigs using direct mud circulation on reverse mud tool shall be as detailed in IS 2911 (Part 1/Sec.2).
- (iv) In case permanent/temporary casing is not used then bored pile is stabilised with drilling fluid. Bentonite supplied to site shall conform to IS 2720 (Part V). A certificate shall be obtained by the contractor from the manufacturer showing properties of each consignment and should be submitted to the Engineer-in-charge. Bentonite shall be mixed thoroughly with fresh clean water to make a suspension which will maintain the stability of the pile excavation for the period necessary to place concrete and complete construction. The temperature of the water used in mixing the bentonite suspension and when supplied to bore hole shall not be lower than 5°C. Consistency of the drilling fluid suspension and when controlled throughout the boring as well as in concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with thick suspension of mud. Frequency and methods of testing drilling fluid shall be as specified and the test results shall be as specified in IS 2720 (Part V).
- (v) Bored cast-in-situ piles in soils which are stable may often be installed with a small casing length at the top. A minimum of 2.0 m length of top of bore shall; invariably be provided with casing to ensure against loose soil falling in to drilling mud, or a suitable steel casing. The casing may be left in place permanently especially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of pile could be exposed due to scour.
- (vi) For bored cast-in-situ piles, casing/liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as directed by the Engineer-in-charge. Materials inside the casing shall be removed progressively by air lift, grab or percussion equipment or other approved means.
- (vii) Where bored cast-in-situ piles are used in soils liable to inflow, the bottom of the casing shall be kept low enough in advance of the boring tool; to prevent the entry of soil into the casing, thus preventing the formation of settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimize inflow of water or leakage of slurry during concreting.
- (viii) Boring shall be carried out using rotary or percussion type equipment. Unless otherwise directed by the Engineer-in-charge the diameter of the bore holes shall be not more than the inside diameter of the liner.
- (ix) After the boring has reached the required depth, the steel reinforcement shall be lowered in position maintaining the specified size of cover on all sides. The bore shall then be flushed with bentonite slurry and concreting shall be taken up exactly as described under clause 20.1.6.8.

49.2.3.4 A proper record of pile driving and other details such as sequence of installation of piles, dimension of piles, depth bored, time taken for concreting etc. shall be maintained in sequence of occurrence at site as per clause 20.1.3.6. While drilling mud is used, the specific gravity of fresh supply and contaminated mud in the hole before concreting is taken up shall be recorded for first ten piles and subsequently at interval of 10 piles or as specified.

49.2.3.5 Reinforcement

(i) The design of reinforcing cage varies depending upon the driving and installation conditions, the nature of the sub-soil and the nature of load to be transmitted by the shaft, axial or otherwise.

The minimum area of longitudinal reinforcement of any type or grade within the pile shaft shall be 0.4 per cent of the sectional area calculated on the basis of the outside area of the casings of the shaft.

(ii) The curtailment of reinforcement along the depth of the pile, in general, depends on the type of loading and sub-soil strata. In case of piles subjected to compressive load only, the designed quantity of reinforcement may be curtailed at appropriate level according to design requirements. For piles subjected to uplift load, lateral load & moments, separately or with compressive loads, it may be necessary to provide reinforcement to the full depth of the pile. In soft clays or loose sands, or where there is likelihood of danger to green concrete due to driving of adjacent piles, the reinforcement should be provided up to full pile depth, regardless of whether or not it is required from uplift & lateral load considerations. However, in all cases, the minimum reinforcement specified in Para (i) above should be provided in full length of the pile.

(iii) Piles shall always be reinforced with a minimum amount of reinforcement as dowels keeping the minimum bond length into the pile shaft below its cut-off level, and with adequate projection into the pile cap, irrespective of design requirements.

Note: In some cases the cage may lift at bottom or at the laps during withdrawal of casing. This can be minimized by making the reinforcement “U” shaped at the bottom and up to well secured joints. Also the lifting 5 percent of the length should be considered not to affect the quality of pile.

(iv) Clear cover to all main reinforcement in pile shaft shall be not less than 50 mm and shall be maintained by suitable spacers. The laterals of reinforcing cage may be in the form of links or spirals. The diameter and spacing of the same is chosen to impart adequate rigidity of the reinforcing cage during the handling and installation. The minimum diameter of links or spirals shall be 6 mm and the spacing of the links or spirals shall be not less than 150 mm. The minimum clear distance between two adjacent main reinforcement should normally be 100 mm for full depth of the cage.

(v) The reinforcing cage should be left with adequate protruding length above the cut off level for proper embedment in the pile cap. Prior to the lowering of reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials.

(vi) Reinforcement in the form of cage shall be assembled with additional support, such as spreader forks and lacings; necessary to form a rigid cage hoops, links, or helical reinforcement has to fit closely around the main longitudinal bars and shall be tied by binding wire of approved quality. The ends of the binding wire shall be turned into the interior of the pile. Reinforcement shall be placed and maintained in correct position. The reinforcements shall be joined wherever necessary by welding and the procedure of welding be followed as described in IS 2751.

49.2.3.6 Concrete

49.2.3.6.1 **Cement** : Cement shall be as specified in agreement item or as specified under Specifications. However, high alumina cement shall not be used.

49.2.3.6.2 **Ready Mix Concrete (RMC)**

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Alternatively, the contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of Engineer-in-Charge, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under clause

49.2.3.7 Testing of Concrete

49.2.3.7.1 The concrete for the piles shall be sampled in accordance with the norms specified in IS 456. The frequency of sampling is given in Table 20.1.

TABLE 20.1

<i>Quantity of Concrete in the Work m³</i>	<i>Number of Samples</i>
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50m ³ or part thereof.

Notes: (i) At least one sample shall be taken from each shift.

(ii) Where concrete is produced as continuous production unit, such as ready mix concrete plant. The frequency of sampling may be agreed upon mutually by suppliers and purchasers.

49.2.3.7.2 Test Specimen: Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or to determine the duration of curing, or check the testing error, additional sample may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimens shall be tested as described in IS 516.

49.2.3.7.3 Test Results of Samples: The test results of the samples shall be the average of the strength of three specimens. The individual variation should not be more than $\pm 15\%$ percent of the average strength. If the variation is more, the test result of the sample is invalid.

49.3 Ready Mix Concrete

As specified under clause (Alternatively, the contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of Engineer-in-Charge, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under clause 49.2.3.7 or alternatively he can propose his own sampling and testing procedure which should in turn be approved by the Engineer-in-Charge. Normally, RMC supplied to site are mixed with certain admixtures which enables the concrete to be used within 3 hours of supply at site. In case RMC supplied is not consumed within 3 hours of supply the quantity of RMC remaining unused beyond 3 hours shall be rejected and removed from site.

49.4 Measurement

Dimensions shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured up to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating, driving etc.

49.5 Rate

The rate includes the cost of material and labour involved in all the operations described above including pile embedded in pile cap except reinforcement, pile cap and grade beam.

50 LOAD TEST ON PILES

50.1 General

The bearing capacity of a single or group of piles shall be determined from test loading. It is most direct method for determining safe load on pile and it is more reliable on account of its being in-situ test. The load test on a concrete pile shall not be carried out earlier than 28 days of its casting. Initial test shall be carried on test pile which is not used as working pile and Routine tests shall be carried out as a check on working pile. Routine test shall be one-half percent to two percent of total number of piles or as specified, applicable to vertical and lateral load. Load Test shall generally conform to provision made in IS 2911 (Part IV) which provides guidelines for determination of safe loads and conducting of different types of tests.

50.2 Types of loadings/tests

- (i) Vertical Load Test (Compression)
- (ii) Cyclic Vertical Load Test
- (iii) Lateral Load Test

50.3 Vertical Load Test

50.3.1 General: Compression load shall be applied to the pile top by means of a hydraulic jack against suitable load frame which is capable of providing reaction and settlement is recorded by suitable dial gauges. The contractor shall apprise of Engineer-in-Charge before test is conducted.

50.3.2 Preparation of Pile Head: Pile head shall be chipped off to horizontal plane, projecting steel shall be cut or bent and top finished smooth and leveled with plaster of Paris or similar synthetic material as specified to give a plane surface which is normal to the axis of the pile. A bearing plate with a hole at the centers shall be placed on the head of pile for the jacks to rest.

50.3.3 Loading Platform: A proper loading platform is installed as specified. Contractor shall ensure that when the hydraulic jack and load measuring devices are mounted on pile head the whole system will be stable on the maximum specified load. For single pile two dial gauges shall be fixed to the pile and bear on surfaces on reference frame. The dial gauges shall be placed in diametrically opposite positions and be equidistant from the pile axis. Four dial gauges are used for groups, having 0.01 mm sensitivity. The arrangement shall be approved by the Engineer-in-charge

50.3.4 Application of Load: The test is carried out by applying a series of downward incremental load (20 per cent of safe loads on pile). In this method application of increment of test load and taking of measurement or displacement in each stage is maintained till the rate of displacement is either 0.1 mm in first 30 minutes or 0.2 mm in first one hour or 2 hours, whichever occurs first. The test load shall be maintained for 24 hours. This method is applicable for both initial and routine test. For testing of raker piles the loading shall be along its axis. Safe load on single pile for initial test is least of following:

- (i) Two-thirds of the final load at which the total displacement attains a value of 12 mm unless otherwise stated, in such case the safe load should be corresponding to total displacement permissible.
- (ii) 50 per cent of the final load at which the total displacement equal 10 per cent of pile diameter and 7.5 per cent of bulb diameter in case of under-reamed piles.

Routine test shall be carried for a test load of one and half times the working load, maximum settlement not to exceed 12 mm or as stated. Safe load on group of piles for initial test shall be least of the two

- (i) Final load at which total displacement is 25 mm or as stated.
- (ii) Two-thirds of final load at which the total displacement is 40 mm.

Routine test shall be carried for a test load equal to not less than working load, the maximum settlement not to exceed 25 mm.

50.3.5 Maintained Load Method: This is applicable for both initial and routine test. In this method application of increment of test load and taking of measurement or displacement in each stage of loading is maintained till rate of displacement of the pile top is either 0.1 mm in first 30 minutes or 0.2 mm in first one hour or till 2 hours, whichever occurs first. If the limit of permissible displacement as given in 20.5.3.4 is not exceeded, testing of pile is not required to be continued further. The test load shall be maintained for 24 hours.

Pile test data such as load, displacement and time shall be recorded in suitable prescribed tabular form. Results can be presented by suitable curves.

Test shall be carried out in proper manner and to the entire satisfaction of the Engineer-in-charge. After the test is completed the test cap shall be dismantled and pile surface shall be resorted to original shape.

50.3.6 Measurement: Each completed test shall be enumerated for initial test, routine test separately.

50.3.7 Rate: The rate includes the cost of labour, material and all the operations described above such as preparatory work including installation of loading platform, applying load, preparing pile head for load test, trimming of pile head etc. complete.

50.4 Cyclic Vertical Load Testing

50.4.1 General: This process shall be used in case of initial test to find out separately skin friction and point bearing load on single piles of uniform diameter in conformity of provisions of IS Code 2911 (Part 4) for conducting of the test.

50.4.2 Preparatory Pile Head: As per clause 50.3.2

50.4.3 Loading Platform: As per clause 50.3.3

50.4.4 Application of Load: Relevant provision as per clause 50.3.4 shall be applicable. The test may be continued up to 50 per cent over the safe load.

50.4.5 Test procedure given in Appendix E shall be followed.

Test shall be carried out in proper manner and to the entire satisfaction of the Engineer-in-charge. After the test is completed, the test cap shall be dismantled and pile surface shall be restored to original shape.

50.4.6 Measurement: Each completed test shall be enumerated for different load ranges.

50.4.7 Rate: The rate includes the cost of labour, materials and all the operations described above such as preparatory work, trimming of pile head etc. complete.

50.5 Lateral Load Testing

50.5.1 Load Platform: A proper loading platform shall be installed as specified. Hydraulic jack is mounted with gauge between two piles or pile groups under test. Dial gauge tips shall rest on central portion of glass plate fixed on the side of pile.

50.5.2 Application of Load: Full load imposed by the jack shall be taken as lateral resistance on each pile or group. Load should be applied in increments of about 20 per cent of the estimated safe load. The next increment shall be applied after the rate of displacement is approximately equal to 0.1 mm per 30 minutes.

50.5.3 The safe lateral load on pile; is least of the following:

- (i) Fifty per cent of the final load at which total displacement increases to 12 mm.
- (ii) Final load when total displacement is 5 mm.
- (iii) Load corresponding to any other specified displacement as per requirement.

Pile group shall be tested as per actual conditions as far as possible.

50.5.4 Displacements: Displacement is read by at least two dial gauges of 0.1 mm sensitivity spaced at 30 cm and kept horizontally one above the other and displacement is interpolated at cut off level. One dial gauge placed diametrically opposite to jack shall directly measure displacement. Where, it is not possible to locate one of the dial gauges in the line of the jack axes, then two dial gauge may be kept at a distance of 30 cm at a suitable height and the displacement interpolated at load point from similar triangles.

Note: One of the methods of keeping dial gauge on pile surface is to chip off uneven concrete on the side of the pile and to fix a piece of glass 20 to 30 mm square. The dial gauge tips shall rest on the central portion of the glass plate. Arrangement and test procedure shall be duly approved by the Engineer-in-Charge.

50.5.5 Measurement: Each completed test shall be enumerated for different load ranges.

50.6 Rate: The rate includes the costs of labour, materials and all the operations described above.

51 HORTICULTURE AND LAND SCAPING

23.0 HORTICULTURE WORK

Horticultural operations shall be started on ground previously levelled and dressed to required formation levels and slopes. In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth. In the course of excavation or trenching during horticultural operations, any walls, foundations, etc. met with shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge.

51.1 TRENCHING IN ORDINARY SOIL

Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regrassing, hedging and shrubbery. Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for regrassing in good soil.

51.1.1 The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.

51.1.2 Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed off and paid.

51.1.3 Trenching

Trenching shall consist of the following operations:

1. The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge.
2. These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.
3. In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.
4. The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

51.1.4 Measurements

Length and breadth of the plot shall be taken correct to 0.1 m and depths correct to cm. Cubical contents shall be calculated in cubic meters, correct to two places of decimal. No deduction shall be made nor extra paid for removing stones, brick bats and other foreign matter met with during excavation upto initial lead of 50 m and stacking the same.

51.1.5 Rate

The rate shall include the cost of all labour and material involved in the operations described above, including cost of all precautionary measures to be taken for protections and supporting all services etc. met with during trenching. It does not include the cost of mixing of earth, sludge/manure.

50.2 GOOD EARTH

50.2.1 The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.

51.2.2 Measurements: Length, breadth and height of stacks shall be measured correct to a cm. The volume of the stacks shall be reduced by 20% for voids before payment, unless otherwise described.

50.2.3 Rate: The rate shall include the cost of excavating the earth from areas lying at distance not exceeding one km. from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

51.3 OIL CAKE

51.3.1 Neem/Castor: The cake shall be free from grit and any other foreign matter. It should be undecorticated and pulverized. The material shall be packed in old serviceable gunny bags of 50 kgs capacity approximately. The weight of gunny bag shall be deducted @1 kg per bag and payment shall be made for net quantity. The quality of cake should be got approved by the Engineer-in-charge before supply.

51.3.2 Measurements

The arrangement for weighing shall be made at site of work by the department. The gunny bags shall be the property of the government.

51.3.3 23.3.3 Rate: The rate shall include the cost of labour and material involved in all operations described above, including carriage up to site of work with all lead and lifts, weighing etc.

51.4 SUPPLY AND STACKING OF SLUDGE

51.4.1 It shall be transported to the site in lorries with efficient arrangement to prevent spilling enroute. It shall be stacked at site. Each stack shall not be less than 50 cm height and volume not less than 3 cum.

51.4.2 Measurements

Length, breadth and depth of stacks shall be measured correct to a cm. The volume of the stack shall be reduced by 8% for looseness in stacking and to arrive at the net quantity for payment.

51.4.3 Rate

The rate shall include the cost of labour and material involved in all operations described above, including carriage up to one km. The rate shall also include royalty if payable.

51.5 SUPPLY AND STACKING OF MANURE

51.5.1 Farmyard Manure: Same as 50.4.1.

51.5.2 Measurements: Same as 50.4.2.

51.5.3 Rate : Same as 50.4.3.

51.6 ROUGH DRESSING OF THE TRENCHED GROUND

51.6 Rough dressing of the area shall include making kiaries for flooding.

51.6.1 The trenched ground shall be levelled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so levelled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at the surface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

51.6.2 Measurements

Length, breadth of superficial area shall be measured correct to 0.1 metre. The area shall be calculated in sqm. correct to two places of decimal.

51.6.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

51.7 UPROOTING WEEDS FROM TRENCHED AREAS

51.7.1 After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

51.7.2 Measurements

Length, breadth of superficial area shall be measured correct to 0.1 meters. Superficial area of the weeded ground shall be measured for purpose of payments.

51.7.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

51.8 FINE DRESSING THE GROUND

51.8.1 Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

51.8.2 Measurements

Length, breadth and depth of stacks shall be measured correct to a cm. The area shall be calculated in sqm. correct to two places of decimal.

51.8.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

51.9 SPREADING GOOD EARTH

51.9.1 Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

51.9.2 Measurements: The quantity of good earth spread shall be determined by the difference in the volume of good earth in stacks before and after spreading duly reduced for looseness in stacking by 20% of good earth.

51.9.3 Rate: The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of the good earth which shall be paid for separately unless specifically described in the item.

51.10 SPREADING SLUDGE/MANURE

51.10.1 Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge. The mixing shall be spread as described in 23.9.1 to the thickness ordered by the Engineer-in-Charge.

51.10.2 Measurements

The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth and sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

51.10.3 Rate

The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

51.11 MIXING OF GOOD EARTH AND SLUDGE/MANURE

51.11.1 The stacked earth shall, before mixing be broken down top particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-charge.

51.11.2 Measurements

The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth, sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

51.11.3 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

51.12 GRASSING WITH SELECT GRASS NO. 1

51.12. The area from where the grass roots are to be obtained shall be specified by the Engineer-in-Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. **Grass is to be arranged by contractor (cost of grass to be paid separately).**

51.12.1 The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material **(grass shall be paid separately.)**

51.12.2 During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

51.12.3 Measurements

Length, breadth of the lawn grassed shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

51.12.4 Rate

The rate shall include of all the labour and material involved in all the operations described above, excluding supply of the requisite quantity of good earth and grass so needed for properly maintaining the levels of the lawns. **(payment of grass to be paid separately).**

51.13 RENOVATION OF LAWNS

51.13.1 The area shall be first weeded out of all undesirable growth. The entire grass shall be scrapped (cheeled) without damaging roots and level of the grounds. Slight irregularities in surface shall be levelled off and the area shall then be forked so as to aerate the roots of the grass without, however uprooting them. Specified quantity of sludge or manure shall than be spread uniformly with wooden straight edge (phatti) as directed by the Engineer-in-charge. The area shall then be slightly sprinkled with water so as to facilitate proper integration of the manure or sludge with the soil and later flooded. The contractor shall be responsible for watering, proper maintenance and tending of the lawn for 30 days or till the grass forms a lawn fit for mowing, whichever is later.

During the above operations, all undesirable growths shall be constantly weeded out and all rubbish removed and disposed off as directed by the Engineer-in-Charge.

51.13.2 Measurements

Length, breadth of the lawn renovated shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

51.13.3 Rate

The rate shall include of all the labour and T&P (excluding RH pipe/grass) involved in all the operations described above, excluding the supply of the requisite quantity of good earth if so needed for proper maintenance of the levels of the lawns. The cost of the sludge or manure shall be measured and paid for separately, unless its supply is specifically included in the description of the item.

51.14 UPROOTING RANK VEGETATION AND WEEDS AND PREPARING THE GROUND FOR PLANTING 'SELECT GRASS NO. 1'

51.14.1 Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetation with roots removed thereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described in 23.1. Clods of excavated earth shall then be broken up to the size not more than 75 mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully. The rubbish arising from the above operations shall be removed and disposed off in a manner directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed as described in 23.6 & 23.8.

51.14.2 Measurements

Length, breadth of uprooted area shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

51.14.3 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above.

50.15 EXCAVATION AND TRENCHING FOR PREPARATION OF BEDS FOR HEDGE AND SHRUBBERY

51.15.1 Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters respectively.

51.15.2 Beds for hedges and shrubbery shall be prepared in the following manner. The beds shall first be excavated to a depth of 60 cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in order to loosen the soil, in the manner described in 23.1. No flooding will be done at this stage but the top surface shall be rough dressed and levelled. The excavated soil from the top 60 cm depth of the bed stacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8:1 by ratio or other proportion described in the item. The mixed earth and manure shall be refilled over the trenched bed, levelled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed. The surface after full subsidence shall again be refilled with the earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50 mm to 75 mm below the adjoining ground or as directed by the Engineer-in-Charge. Surplus earth if any, shall be disposed off as directed by the Engineer-in-charge. Any surplus earth if removed beyond initial lead shall be paid separately. Stones, bricks, bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initial lead & lift, such material as is declared unserviceable by the Engineer-in-charge shall be disposed by spreading and levelling at places ordered by him. If disposed outside the initial lead & lift, then the transport for the extra leads will be paid for separately. If a large proportion of material unsuitable for the hedging and shrubbery operations is met with and earth from outside is required to be brought in for mixing with manure and filling, the supply and stacking of such earth will be paid for separately.

51.15.3 Measurements

Length, breadth and depth of the pit excavated and trenched shall be measured correct to a cm. The cubical contents shall be calculated in cubic meter correct to two places of decimal.

51.15.4 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above. The rate shall not include the cost of supply & stacking of the manure unless the same is specifically included in the description of the item.

51.16 DIGGING HOLES FOR PLANTING TREES

51.16.1 In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.

51.16.1.1 Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The tree holes shall be manured with powdered Neam/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

51.16.1.2 Measurements : Holes shall be enumerated.

51.16.1.3 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, excluding the cost of supply and stacking the requisite quantity of manure/sludge and oil cake.

51.16.2 In Soil other than Ordinary Soil

51.16.2.1 Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and /or ordinary soil in any hole, the different excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only.

51.16.2.2 The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.

51.16.2.3 Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately.

51.16.2.4 The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge. If such places are outside initially leads, carriage for the extra lead shall be paid for separately.

51.16.2.5 The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 16 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

51.16.2.6 Measurements: The pit shall be enumerated. The volume of excavation in soil and other than a ordinary soil shall be determined by reducing the stack volume of the relevant soil with respective percentage for voids specified in 23.14.2.2.

51.16.2.7 Rate: The rate shall include the cost of all the labour and material involved in all the operations described above, including mixing refilling, watering, dressing etc. but shall not include (a) cost of manure over sludge (b) cost of supplying and stacking of good earth for replacement and (c) the cost of carriage beyond initial lead for disposing off useless materials. The excavation other than that of ordinary soil shall be paid extra over and above the rate if excavation in ordinary soil.

51.18 FILLING MIXTURE OF EARTH & SLUDGE OVER MANURE

51.18.0 The separately specified earth and sludge shall be broken down to particles of size not exceeding 6 mm in any directions before mixing. Good earth shall be thoroughly mixed with sludge over manure in specified proportions as directed by Officer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and levelled.

51.18.1 Measurements

Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

51.18.2 Rate

The rate shall include the cost of all the labour and material involved in all the operations described above, but do not include the good earth, sludge or manure which will be paid separately.

51.19 FLOODING THE GROUND WITH WATER AND MAKING KIARIES

51.19.1 The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

51.19.2 Measurements

Measurement shall be made in sqm. of area.

51.19.3 Rate

The rate shall be for 100 sqm of area and include the cost of all the labour and material involved in all the operations described above.

52.0 ROAD WORK

52.0 TERMINOLOGY

Asphalt : A natural or artificial mixture in which bitumen is associated with mineral matter. The word 'Asphalt' should always be qualified by indication of its origin or nature.

Asphalt Mastic : An intimate mixture of mineral fillers, well graded sand and/or stone chippings with a hard grade of bitumen, cooked and laid hot manually by means of wooden float. The mixture settles to a coherent, voidless and impermeable solid or semi-solid mass under normal temperature condition.

Bitumen : A noncrystalline solid or viscous material, having adhesive properties derived from petroleum either by natural or refinery processes and substantially soluble in carbon disulphide.

Bitumen-Cutback : Bitumen, the viscosity of which has been reduced by a volatile diluent when blended with kerosene or naphtha type diluent or fuel oil, is called, medium or rapid or slow curing cut backs respectively.

Bitumen-Emulsion : A liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium containing an emulsifier and stabiliser. The emulsion is termed 'Anionic' when the bitumen particles are negatively charged and the aqueous phase is alkaline. The emulsion is termed 'cationic' when the particles are positively charged and the aqueous phase is acidic.

Bitumen Mastic Filler : Inorganic mineral material all of which will pass through specified IS sieve used in admixture with solid or semi-solid bituminous material.

Road tar : A product obtained by treating at high temperature coal tar in such a manner that it conforms to a specification which defines its suitability for road construction.

Tar : A viscous material having adhesive properties and resulting from the distinctive distillation of certain type of organic material. The term Tar should be preceded by the name of the material from which it is produced e.g. coal, shale, peat, vegetable matter and its mode of production shall be indicated.

Flash point : The lowest temperature at which the vapour of a substance can be ignited in air by a flame under specified conditions of test. The substance itself does not continue to burn.

Tack Coat : It shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to further bituminous construction.

52.1 MATERIALS

52.1.1 Aggregate Coarse

Coarse aggregate as specified in the item shall be either crushed/broken stone, crushed slag, over burnt brick aggregate or one of the naturally occurring aggregates such as kankar or laterite of suitable quality as stated hereinafter and approved by the Engineer-in-Charge. The stone aggregate shall conform to the physical requirements set forth in Table 16.1. The type and size range of the aggregate shall be specified in the contract.

Sl. No	Type of Constn.	Test for W.B.M.	Test method	Requirements
1	Sub-base	Los Angles Abrasion value or Aggregate impact value	IS 2386 (Pt.IV) IS 2386 (Pt.IV) IS 5640***	60% max. * 50% max.
2	Base	Los Angles Abrasion value or Aggregate impact value (b) Flakiness Index	IS 2386 (Pt.IV) IS 2386 (Pt.IV) IS 5640***	50% max. * 40% max.
3	Surface Course	Los Angles Abrasion value or Aggregate impact value (b) Flakiness Index	IS 2386 (Pt.I) IS 2386 (Pt.IV) IS 2386 (Pt.IV) IS 2386 (Pt.I)	**15% max. * 40% max. 30% max. **15% max.
* Aggregates may satisfy requirements of either of the two tests. ** The requirements of flakiness index shall be enforced only in case of crushed/broken stone and crushed slag. *** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under wet conditions in accordance with IS 5640.				

The coarse aggregate shall conform to one of the gradings given in Table 16.2 as specified. For crushable type of aggregates such as brick metal, kankar and laterite, grading shall not be regarded as very important, but the material should generally be within the specified range.

TABLE
Grading Requirements of Coarse Aggregate for W.B.M.

Grading No.	Size Range	Sieve Designation	% by weight passing the sieve
1	90 mm to 45 mm (Suitable for sub base courses of compacted layer not less than 90 mm thickness)	125 mm 90 mm 63 mm 45 mm 22.4 mm	100 90-100 25-60 0-15 0-5
2	63 mm to 45 mm	90 mm 63 mm 53 mm 45 mm 22.4 mm	100 90-100 25-75 0-15 0-5
3	53 mm to 22.4 mm	63 mm 53 mm 45 mm 22.4 mm 11.2mm	100 95-100 65-90 0-10 0-5

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52.1.1.1 Brick Aggregate : Brick aggregate shall be broken from over-burnt and dense brick bats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt and other foreign matter.

52.1.1.2 Crushed or Broken Stone : When crushed or broken stone is specified as the coarse aggregate, it shall be hard, durable and free from excess of flat, elongated, soft, disintegrated particles, dirt and other objectionable matter. The total quantity of such deleterious material including clay lumps, soft fragment, foreign material etc. shall not exceed 5% of the weight of the aggregate.

52.1.1.3 Crushed Slag : Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other objectionable matter. Crushed slag shall not weigh less than 1120 kg per cubic metre and the percentage of glossy material in it shall not be in excess of 20. Water absorption of slag shall not exceed 10% (IS 2386 Pt.III).

52.1.1.4 Kankar : Kankar shall be tough, having a blue almost opalescent fracture. It shall not contain any clay in the cavities between nodules.

52.1.1.5 Laterite : Laterite shall be hard, compact, heavy and of dark colour. The light coloured sandy laterite as well as those containing much ochreous clay shall be rejected.

52.1.2 Aggregate-Fine

The fine aggregate shall be the fraction passing 2.8 mm sieve and retained on 90 micron sieve. It shall consist of crusher run screenings, natural sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from injurious, soft or flaky pieces and organic or deleterious substance. The contents of organic and deleterious materials shall not exceed the limits specified in

TABLE

		<i>Uncrushed</i>	<i>Crushed</i>
Coal and lignite	1%	1%	
Clay lumps		1%	1%
Material passing through 75 microns (I.S.S.) Sieve	3%	3%	
Shale		1%	1%

The sum of the percentages of all deleterious material shall not exceed 5%. Tests for estimation of deleterious materials and organic impurities shall be done as per IS 2386 (Pt. II).

52.1.4 Binding Material

Binding materials to prevent ravelling of water bound macadam construction shall consist of a fine grained material possessing plasticity index value of 4 to 9 when the water bound macadam is to be used as a wearing course, and 4 to 6 when W.B.M. is being adopted as a sub-base/base course with bituminous surfacing on top of it. The plasticity index shall be determined in accordance with IS 2720 (Pt. V). The quantity of binding material used in each layer shall be as per direction of Engineer-in-Charge. Application of binding material may be dispensed with the approval of Engineer-in-Charge, where screenings consisting of crushable type material like moorum or gravel are used. Where earth cut for sub-grade formation is used as binder with the approval of Engineer-in-Charge, no separate payment shall be made for collection of this binder material.

52.1.5 Filler

The filler, where specified, shall be an inert material, the whole of which passes through a 710 micron sieve, atleast 90 per cent passing through a 180 micron sieve and not less than 70 per cent passing through a 90 micron sieve. The filler shall be cement, stone dust, hydrated lime, lime stone dust, flyash or any other non-plastic mineral matter approved by the Engineer-in-Charge.

TABLE
Aggregate Gradation including Filler

Sieve designation	Percent by weight passing the sieve	
	For 25 mm thickness	For 20 mm thickness
20.0 mm	100	—
12.5 mm	75-100	100
10.0 mm	60-85	75 - 100
4.75 mm	35-55	35 - 55
2.36 mm	20-35	20 - 35
600 micron	10-22	10 - 22
300 micron	6-16	6 - 16
150 micron	4-12	4 - 12
75 micron	2- 8	2 - 8

52.1.6 Moorum

It shall be obtained from pits of weathered disintegrated rocks. It should preferably contain silicious material and natural mixture of clay of calcareous origin. The size of moorum shall not be more than 20mm.

52.1.7 Premoulded Joint Filler

It shall conform to IS 1838, the thickness shall be 20 mm or 25 mm as specified and shall be of the maximum available standard length. During the casting of the slab the premoulded joint filler shall be placed accurately in position against the finished end of concrete slab. The filler shall remain 20 mm below the top surface of the pavement and shall extend upto the subgrade.

52.1.8 Red Bajri

This shall be disintegrated rock dark red in colour consisting of coarse grains, free from mica, dust and other foreign matter.

52.1.9 Screenings

Screening to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than river borne rounded 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 gradings set forth in Table 16.9. Screenings of type A shall be used with coarse aggregate of grade I of Table 16.2. Screenings of type A or B as specified shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3. The use of screenings may be omitted in the case of soft aggregates such as brick metal, kankar and laterite. For screenings like moorum or gravel the gradings given in

TABLE
Grading for Screenings

Grading Classification	Size of Screenings	Sieve Designation	% by Weight Passing Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95 - 100
		5.6 mm	15 - 35
		180 micron	0 - 10
B	11.2 mm	11.2 mm	100
		5.6 mm	90 - 100
		180 micron	15 - 35

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52.1.10 Sealing Compound

After the curing period is over the joint portion above the filler board shall be cleaned thoroughly as directed by the Engineer-in-Charge. The joints shall be filled with hot applied sealing compound. Grade A (Normal) for concrete constructions other than those which are subjected to spillage of kerosene or other heavy petroleum oils and Grade B (Jet fuel resistant) for concrete constructions of runways for jet aircrafts, conforming to IS 1834.

52.1.11 Soil

Soil having a plasticity index (PI) between 5 and 20 shall be suitable. At least one test for 200 cubic metre of soil for determining P.I. shall be conducted.

52.1.12 Stones

These shall be clean, hard, sound and durable stones, free from decay and weathering. They shall be in blocks and hammer dressed on all sides. The size of pitching stones shall be approximately 22.5 cm in depth and not less than 15 cm in any other direction.

52.1.13 Stone Chippings For Surface Dressing/Painting

The stone chipping shall consist of fairly cubical fragment of clean, hard, tough and durable rock of uniform quality throughout. These shall be obtained by crushing stone river gravel (shingle) or other approved materials. Rounded gravel shall be used only if specifically permitted by the Engineer-in-Charge. The chipping shall be free of elongated or flaky pieces, soft or disintegrated stone, salt, alkali, vegetable matter, dust and adherent coatings. They shall conform to the quality requirements. However, the total quantity of such deleterious material including clay lumps, soft fragments, foreign material shall not exceed 5% of the weight of the aggregate.

The aggregate shall be got tested to ensure the requirements

TABLE
Physical Requirements of Aggregates for Surface Dressing

<i>Sl. No.</i>	<i>Test</i>	<i>Test method</i>	<i>Requirements</i>
1.	Los Angeles Abrasion	Value IS 2386 (Pt.IV)	40% max.
2.	Aggregate Impact Value*	IS 2386 (Pt.IV)	30% max.
3.	Flakiness Index	IS 2386 (Pt.I)	25% max.
4.	Stripping Value	IS 6241	25% max.
5.	Water Absorption	IS 2386 (Pt.III)	1% max.

* Aggregates may satisfy requirements of either of the two tests.

52.1.14 Stones for Kerb and Channels

Kerb and channel stones are provided on roads having raised berms for foot path etc. These shall be of selected hard stone, sound, durable free from laminations and other structural defects. The length of each kerb and channel stone shall be not less than 49.5 cm except that 29.5 cm long stones shall be permitted for closures and for curves. The other dimensions shall be 30 x 20 cm for kerb stones and 30 x 10 cm for channel stones, unless specified otherwise. Kerb and channel stones shall be chisel dressed on exposed surface and edges. The dimensions of the exposed faces of kerb and channel stones shall be of sizes as specified with a tolerance of 10 mm in width and depth. In the case of kerb stones a tolerance of 5 cm shall be allowed in the dimensions of unexposed back and bottom faces and in the case of channel stones a tolerance of 10 mm shall be allowed in thickness.

52.2 SUB-GRADE : PREPARATION AND CONSOLIDATION

52.2.0 In sub-grade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operation, an insulation layer of suitable thickness of granular materials or oversize brick aggregate not less than 10 cm thick shall be provided for blanketting the sub-grade, which shall be paid for separately, unless otherwise specified. In slushy soils or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total pavement thickness shall be designed after testing the properties of the subgrade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

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52.2.1 Preparation of Sub-Grade

The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

52.2.2 Consolidation

The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass (the roller shall pass a minimum of 5 runs on the sub grade). All undulations in the surface that develop due to rolling shall be made good with material or quarry spoils as the cases may be and the sub-grade is rerolled.

52.2.3 Surface Regularity

The finished surface shall be uniform and conform to the lines, grades and typical cross section shown in the drawings, when tested with the template and straight edge, the variation shall be within the tolerances

TABLE

Permissible Tolerances of Surface Evenness of Sub Grade

<i>Longitudinal profile maximum permissible undulation when measured with a 3 metre straight edge</i>	<i>Cross profile maximum permissible variation from specified profile when measured with a camber template</i>
24 mm	15 mm

Where the surface irregularity of the sub grade falls outside the specified tolerances, the contractor shall be liable to rectify these with fresh material or quarry spoils as the case may be, and the sub-grade rerolled to the satisfaction of Engineer-in-Charge.

52.2.4 Measurements

The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal.

52.2.5 Rate

The rate for preparation and consolidation of sub grade shall include the cost of materials and labour involved for all the operations mentioned in above unless otherwise specified.

52.3 EMBANKMENT CONSTRUCTION (UNDER OPTIMUM MOISTURE CONDITIONS)

52.3.1 In the case of earth work consolidated under optimum moisture conditions each layer of earth shall be carefully moistened to give field moisture content of about +1% to -2% of the optimum moisture content (OMC). The OMC shall be determined according to IS 2720 (Pt.VIII) Methods of Tests for Soils. Each layer shall then be compacted by rolling with 8 to 10 tonnes power road roller and a sheep foot roller if required. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved for each layer of the material shall not be less than 95% of the density obtained in the laboratory (Proctor Method).

52.3.2 Each compacted layer shall be tested in the field for density and accepted before the operations for next layer are begun.

52.3.3 Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent ponding.

52.3.4 Density Measurement and Acceptance Criteria

52.3.4.1 One measurement of density shall be made for each 500 sqm of compacted area or for a smaller area as decided by the Engineer-in-Charge. Each measurement shall consist of at least 5 density determinations and the average of these 5 determinations shall be treated as the field density achieved. The determination of density shall be as per IS 2720 (Pt. XXVIII).

52.3.4.2 In general the control at the top 40 cm thickness of the formation shall be more strict with density measurements being done at the rate of one measurement for 250 sqm of compacted area. Further for the determination of the mean density the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.

52.3.4.3 When density measurements reveal any soft areas in the embankment, the Engineer-in-Charge shall direct that these be compacted further. If inspite of that the specified compaction is not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted to the satisfaction of the Engineer-in-Charge.

52.3.4.4 Control Tests on Borrow Material

52.3.4.5 Soil suitable for consolidation under O.M.C. conditions should preferably have the following characteristics :

- (a) Minimum percentage of clay 10%
- (b) Liquid limit 14
- (c) Plasticity index 4
- (d) Percentage of silt should not exceed 50%
- (e) Peat, muck and organic soils are unsuitable.

52.3.4.6 The Engineer-in-Charge may, however, relax these requirements taking into account availability of materials, cost of transportation and other relevant factors.

52.3.4.7 Various test required to be conducted on the borrow material with their recommended frequency are indicated below. All the test need not be stipulated on every project. Depending upon site condition etc. only some may be found necessary at a particular project. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed at a project.

- (a) *Gradation* : At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.
- (b) *Plasticity* : At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.
- (c) *Proctor Tests* : At the rate of 1 to 2 tests per 8000 cum of soil.
- (d) *Deleterious Contents* : As required.
- (e) *Moisture contents* : One test for every 250 cum of soil.

52.3.4.8 Measurements : The filling shall be measured and quantity of earth work computed from cross sections of filling or the embankment. No deduction shall be made for voids.

52.3.4.9 Rate shall include the cost of all operations described above including operation mentioned in 16.3 to the extent applicable.

52.4 SUPPLYING AND STACKING OF MATERIALS

16.4.1 Aggregates/Red Bajri

52.4.1.0 The item of work shall specify stone aggregate/brick aggregate/red bajri, as the case may be.

52.4.1.1 Stacking : Ground where stacks are proposed to be made shall be cleared, levelled or dressed to a uniform slope and all lumps, depressions etc. shall be removed. The stacked material shall be free from vegetation and other foreign matter. Coarse aggregates stack shall be made at places as directed by the Engineer-in-Charge. All rejected stone material shall be removed from the site. The aggregate shall be stacked in convenient units of one metre top width, 2.2 m bottom width, 60 cm height and of length in multiples of 3 m for new roads. Where berm width is limited or for repair works it shall be stacked in units of 40 cm top width 1.4 m bottom width, 50 cm height and length in multiples of 3 m. Template of steel shall be used for making the stacks and shall always be kept at site for check measurements. The Engineer-in-Charge may permit stacking in different sizes and height ranging between 45 to 75 cm for new roads and 40 to 60 cm for repair work, in case the site conditions so demand. In a particular reach of road as decided by the Engineer-in-Charge, the quantity of stacked material shall be comparable to the theoretical
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quantity required for W.B.M. to be laid in that reach. The stacks shall be uniformly distributed along the road and shall be numbered serially. The number plate shall be planted on each stack, which shall remain in position until the stack is used in the work. A register showing daily consumption of stacks shall be maintained at site of work. The collection of stone metal shall be for completed length of one km (for each layer of W.B. macadam) or as directed by the Engineer-in-Charge in writing.

52.4.1.2 Measurements : Length, breadth and height shall be measured correct to a cm. The total quantity so arrived shall be reduced by 7.5% to arrive at the net quantity for payment, in cases of aggregates. No such reduction shall be made in case of fine aggregate i.e. Red Bajri & screening etc.

52.4.2 Binder

52.4.2.1 Stacking : Specified binder shall be brought to the site of work in the sealed original containers. Binder brought in damaged containers shall not be allowed. The material shall be stacked in fenced enclosures, as directed by the Engineer-in-Charge, on one side of the roadway. The material shall be purchased from reputed firms or their authorised dealer. All the drums brought to site shall be serially numbered and used in the same order. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or for atleast a fortnight's work. For major bituminous road works, supply of bitumen in bulk may be taken for economic reasons, or if the contingencies of the work so require. Sufficient storage arrangement shall be made at site for at least ten days requirement.

Materials shall be kept in the joint custody of the contractor and the representative of the Engineering-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 from the Engineer-in-Charge. A few drums may be removed before completion of work for heating bitumen and mixing aggregates etc. with the permission to the Engineer-in-Charge. Empty drums required to be returned to stores shall be in good condition. Recovery rate for nonreturn of the empty drums or for the damaged drums shall be as decided by the Engineer-in-Charge.

52.4.2.2 Measurements: The materials shall be recorded as per standard weights of different type of container as intimated by manufacturers. The material shall be weighed where containers are found leaking.

52.4.2.3 Rate : The rate shall include the cost of all labour and materials involved in all the operations described above.

52.4.3 Moorum/Stone Chippings/Good Earth

52.4.3.0 The item of work shall specify moorum/stone chippings/Good Earth as the cases may be.

52.4.3.1 Stacking : Ground where stacks are proposed to be made, shall be dressed to a uniform slope and all lumps, depressions etc. shall be removed. Sample of moorum shall be got approved from the Engineer-in-Charge, before the material in bulk is brought to site.

Moorum/Good Earth shall be stacked in convenient units of one cubic metre in between aggregate stacks in each length of 100 m as per requirement. The stacks shall be made with wooden boxes open at both ends and of $2 \times 2 \times 0.25$ m dimensions. These shall always be kept at site for stacking and check measurement. The stacks shall be uniformly distributed along the road. The supply of moorum shall be completed for the entire work or for a complete length of one km or as directed by the Engineer-in-Charge in writing.

52.4.3.2 Measurements : Length and breadth of boxes shall be measured correct to a cm. Volume shall be calculated in cubic metres, correct to two places of decimal.

52.4.3.3 Rate : The rate shall include the cost of all materials and labour involved in all the operations described above.

52.5 EARTHWORK IN ROAD CONSTRUCTION

52.5.1 Earthwork connected with road construction fall broadly into three categories.

- (a) Earthwork in cutting including borrow pits.
- (b) Earthwork in fillings in embankments (without optimum moisture conditions).
- (c) Earthwork in fillings in embankments (under optimum moisture conditions).

52.5.2 so far as the various options in the earthwork for road construction as indicated below shall be applicable.

- 2.4 Site clearance
- 2.5 Setting out and making profile
- 2.6 Blasting operations
- 2.7 Excavation in all kinds of soils
- 2.8 Excavation in ordinary/hard rock
- 2.10 Earthwork in filling
- 2.11 Measurements
- 2.12 Rates
- 2.13 Surface excavation
- 2.14 Rough excavation and filling

52.5.3 In addition to the above, there are certain special requirements of earthwork for road constructions, especially in embankments and excavations from borrow pits. These shall broadly conform to.

- (a) IRC : 36 Recommended practice for construction of earth embankments for road works.
 - (b) IRC : 10 Recommended practice for borrow pits for road embankments by manual operations.
- Excavation from borrow pits shall conform to provisions in para 3 of IRC: 10 and the road embankment shall generally conform to section, slopes and location of borrow pits.

52.6 EMBANKMENT CONSTRUCTION (WITHOUT OPTIMUM MOISTURE CONDITIONS)

52.6.0 In addition to what is described in 16.5 above, the following shall apply : materials used in embankments shall be earth moorum, gravel, a mixture of these or any other material approved by the Engineer-in-Charge. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment. The work shall be so planned and executed that the best available materials are saved for the top portion of the embankment. Highly expansive clays exhibiting marked swell and shrinkage properties may be deposited only at the bottom of the embankment and no such material shall be placed nor permitted to remain in the top 500 mm portion of the embankment below the sub-grade.

52.6.1 Preparation of Foundations

The foundations of the embankment shall be ploughed to a depth of 15 to 25 cm. All clods shall be broken into fine earth and the area roughly levelled. The surface shall then be well watered before the earth work is started.

52.6.2 Source of Supply

52.6.2.1 The material used in embankment shall be obtained either from cutting high ground or from borrow pits as directed by the Engineer-in-Charge. In case of road embankments, the borrow pits may be excavated along the sides of the road so as to form road side drains with proper slopes and sections. The clear berm width between the toe of the bank and the inner edge of the borrow pits shall be specified by the Engineer-in-Charge but it shall not be less than 5 metres after making due allowance for future development.

52.6.2.2 Borrow pits shall be rectangular in shape with one side parallel to the centre line of the road. If on road land, these shall be dug as near the boundary as possible. Borrow pits shall not be dug continuously. Ridges of not less than 8 metres width should be left at intervals not exceeding 300 metres. Small drains should be cut through the ridges to facilitate drainage. Borrow pits shall be well drained. The bed level of the borrow pits, shall, as far as possible, slope down progressively towards the nearest cross drain, if any and shall not be lower than the bed of the cross drain. Borrow pits shall not be dug within 0.8 km of towns or villages. If unavoidable these shall not exceed 30 cm in depth and shall be drained.

52.6.2.3 Where it becomes necessary to borrow filling materials from temporarily acquired cultivable lands the depth of borrow pits shall not exceed 45 cm. The top soil to a depth of 15 cm shall be stripped and stacked aside. Thereafter soil shall be dug out to a further depth not exceeding 30 cm and used in forming the embankment. The top soil shall then be spread back on the land.

52.6.2.4 In case of flood and marginal banks, earth shall be obtained from borrow pits on the river side of the banks. No borrow pit shall be excavated on the land side of the bank, unless permitted by the Engineer-in-Charge in writing depending upon the depth of borrow pits and height of embankment.

However the minimum berm width between the toe of the bank and the edge of the borrow pits on the river side shall be 15 metres and that between the toe of the bank and the edge of the borrow pits on the land side 25 metres.

52.6.2.5 Guide-banks shall be constructed from material obtained from excavation for laying stone aprons and further borrow pits excavated if necessary, according to the directions of the Engineer-in- Charge.

52.6.3 Earth Filling and Compactions

52.6.3.1 Before commencement of filling the toe lines of the embankment shall be marked by pegs driven into the ground at 15 metres intervals and by continuous nicking (daf balings) to indicate the limits of the side slopes. Bamboo and string profiles shall be erected at every 60 metres interval in straight reaches and 15 metres apart in curved portions.

52.6.3.2 Embankment material shall be laid in 20 cm layers which shall be continuous and parallel to the finished grade. The placing of earth fill shall be done in the full width of embankment including slopes, and the section of formation shall be kept slightly sloping away from the centre to avoid pools of water forming due to rain. The height of filling in different sections shall be uniform as far as possible. All clods shall be broken while the earth is being placed. Organic matter of any kind shall be removed and disposed off as directed by the Engineer-in-Charge.

52.6.3.3 Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5.

52.6.3.4 Each layer of earth shall be adequately watered to aid compaction.

52.6.3.5 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. It shall then be rolled with roller of minimum 1/2 tonne weight, not less than 5 times, till it gets evenly and densely consolidated with wooden or steel rammers of 7 to 10 kg weight having a base of 20 cm square or 20 cm diameter. The labour for ramming shall be atleast one rammer to six diggers. Every third layer of earth and the top most layer shall be well consolidated with a power roller of minimum 8 tonnes weight, rolled not less than 5 times, till the soil behaves as an elastic material and gets compressed only elastically under the load of roller.

52.6.3.6 Dressing : The embankment shall be dressed neatly as per designed section and grade, after it has been completed and thoroughly consolidated. The top and slopes shall be protected from any damage and maintained, till the work is completed and handed over to the Engineer-in-Charge.

526.6.4 Embankment Around Structures

52.6.4.1 To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structure, the contractor shall at points to be determined by the Engineer-in-Charge suspend work on embankments forming approaches to such structures, until such time as the construction of the latter of sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the bridge works.

52.6.4.2 Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the embankment shall not be done. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer-in-Charge but in any case not until the concrete or masonry has been in position for 14 days. The embankment shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer-in- Charge.

52.6.4.3. Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter material shall conform to the requirements for filter medium as specified. Payment for providing filter material shall be made separately under relevant items.

52.6.4.4. Where it may be impracticable to use power roller or other heavy equipment, compaction shall be carried out by mechanical tampers or other methods approved by the Engineer-in-Charge. Care shall be taken to see that the compaction equipments does not hit or come too close to any structural member so as to cause any damage to it.

53.0 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 lesser than NP2. These shall conform to IS 458 and shall be capable of withstanding a test pressure of 0.07 MPa (7 m head). 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 un-reinforced and 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 for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm, the maximum size of aggregate should be 10mm. 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. The dimensional requirements of concrete pipes are given in Appendix I. The minimum clear cover for reinforcement in pipes and collars shall be as given in Table

TABLE

<i>Sl. No</i>	<i>. Precast concrete pipe/collar</i>	<i>Minimum clear cover, mm</i>
(i)	Barrel wall thickness	
(a)	Upto and including 75 mm	8
(b)	Over 75 mm	15
(ii)	At spigot steps	5
(iii)	At end of longitudinal	5

Note : An effective means shall be provided for maintaining the reinforcement in position and for ensuring correct cover during manufacture of the unit. Spacers for this purpose shall be of rust proof material or of steel protected against corrosion.

53.1 Laying and Jointing Cement Concrete Pipes and Specials

(i) **Trenches:** Trenches shall be as described in 18.4.4. Where the pipes are to be bedded directly on soil, the bed shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.

(ii) 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.

(iii) 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.

(iv) 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.

(v) 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 the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over in dia. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by

excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under around the curve of the pipe to form an even bed.

Necessary provision shall be made for joints wherever required.

(vi) When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.

(vii) The method of bedding and laying the pipes under different conditions

(viii) When the pipes are laid completely above the ground the foundations shall be made even and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in the centre of the span. Care shall be taken to see that super imposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted.

Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

(ix) **Jointing:** Joints are generally of rigid type. Where specified flexible type joints may also be provided.

(a) *Rigid Spigot and Socket Joint (Fig. 19.10):* The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine 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.

(b) *Rigid Collar Joint (Fig. 19.10):* The two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) which shall be rammed with caulking tool. After a day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

(c) *Semi Flexible Spigot and Socket Joint (Fig. 19.10):* The joint is composed of specially shaped spigot and socket ends on the concrete pipes. A rubber ring shall be placed on the spigot which shall be forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and the socket, stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

(d) *Semi Flexible Collar Joint:* This is made up of a loose collar which covers two specially shaped pipe ends as shown in the Fig. 19.10. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. Stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand), shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

(e) *Internal Flush Joint (Fig. 19.10):* This joint is generally used for culvert pipe of 60 cm dia and over. The ends of the pipe are specially shaped to form a self centering joint with an

internal jointing space 1.3 cm wide the finished joint is flush with both inside and outside with the pipe wall as shown in Fig. 19.10. The jointing space is filled with cement mortar 1:2 (1 cement: 2 fine sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. After day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

(f) *External Flush Joint* : This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends as shown in Fig. 19.10. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.

(x) In all pressure pipe lines the recess at the end of the pipe line shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

The number of pipes that shall be jacked together at a time shall depend on the diameter of the pipes and the bearing capacity of the soil, for small pipes up to 25 cm diameter, six pipes can be jacked together at a time.

The quantity of jute and bitumen in the ring shall be just sufficient to fill the recess in the pipe when pressed hard by jacking or by any other suitable method. Before and during jacking care shall be taken to see that there is no offset at the joint.

(xi) *Testing*: For pressure pipes, the completed pipeline shall be tested for pressure (Known as site test pressure) which shall not be less than the maximum pipeline operating pressure plus the calculated surge pressure, but in no case shall it exceed the hydrostatic test pressure. For nonpressure pipes the joints shall be tested.

(xii) *Refilling of Trenches*: The specification described in 19.2.1.2 (v) shall apply. In case where pipes are not bedded on concrete special care shall be taken in refilling, trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe and rammed with a shovel and light tamper. This method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe and continued up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping shall be done within 15 cm of the top of pipe. The tamping shall become progressively heavier as the depth of the backfill increases.

(xiii) *Measurements* : The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, collars, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

(xiv) *Rate*: The rate shall include the cost of materials and labour involved in all the operations described above.

54.0 Providing and fixing 40mm thick (minimum) cladding comprising of second Class kail wood framework using 25mx50mm sections at a maximum spacing of 600mm in any one direction (including adding members as required) covered with 12mm thick BWP ply layered with 4mm thk. veneer on one side pasted and pressed with adhesive to give a uniform and smooth finish, including 4mm thk. S.S. strip framework of grade 304 on all sides of veneer panels with wooden member surround, top mouldings / margins, melamine polish etc. to finish the thickness, as shown complete in drawing. All members / ply etc. shall be treated with anti-termite solution as per norms. No extra shall be paid for making of openings, door / window frames and for making provisions for electric conduits. complete in all respects as per direction of the Engineer-in-charge.

55.0 Fittings

Fitting shall be of Stainless Steel made of approved manufacturer. These shall be of the following types according to the material used. The sample of fittings to be actually provided in a particular work shall however be approved by ENGINEER - IN – CHARGE prior to bringing in bulk quantities at site. Approved samples shall be kept at site for any reference. Screws used for fittings shall be of the same metal. The rate quoted for doors shall include all necessary hardware and screws as generally required to complete the job, as specified in the relevant items of BOQ and as per PWD and IS specifications.

55.1 Measurement

The rates quoted by the Contractor under each item in the Bill of Quantities for a complete finished item of and no claims by the Contractor in this regard shall be admissible. Supplying and fixing of all the fittings and iron mongery shall be deemed to have been included in Contractor's rates and consequently shall not be paid for separately.

56.0 Wooden Flooring

Produced should be Exotics Bruce range with 7 Ply construction Engineered wood of most reputed brand. The length of the range varies from 400mm to 1200 mm, width being 120mm and thickness 12mm to give a variety of dimensional choices. The veneer thickness of the products remains to be 2mm with only African teak offering you a veneer thickness of 0.6mm. The edge offers you in micro beveled shape with Permion finish in order to resist stains and spots. The range may be of different shades viz. Golden oak, Oak toast, Smoked Oak, Hickory antique natural, Hickory Brandy wine, Hickory Antler brown, Walnut autumn dusk, Sapele exotic spice and African teak. The Hickory range has distressed feature to give the plank a more premium look.

56.1 Installation:

It is important to ensure the sub floor on which the planks are being laid is smooth, flat & hard & free from moisture, greases, etc. In case of uneven sub floor the same should be leveled by self leveling compound. The moisture level present in the sub floor should be less than 8% before installation of the floor. The Engineered planks must be installed on a thin layer of underlayment to keep the wood safe from moisture below and keep it noise proof. The planks can be fixed easy with its lock and fold installation system. The installation should be carried out as per the manufacturer installation guide and process.

56.2 Maintenance:

The manufacturer should recommend the cleaning system is recommended for the floors and the floor should be mopped with a microfiber mop. The floor needs to be dry mopped and vacuumed once a week. Do use an exterior and an interior door mats to prevent dusts settle on the floor. Use furniture leg cover to protect your floors and do trim nails of your pets regularly. Note: Spills need to be cleaned and mopped immediately. If stain remains, follow manufacturers cleaner instructions to remove it.

57.0 Providing & fixing trap door in the false ceiling using 19 mm thk commercial ply laminated with approved finish 1mm thick laminate with necessary 2nd Class teak frame work of size 2" x 1.5", Oak wood mouldings as per Architect's drawing, brass hinges, latches etc. complete in all respect as directed by Engineer-in-charge.

58.0 Providing and making 75mm deep suspended feature panel ceiling comprising of 19mm Thk. Commercial Board layered with 4mm Thk. Italian Veneer ply including all edge mouldings, melamine polish, suspension system etc. complete as per drawing & as directed by Engineer-in-charge.

59.0 Providing and fixing over glass 1.5mm thick Etching strips (film) of approved make fixed as per manufacturer's specifications all complete as per direction of the Engineer-in-charge.

- 60.0** Providing and laying foam concrete filling in sunken portion of W.C. & kitchen with approved quality of cinder including supply of labour, material, and tools and plant etc. required for proper completion of the work as per direction of Engineer-in-charge.
- 61.0** Providing and fixing 2mm thk grade-304, SS Kick plate over flush door with suitable adhesives, screws etc. all complete as per direction of Engineer-In-Charge.
- 62.0** Providing & fixing Chicken wire mesh on joints of RCC & Brick work before plastering complete in the direction of Engineer-in-charge.
- 63.0** Supply & Planting best quality trees inclusive of cultivation of trees bead to required depth. All trees / plants to be approved before planting including watering & maintenance for 180 days.

64 LIST OF MAKES AND MANUFACTURER'S CIVIL / INTERIOR WORKS:

All materials and products shall conform to the relevant standard specification, IS and other relevant codes etc. as applicable and updated from time to time.

- | | | |
|----|---|--|
| 1. | EPOXY, GROUTING MORTAR/ADMIXTURES | MBT, SIKA, STP,
ENDURA, DUBOND,
KERAKOLL |
| 2. | WATERPROOFING CHEMICALS
DUPONT, PIDILITE | UMB, KRYTON, XYPEX, CICO, |
| 3. | EXPANSION/ REBAR/ANCHOR FASTENER | HILTI, BOSCH, FISHER |
| 4. | ALUMINIUM BLDG. EXPANSION JOINT | MANUFACTURED BY
M/S VEXCOLT
AND SUPPLIED BY M/S
TRISTAR INTEC PVT. LTD, M/S
WATSON BOWMAN, ACME
AND SUPPLIED BY SANFIELD
INDIA LTD., MANUFACTURED
BY M/S C/S EXPANSION JOINT
AND SUPPLIED BY M/S Z-TECH
INDIA PVT. LTD,
MANUFACTURED BY, J. SONS,
METCO, CS GROUP, P.D.Projects |
| 5. | PLYWOOD
BWR GRADE) | DUROPLY (GREEN MARKED,
OF SARDA PLYWOOD
INDUSTRIES LTD., GREEN
PLYWOOD, JYOTI PLY,
CENTURY, ARCHID PLY,
MAYUR |
| 6. | BLOCK BOARD | DUROBOARD OF SARDA
PLYWOOD,CENTURY,
GREEN, GARNET, ARCHID
PLY, MAYUR |
| 7. | INDIAN VENEERS | DUROBOARD OF SARDA
PLYWOOD INDUSTRIES
LTD.,(NATURE SIGNATURE)
CENTURY,GREENLAM,
ARCHID PLY, MAYUR |

Tenderer's Signature and Stamp

8.	PLASTIC LAMINATES	CENTURY, MERINO, REENLAM, FORMICA, AMULYA
9.	ADHESIVE	PIDILITE, ARALDITE, CENTURY
10.	FLUSH DOORS	NON DECORATIVE DURO, CENTURY, GREENLAM
11.	ALUMINIUM SECTIONS	INDIAN ALUMINIUM CO. / HINDUSTAN ALUMINIUM/JINDAL, BHARUKA, MAHAVIR
12.	FLOAT GLASS/ MIRROR	SAINT GOBAIN, ASAHI INDIA, MODIGUARD
13.	ALUMINIUM COMPOSITE PANELS	ALUCOBOND,RENOBOND, DURABUILD, ALSTONE,ALU- DÉCOR,ALSHINE
14.	POWDER COATINGS PAINTS	BERGER/ POLYCOATNEROLAC /JENSON& NICHOLSON, ASIAN PAINTS,RAPID COAT
15.	ASPHALT EMULSION	STP / KARNAK CHEMICAL CORPORATION
16.	ROOF SHEETING	GE, ZESTHA, MIDORI, DANPLON, STANDING SEAM
17.	FIRE DOOR	GODREJ, SHAKTI, KUTTY, GMP , GODREJ OR EQUIVALENT
18.	TILE JOINT FILLER	“ROFF RAINBOW TILE MATE” OF ROFF CONSTRUCTION CHEMICALS PVT LTD., WINSIL 20/ SILICON SEALANT OF GE BAYER SILICON, MATRIX GROUP, DUBOND, and KERAKOLL
19.	POLYSULPHIDE SEALANTS	PIDILITE INDUSTRIES LTD./STP OR EQUIVALENT
20.	SILICONE SEALANTS	G.E. BAYER SILICONE/ DOW CORNING/ WACKER, REMMERS
21.	PAINTS	I.C.I./BERGER/ JENSON & ASIAN PAINTS, NEROLAC, NICHOLSON
22.	TEXTURE PAINTS	SPECTRUM, UNITILE, OIKOS

Tenderer's Signature and Stamp

23.	POLYURETHANE PAINT	MRF OR EQUIVALENT
24.	WAX POLISH	RECKITT & COLMAN OR EQUIVALENT
25.	MELAMINE	ICI DULUX, TIMBERSTONE MELAMINE COATING OR EQUIVALENT
26.	SILICON WATER REPELLENT SOLUTION	G.E. BAYER SILICON (I) P LTD., METROARK P LTD OR “SILICON WATERPELLER” BY STP LTD, “NISIWA-SH” OF MC- BAUCHEMIE (INDIA) P LTD., “TECHREPEL” OF CHOKSY CHEMICALS P LTD.
27.	STAINLESS STEEL RAILINGS	SALEM STEEL, CAVELIER, JINDAL
28.	VITRIFIED TILE	RESTILE, JOHNSON, SOMANY, KAJARIA, RAK, NAVIN, NITCO
29.	CERAMIC TILE	KAJARIA, SOMANY, JOHNSON, NAVIN, NITCO
30.	CEMENT	BIRLA UTTAM, VIKRAM, JK, ACC, LAFARGE, INDIA CEMENT
31.	GYPSUM CEILING	INDIA GYPSUM OR EQUIVALENT
32.	MINERAL FIBRE TILES	ARMSTRONG, AMF, USG, SAINT GOBIN
33.	LAMINATED WOODEN FLOORING	KRONO, PERGO, HARO, BERRY, ARMSTRONG
34.	VENETIAN BLINDS DOUGLAS, OR	MAC DÉCOR, VISTA, HUNTER EQUIVALENT
35.	PVC FLOORING	POLYFLOR, TARKET, ARMSTRONG, GERFLOR, RESPONSIVE
36.	MDF	NUWUD, URO
37.	STRETCHER GUARD /CHAIR RAIL	CS GROUP, GERFLOR
38.	CHAIR	GODREJ, BLOWPLAST, FEATHERLITE, WIPRO, HERMAN MILLER, GEEKEN

- | | | |
|-----|-----------------|--------------------------|
| 39. | FURNITURE | GODREJ OR EQUIVALENT |
| 40 | LINOLEOUM FLOOR | ARMSTRONG, TARKET, FORBO |

65 TECHNICAL SPECIFICATIONS FOR PLUMBING & FIRE FIGHTING WORKS

Section I General Requirements

1 Scope of work

- 1.1 The form of Contract shall be according to the "Conditions of Contract". The following clauses shall be considered as an extension and not in limitation of the obligation of the Contractor.
- 1.2 Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialised services as described hereinafter and as specified in the schedule of quantities and/or shown on the plumbing drawings.
- 1.3 Without restricting to the generality of the foregoing, the sanitary installations shall include the following:-
- A. Plumbing Works**
- Sanitary Fixtures
 - Soil, Waste, Vent, Rainwater Pipes & Fittings
 - Water Supply System
 - Garden Irrigation System
 - Sewerage & Storm Water Drainage
- B. Fire Suppression Works**
- Wet riser System
 - Hand Appliances
 - Fire Pumps at Pump Room
- C. Water supply Pumps**
- Pumps & Allied Equipment
- 1.4 Services rendered under this section shall be done without any extra charge.

2 Specifications

- 2.1 Work under this Contract shall be carried out strictly in accordance with specifications attached with the tender.
- 2.2 Items not covered under these specifications or due to any ambiguity or misprints, or additional works, the work shall be carried out as per specifications of the latest Central Public Works Department with up to date amendments as applicable in the Contract.
- 2.3 Works not covered under Para 2.1 and 2.2 shall be carried out as per relevant Codes & Bureau of Indian Standards and in case of its absence as per British Standard Code of Practice.

3 Execution of work

- 3.1 The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work. No extra charge made in consequence of any misunderstanding, incorrect information on any of these points or on ground of insufficient description will be allowed.

- 3.2 The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural, HVAC, electrical, structural and other specialised services drawings.
- 3.3 The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners.
- 3.4 On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the Project Manager/Architect/ Consultant. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of completion/ commissioning along with the specified phasing, if any.

4 Drawings

- 4.1 Contract drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the architectural and other services drawings.
- 4.2 Architectural drawings shall take precedence over plumbing or other services drawings as to all dimensions.
- 4.3 Contractor shall verify all dimensions at site and bring to the notice of the Project Manager all discrepancies or deviations noticed. Decision of the Project Manager shall be final.
- 4.4 Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.
- 4.5 Any drawings issued by the Architects/Consultant for the work are the property of the Architects/ Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

5 Inspection and testing of materials

- 5.1 Contractor shall be required, if requested, to produce manufacturers test certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Bureau of Indian Standards.
- 5.2 For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following:
- a) Steel tapes
 - b) Weighing machine
 - c) Plumb bobs, spirit levels, hammer
 - d) Micrometers
 - e) Hydraulic machine
- 5.3 All such equipment shall be tested for calibration at any approved laboratory, if required by the Project Manager. All testing equipment shall be preferably located in special room meant for the purpose.
- 5.4 Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Project Manager.

6 Metric conversion

- 6.1 All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.
- 6.2 Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

7 Reference points

- 7.1 Contractor shall provide permanent bench marks, flag tops and other reference points and check that with other agencies to confirm the same reference point for all the proper execution of work and these shall be preserved till the end of the work.
- 7.2 All such reference points shall be in relation to the levels and locations, given in the architectural and plumbing drawings.

8 Reference drawings

- 8.1 The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.
- 8.2 All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.
- 8.3 On award of the work the contractor shall be issued four sets of consultant's working drawings stamped "good for construction" by the Project Manager. The consultant's drawings shall be the basis of contractor's shop drawings. In addition, the Project Manager shall also issue one copy of the Interior Designer's; Electrical & HVAC approved shop drawings relevant to his work
- 8.4 Shop drawings are detailed working drawings which incorporate the contractor's details for execution of the work and incorporate equipment manufacturer's details and dimensions to ensure that the same can be installed in the space provided.
- 8.5 All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully co-ordinated with other services and approved by the Project Manager before execution of the works. Project Manager shall arrange to issue two copies/prints of services drawings from the respective contracting agencies. Additional copies/prints may be provided on payment of actual cost of the copies/ prints. **All drawings will valid only when stamped and issued by the Project Manager.**
- 8.6 Shop drawings shall also be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.
- 8.7 Six sets of manufacturer's equipment drawings, roughing in and wiring diagrams shall be submitted.
- 8.8 Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.
- 8.9 Three copies of each set of shop drawings shall be submitted for initial scrutiny, discussion and approval.
- 8.10 Each submission shall be accompanied by contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.

- 8.11 On approval of the above the contractor shall furnish six sets of the approved shop drawings for execution of the work.

9 Completion drawings

- 9.1 On completion of work, Contractor shall submit one complete set of original tracings and two prints of "as built" drawings to the Project Manager. These drawings shall have the following information.

- a) Run of all piping, diameters on all floors, vertical stacks and location of external services.
- b) Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.
- c) Run of all water supply lines with diameters, locations of control valves, access panels.
- d) Location of all mechanical equipment with layout and piping connections and mechanical equipment.
- e) All shop drawings shall be updated from time to time for the purpose of making completion drawings.

No completion certificate shall be issued unless the above drawings are submitted.

- 9.2 Contractor shall provide four sets of catalogues, service manuals, manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.
- 9.3 All "warranty cards" given by the manufacturers shall be handed over to the Project Manager.

10. Contractor's rates

- 10.1 Rates quoted in this tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, octroi and levies, breakage, wastage and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.
- 10.2 Rates quoted are for all heights and depths and in all positions as may be required for this work.
- 10.3 All rates quoted must be for complete items inclusive of all such accessories, fixtures and fixing arrangements, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.
- 10.4 All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete/water proofing of appropriate mix and strength as directed by the Project Manager. Contractor shall provide holes, sleeves, recesses in the concrete and masonry work as the work proceeds. All hot and cold water supply pipes crossing masonry walls shall be provided with G.I. pipe sleeves. The annular space between the pipe and sleeve shall be filled up with fire proof sealant after testing. Contractor shall give the pipe sleeves to the civil contractor well in time so that the same can be fixed along with civil works. Any co-ordination gap shall be of contractor's responsibility.
- 10.5 The Contractor shall furnish the Project Manager with vouchers & test certificates, on request, to prove that the materials are as specified and to indicate that the rates at which the materials are purchased in order to workout the rate analysis of non tendered items which he may be called upon to carryout.

11 Testing

- 11.1 Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.
- 11.2 Tests shall be performed in presence of the Project Manager and test records for the tests shall be duly signed by Contractor and the Project Manager.
- 11.3 All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.
- 11.4 Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.
- 11.5 Contractor shall provide all labour, equipment and materials for the performance of the tests.

12 Site clearance and cleanup

- 12.1 The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site.
- 12.2 After the fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints, stains, stickers and other foreign matter or discolouration leaving the same in a ready to use condition.
- 12.3 On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Project Manager at the Contractor's risk and cost. Cost of the cleanup shall be deducted from the contractor's bills on pro-rata basis in proportion to his contract value.

13 Licence permits and authorities

- 13.1 Contractor must hold a valid plumbing or any other as required licence by the municipal authority or other competent authority under whose jurisdiction the work falls.
- 13.2 Contractor must keep constant liaison with the local development, municipal/statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.
- 13.3 Contractor shall obtain, from the municipal and other authorities 'C' & 'D' & other forms as required for approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. CLIENT shall reimburse the fees paid to the authorities towards the connection charges on production of receipts for money paid.
- 13.4 Contractor shall get any materials tested from the appropriate authority if so required with no cost to the CLIENT.

14 Recovery of cost for materials issued to Contractors free of cost

If any material issued free of cost by the CLIENT to the contract for use on the work and the same is lost, stolen, pilfered or broken while in contractor's possession, the cost of the same shall be recovered from the Contractor on the basis of actual cost to CLIENT. The cost shall include the cost paid, freight, transportation, excise duty, sales tax, octroi, import duty and other levies, plus 100% as penalty. The decision on the actual cost given by the CLIENT shall be final and binding on the Contractor.

- 14.1 Contractor has to keep full records of material issued by the CLIENT with reference and challans etc. Contractor has to give account of all such materials to the Project Manager.

15 Cutting of Water Proofing Membrane:

No walls terraces shall be cut for making and opening after water proofing has been done without written approval of project manager. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water

proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Project Managers.

16 Cutting of structural members

No structural member shall be chased or cut without the written permission of the Project Manager

17 Materials supplied by CLIENT.

The Contractor shall verify that all materials supplied by the CLIENT conform to the specifications of the relevant item in the tender. Any discrepancy found shall be brought to the notice of the Project Manager.

18 Materials

18.1 Unless otherwise specified and expressly approved in writing by the Project Manager, only materials of makes and specification as mentioned in the list of approved makes attached with the specifications shall be used.

18.2 If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Project Manager.

Section II Sanitary Fixtures

1 Scope of work

- 1.1 Work under this section shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required by the drawings specified hereinafter and given in the Schedule of Quantities.
- 1.2 Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-
- a) Sanitary fixtures
 - b) Chromium plated fittings
 - d) Accessories e.g., toilet paper holders, soap dish, coat hooks etc.
 - e) Connections to all kitchens, equipment, pump headers and other equipment requiring water and drainage connections.
- 1.3 Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.
- 1.4 All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

2 General requirements

- 2.1 Sanitary fixtures and C.P. fittings in manufacturer's packing as specified in the schedule of quantities shall be supplied by the Contractors.
- 2.2 All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, screws and required connection pieces, WC flexible connectors etc.
- 2.3 Fixing screws shall be half round head chromium plated brass screws with C.P. washers where necessary.
- 2.4 Contractor shall furnish without cost all such accessories and fixing devices that are necessary and required but not supplied along with the Plumbing Fixtures & CP Fittings by the manufacturers as a part of the original and standard supply.
- 2.5 All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.
- 2.6 Contractor shall seal all fixtures fixed near wall, marble and edges with an approved type of poly-sulphide sealant appropriate for its application.

3 European W.C

- 3.1 European W.C. shall be wash down or syphonic type floor or wall mounted set flushed by means of porcelain/ plastic flushing cistern, which will be an integral part of the WC system. **Framework, walling and finishing will not form a part of the contractor's work.** Where applicable flush pipe/ bend shall be connected to the W.C. by means of a suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.
- 3.2 Each W.C. set shall be provided with a plastic seat shall be with rubber buffers and chromium plated hinges.
- 3.3 Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Each W.C. shall be suitable for flushing in low volume of water 3-6 litres.

- 3.4 Flushing cistern when provided shall be provided with all internal flushing mechanism, 15 mm dia ball cock with unbreakable polythene float and overflow pipe. Any frame work required for fixing cistern has to be provided by the contractor.

4 Urinals

- 4.1 Urinals shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.
- 4.2 Bowl urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia stainless steel domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by C.I. brackets and C.I. wall clips as recommended by manufacturers complete as directed by Project Manager.
- 4.3 Urinals shall be fixed with C.P. brass screws and shall be provided with 32 mm dia domical waste leading to urinal's trap.
- 4.4 Flush pipes shall be G.I. pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Schedule of Quantities.
- 4.5 Urinals shall be flushed by means of fully automatic no-touch flush valve with solenoid valves.
- 4.6 Waste pipes for urinals shall be G.I pipes (Medium class) to IS: 1239 or uPVC class III (6 kg/sqcm) conforming to IS: 4985 as given in schedule of quantities.

Waste pipes may be exposed on wall or concealed in chase as directed by the Project Manager. Specifications for waste pipes shall be same as given in Section II.

5. Wash Basins

- 5.1 Wash basins shall wall mounted type or Counter top type as specified in the BOQ.
- 5.2 Each basin shall be supported on MS galvanised or CI brackets and clips and the basin securely fixed to wall or on the counter. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.
- 5.3 Each basin shall be provided with 32 mm dia C.P.waste with overflow, pop-up or standard waste with rubber plug and chain, 32 mm dia C.P. brass bottle trap with CP pipe to wall and flange.
- 5.4 Each basin shall be provided with a Hot & cold CP mixer with pop up waste fittings, 32 mm dia. CP cast brass bottle trap with outlet pipe and wall flange.
- 5.5 Some of the selected wash basins as identified in the BOQ shall be similar to the one described above but the supply tap shall be a Magic Eye Infrared operated automatic hot and cold mixing fittings.
- 5.6 Washbasins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms or as directed by Project Managers.

6 Accessories

- 6.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings or directed by the Project Manager.
- 6.2 All C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Project Manager.
- 6.3 Recessed porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work as per Interior Designer's drawings.

7 Urinal partitions

- 7.1 Urinal partitions shall be white glazed vitreous china, marble, granite or any other material selected by the Project Manager..
- 7.2 Urinal partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners And M.S. Clips as recommended by the manufacturer and directed by Project manager

8 Measurement

- 8.1 Sanitary fixtures and accessories shall be measured by numbers in the unit given in the Schedule of Quantities.
- 8.2 Rates for all items shall be inclusive of cutting holes and chases and making good the same, C.P Brass screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning.

SECTION III: SOIL, WASTE, VENT & RAINWATER PIPES & FITTINGS

1. SCOPE OF WORK

- 1.1 Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the Schedule of Quantities.
- 1.2 Without restricting to the generality of the foregoing, the soil, waste & vent and rainwater piping system shall include the following:-
- a) Vertical and horizontal soil, waste & vent and rainwater pipes and fittings, joints, clamps and connections to fixtures.
 - b) Connection of all pipes to sewer lines as shown on the drawings at ground floor levels.
 - c) Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads.
 - d) Testing of all pipe lines.

2. GENERAL REQUIREMENTS

- 2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.
- 2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 2.4 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- 2.5 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

3. CAST IRON PIPES & FITTINGS

- 3.1 Pipes
- 3.1.1 Soil, waste, vent and anti-siphon age pipes shall be cast iron pipes. All pipes shall be straight and smooth and inside free from irregular bore, blow holes, cracks and other manufacturing defects. Pipes shall be centrifugally spun iron soil pipes conforming to I.S. 3989-1970 as given in schedule of quantities.
- 3.1.2 Standard weight, dimensions and pig lead required for joints shall be as follows:-

For pipes conforming to I.S. 3989-1970 (centrifugally spun soil pipes)

S. N.	Nominal diameter		thickness	overall Weight 6'length 1.83 mm	internal diameter of socket	depth of lead
	in	mm	mm	Kg	mm	mm
1.	2	50	3.5	8.5	73	25
2.	3	75	3.5	12.7	99	25
3.	4	100	4.0	19.2	126	25
4.	6	150	5.0	35.5	178	38

3.1.3 Tolerance: Acceptable tolerance for pipes to IS : 3989 and IS : 1729 shall be as follows:-

- a) Wall thickness -15%
- b) Length +/- 20 mm
- c) Weight -10%

4. UPVC PIPES & FITTINGS“

4.1 Pipes

- 4.1.1 uPVC pipes for drainage system shall be un-plasticized (rigid) PVC pipes conforming to I.S.: 4985 as specified in schedule of quantities.
- 4.1.2 Fittings for the pipes shall be injection molded with approved type of sockets and 'O' rings joints/solvent welded joints as per recommendations of the manufacturers.
- 4.1.3 Jointing shall be done as per the manufacturers recommendation. The pipes and fittings must have matching dimensions for a perfect joint. Loose or excessively tight joints in the system shall not be accepted. Fittings must have sufficient gap (approx. 10 mm) for permissible thermal expansion of pipes.
- 4.1.4 uPVC pipes shall be clamped to the wall with approved type uPVC saddle clamps.

4.2 Fittings

- 4.2.1 Fittings shall conform to the same Indian Standard as for pipes. Contractor shall use pipes and fittings of matching specifications.
- 4.2.2 Fittings shall be of the required degree of curvature with or without access door.
- 4.2.3 Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

4.3 Fixing

- 4.3.1 All vertical pipes shall be fixed by M.S. clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).
- 4.3.2 Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- 4.3.3 Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such ovisions in the structure as necessary. All damages shall be made good to restore the surfaces.

5. CLAMPS

- 5.1 Holder bat clamps shall be of standard design and fabricated from M.S. flats 40x3 mm thick and 12 mm dia M.S. Rod and 6 mm nuts and bolts. They shall be painted with two coats of black bitumen paint before fixing. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.
- 5.2 Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.
- 5.3 Structural clamps shall be fabricated from M.S. structural members e.g. rods, angles, channels flats as per detailed drawing or as directed. Contractor shall provide all nuts, bolts, welding material and paint the clamps with one coat of red oxide and two or more coats of black enamel paint.
- 5.4. Slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.
- 5.5 Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.

6. TRAPS

- 6.1 Nahni trap or floor traps: Nahni traps or floor traps shall be cast iron, deep seal with an effective seal of 50 mm. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1 cement :2 coarse sand :4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30x30 cms of the required depth.

- 6.2 Urinal traps: Urinal traps shall be cast iron P or S traps with or without vent and set in cement concrete block specified in Para above without extra charge.
- 6.3 Floor trap inlet: Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type Galvanized iron inlet fitting hopper fabricated from 100 mm GI (IS:1239 -Medium class) pipe without or with one, two or three inlet sockets to receive the waste pipe (s). Joint between waste and hopper inlet socket shall be lead caulked. Hopper shall be connected to a C.I. P or S trap with at least 50 mm seal (hopper and traps shall be paid for separately.) Floor trap inlet hoppers and the traps shall be set in cement concrete blocks as specified in Para above without extra charge.
- 6.4 Floor Trap Grating: Floor and urinal traps shall be provided with 75-150mm square or round C.P./Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm (for C.P. brass) or 1.2 mm (for SS), as specified in the Schedule of Quantities.

7. JOINTING

- 7.1 Soil, waste vent, anti-syphonage and rainwater pipes shall be jointed with refined pig lead conforming to I.S.27-1977. leave a minimum space for the pig lead as given in Para 3.1.2 to be poured in. After the pouring the lead shall be caulked into the joint with caulking tool and hammer. all surplus lead shall be cut and joint left flush with the rim of the socket neatly.

8. CLEANOUT PLUGS

- 8.1 Contractor shall provide cast brass cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for opening . Cleanout plugs shall be fixed to the pipe by a G.I. socket and lead caulked joint.

9. WASTE PIPE FROM APPLIANCES

- 9.1 Waste pipe from appliances e.g. washbasins, sinks and urinals shall be of galvanized steel or P.V.C. as given in the Schedule of Quantities.
- 9.2 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps. Spacing for clamps for such pipes shall be as follows:-

	Vertical	horizontal
G.I. pipes	300 cms	240 cms
P.V.C. pipes	180 cms	120 cms

- 9.3 Galvanized pipes: Pipes shall be galvanized steel tubes conforming to I.S.1239-1979 (medium class) and quality certificates shall be furnished. Pipes shall be provided with all required fittings e.g. tees, couplings, bends, elbows, unions, reducers, nipples, plugs. All G.I. waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes in chase shall be painted with two coats of black bitumen paint and exposed pipes with one coat of red oxide primer and two or more coats of synthetic enamel paint or as given in the Schedule of Quantities.

10. KHURRAS

10.1 The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be 45cmx45cm unless otherwise specified in the description of the item and shall be formed of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

10.2 Laying:

10.2.1 A PVC sheet 1mx1mx400 micron shall be laid under the khurras and then cement concrete shall be laid over it to average thickness of 50mm with its top surface lower than the level of adjoining roof surface by not less than

- a) 20mm in case of roof surface finished with lime concrete terracing.
- b) 70 mm in case of roof surface finished with lime concrete terracing covered with brick tiles.
- c) 50mm in case of roof surface finished with mud phuska with brick tile covering.

10.2.2 The concrete shall be laid to a size greater than the stipulated size of the khurras in such a way that the adjoining terracing whether of lime concrete or of the tile brick shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlets the slope as being as much as possible and in no case less than 20mm cement concrete at outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

10.2.3 The khurras and the side of the outlet shall than be rendered with 12mm coat of cement plaster 1:3 mix (1 cement:3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished with floating coat of neat cement. The sides of the khurras and the sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10cm wide by 20 cm high or as directed by Engineer -in-charge.

10.2.4 As a safeguard against choking of rainwater outlet through rain water pipes at terrace level, Cast Iron rainwater outlet fitting with aluminum ring and aluminum domical head (fixed with SS screw) of size 250x100 mm shall be provided as directed by the Engineer in-Charge.

11. CAST IRON PIPES FOR DRAINAGE

11.1 All drainage lines passing under building, floors, in exposed position above ground e.g. basement ceiling shall be cast iron pipes. Position of such pipes shall generally be shown on the drawings.

11.2 Cast iron pipes shall be centrifugally spun iron pipes conforming to I.S. 1536-1967. Quality certificates shall be furnished.

11.3 Fittings

- a) Fittings used for C.I. drainage pipe shall conform to I.S.1538-1967. Wherever possible junction from branch pipes shall be made by a Y tee.
- b) Cleanout plugs shall be provided on head of each drain and at location indicated on plans or directed by Engineer-in-Charge. Cleanout plugs shall be of size matching the full bore of the pipe. Plugs shall be made out with G.I. coupling caulked into the socket of the pipe or fittings. The end shall be provided with a brass screwed plug with suitable key for opening.

11.4 Laying

- a) All cast iron pipes and fittings shall be jointed with best quality soft pig lead (conforming to I.S. 27-1977) which shall be free from impurities. In wet trenches joints shall be made from lead wool. Nothing extra will be paid for lead wool joints. Depth of pig lead and weight for joints shall be as per I.S. code.
- b) The spigot of pipe or fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gaskin will be given to leave unfilled the required depth of socket for depth of 45 mm when the gaskin has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighing not less than 2 kg.
- c) For lead wool joints the socket shall be caulked with tarred gaskin, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home with lead wool with suitable tools and hammers of not less than 2 kg weight until joint is filled.

- 11.5 Testing: All cast iron pipes for drainage shall be tested to a hydraulic test of 3 meter head. A test register shall be maintained which shall be signed and dated by Contractor, Engineer-in-Charge and representative of Architect/Consultant.

12. CEMENT CONCRETE

- 12.1 Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of 1.8 m. Rate for concrete round pipes shall be inclusive of pillars, supports, shuttering and centering.

13. PAINTING

- 13.1 Soil, waste vent, anti-syphonage and rainwater pipes in exposed location in shafts and pipe spaces shall be painted with two or more coats of synthetic enamel paint to give an even shade.
- 13.2 Paint shall be of approved quality and shade. Where directed pipes shall be painted in accordance with approved pipe colour code.

13.3 G.I. waste pipes in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with two or more coats of synthetic enamel paint.

13.4 C.I. soil and waste pipes below ground and covered in cement concrete or lead pipes shall not be painted.

14. CUTTING AND MAKING GOOD

14.1 Pipes shall be fixed and tested as building proceeds. Contractor shall provide all necessary holes cut outs and chases in structural members as building work proceeds. wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

15. TESTING

15.1 Before use at site all C.I. soil pipes shall be tested by filling up with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Engineer-in-Charge.

15.2 Pipes shall be tested after installation, by filling up the stack with water. All opening and connections shall be suitably plugged. The total head in the stack shall be however not exceed 3 m.

15.3 Alternatively Contractor may test all soil and waste stacks by a smoke testing machine. Smoke shall be pumped into the stack after plugging all inlets and connections. The top end shall, however, be left open. The stack shall then be observed for leakages and all defective pipes and fittings removed or repaired as directed by the Engineer-in-Charge.

15.4 A test register shall be maintained and all entries shall be signed and dated by Contractors and Engineer-in-Charge.

16. MEASUREMENTS

16.1 General

16.1.1 Rates for all items quoted shall be inclusive of all work and items given in the above mentioned specifications and Schedule of Quantities and applicable for the work under floors, in shafts or at ceiling level at all heights and depths.

16.1.2 All rates are inclusive of cutting holes and chases in RCC and masonry work and making good the same.

16.1.3 All rates are inclusive of pre testing and on site testing of the installations, materials and commissioning.

16.2 Pipes (Unit of measurement: Linear meter to the nearest centimeter)

- 16.2.1. All uPVC & C.I. soil, waste, vent, anti-syphonage and rain water pipes shall be measured net when fixed correct to a centimeter including all fittings along its length. No allowance shall be made for the portions of pipe lengths entering the sockets of the adjacent pipes or fittings. The above will apply to both case i.e. whether pipes are fixed on wall face or pillars or embedded in masonry or pipes running at ceiling level.
- 16.2.2 G.I., pipes shall measured per running metre correct to a centimeter for the finished work which shall include fittings e.g. bends, tees, elbows, reducers, crosses, sockets, nipples and nuts. The length shall be taken along centre line of the pipes and fittings. All pipes and fittings shall be classified according to their diameter, method of jointing and fixing substance, quality, and finish. The diameters shall be nominal diameter of internal bore. The pipes shall be described as including all cutting and waste. In case of fittings of un equal bore, the largest bore shall be measured.
- 16.3 Cement concrete around pipes shall be measured along the centre of the pipe line measured per linear metre and include any masonry supports, shuttering and centering cutting complete as described in the relevant specifications.
- 16.4 Slotted angles/channels shall be measured per linear metre of finished length and shall include support bolts and nuts embedded in masonry walls with cement concrete blocks and nothing extra will be paid for making good the same.
- 16.5 Fittings: Unit of measurement shall be the number of pieces. All urinal traps, trap gratings, hoppers, cleanout plugs shall be measured by number per piece and shall include all items described in the relevant specifications and Schedule of Quantities.
- 16.6 Painting: Painting of pipes shall be measured per running metre and shall be inclusive of all fittings and clamps. No deduction for fittings shall be made.
- 16.7 Excavation for soil, waste, anit-siphonage and rainwater pipes: - no extra payment shall be admissible with respect to excavation, refilling and disposal of surplus earth for cast iron and uPVC pipes.
- 16.8 Khurras shall be counted in numbers. The rate for each completed khurra of the specified size shall include the cost of all materials and labour involved in forming the khurra an the outlet opening as described in specifications above, except for the rainwater head grating, which shall be paid separately.

Section IV Water Supply System

1. Scope of work

- 1.1 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities.
- 1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:-
- a) Distribution system from main supply headers to all fixtures and appliances for cold & hot water.
 - b) Cold water supply lines from city water connections to Under Ground Water Tank.
 - c) Garden irrigation system
 - d) Excavation and refilling of pipes trenches.
 - e) Pipe protection and painting.
 - f) Control valves, masonry chambers and other appurtenances.
 - g) Connections to all plumbing fixtures, tanks, appliances and municipal mains
 - h) Inserts for R.C.C. tanks

2 General requirements

- 2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.
- 2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 2.3 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- 2.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- 2.6 Clamps, hangers and supports on RCC walls, columns & slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.
- 2.7. All pipe clamps, supports, nuts, bolts, washers shall be galvanised MS steel throughout the building. Painted MS clamps & MS nuts, bolts & washers shall not be accepted.
- 2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3 Water Supply System

- 3.1 Contractor should study the site plan and the water supply systems one for domestic water supply.
- 3.1.1 Source
Water supply will be acquired from Municipal Corporation water mains (as available) to a service connection and collected in water storage tanks located underground.
- 3.1.2 The system has been connected to a gravity feed system from overhead tanks to all parts of the building
- 3.1.3 It is proposed to provide flushing cistern for all WCs. Infra red NO-TOUCH flush valves shall be provided for Urinals. These will be fed from over head tank by gravity.
- 3.1.4 Domestic water supply shall be provided with cold water system only. Hot water provisions to kitchen and all toilets connected to a local electric hot water storage geyser other than add on solar system at terrace for inlet of geyser in kitchen etc.

Tenderer's Signature and Stamp

4 (CPVC) G.I. pipes, fittings & valves

4.1 All pipes inside the buildings for domestic hot and cold water supply shall be CPVC conforming to CTs SDR-13.5 at a working pressure of 320 PSI at 23 deg.C. and 80 PSI at 82 deg. C.

4.2 Solvent welded CPVC fittings etc. tees, elbows, couplers, unions, reducers, brushing etc. including transition fittings (connection between CPVC and metal pipes/G.I. ie. Brass adapters conforming to ASTM D-2846) shall be provided.

4.3 All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. G.I. pipes inside toilets shall run above false ceiling with vertical drop in wall chases for all fixtures. No pipes to run inside sunken floor as far as possible. Pipes may run under the ceiling or floors and other areas as shown on drawings.

4.4 Joining Pipes & Fittings

a) Cutting

Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut. All burrs should be removed for proper contact between pipe and fittings during jointing.

b) Solvent Cement Application

Only CPVC solvent cement conforming to ASTM-F-493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket.

c) Assembly

After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up.

d) Testing

The system should be hydrostatically pressure tested at 150 psi (10 Bar) for one hour. During pressure testing, the system should be fitted with water and if a leak is found, the joint should be cut out the replaced with new one.

4.5 Transition of Flow guard CPVC in metals

When making a transition connection to metal threads, special brass/plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torque.

4.5.1 Threaded sealants

Teflon tape shall be used to make threaded connections leak proof.

4.5.2 Solvent Cement

Only CPVC solvent cement conforming to ASTM F 493 should be used for joining pipe with fittings and valves.

4.6 Hangers and supports

For Horizontal runs, support should be given at 3 feet (90 cms) intervals for diameters of one inch and below and at 4 feet (1.2 m) intervals for larger sizes.

Supports should be as per the below mentioned table:

Size of pipe	20°C	49°C	71°C	82°C
Inch	Ft.	Ft.	Ft.	Ft.
½"	5.5	4.5	3.0	2.5
¾"	5.5	5.0	3.0	2.5
1"	6.0	5.5	3.5	3.0
1¼"	6.5	6.0	3.5	3.5
1½"	7.0	6.0	3.5	3.5
2"	7.0	6.5	4.0	3.5

4.7. Anchor Fasteners

- 4.7.1 All pipe supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommend and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the DPL for any damage that may be caused by such failures.

4.8 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

4.9 Flanges

Flanged connections shall be provided on pipes as required or where shown on the drawings, all equipment connections as necessary and required or as directed by the Project Manager. Connections shall be made by correct number and size of GI nuts, bolts & washers with 3 mm thick gasket. Where hot water connections are made insertion gasket shall be of suitable high temperature grade and quality approved by the Project Manager. Bolt hole dia for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780. and C.I. butterfly valve to IS: 13095.

4.10 Trenches

All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia of pipe	Width of trench	Depth of trench
-----	-----	-----
15 mm to 50 mm	30 cms	75 cms
65 mm to 150 mm	45 cms	100 cms

4.11 Sand filling

G.I. pipes in trenches shall be protected with fine sand 15 cms all round before filling in the trenches.

4.12 Painting (Painting for CPVC pipes not required)

- 4.12.1 All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code given in this documents or specified by Project Manager.

4.13 Pipe protection (Protection for CPVC pipes not required)

4.13.1 All G.I. pipes in wall chase /below floors or laid under ground shall be protected against corrosion by the application of two coats of bitumen paint covered with polythene tape and a final coat of bitumen paint.

4.13.2 G.I. waste pipes buried in ground or sunken slab shall be protected with multilayer bitumen membrane tape 3mm thick with a final coat of hot or cold applied bitumen. Pypkote or equivalent.

4.14 Valves

4.14.1 Ball Valves

Valves upto 40 mm dia. shall be screwed type Ball Valves with stainless steel balls, spindle, teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm², and accompanying couplings and steel handles.(to BS 5351)

4.15 Butterfly Valves

4.15.1 Valves 50 mm dia and above shall be cast iron butterfly valve to be used for isolation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction with accompanying flanges and steel handle.

4.15.2 Butterfly valve shall be of best quality conforming to IS: 13095.

4.16. Non Return Valve (Slim Type)

Where specified non return valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality.

4.16.1 Each Butterfly and Slim Type Swing Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanised nuts, bolts and washers of correct length.

4.16.2 Storage tanks Underground & Overhead Tank. (Accessories & Connections)

4.16.6 Storage tanks for water supply shall be in reinforced cement concrete built by the building Contractor.

4.16.4 Each tank shall be provided with lockable type manhole cover fabricated from M.S. sheets. Manhole covers shall be 450-500 mm dia and fully galvanised after fabrication or as approved by the Project Manager.

4.17 Storage Tanks

4.17.1 Underground

Underground storage tanks for water supply shall be reinforced cement concrete built by the building contractor.

Each tank shall be provided with lockable type manhole cover fabricated from M.S. sheet or standard cost iron tank covers. Manhole covers shall be 450-500 mm dia or as approved by local municipal authority.

4.18 Outlets and overflow

All nozzles for puddle flanges in RCC tank for inlet, outlet, overflow and scour etc. shall be provided by civil contractor or as given in the Schedule of Quantities. Further connections and accessories shall be provided under this contract.

4.19 Testing

4.19.1 All pipes, fittings and valves after fixing at site, shall be tested by hydrostatic pressure of 1.5 times the working pressure or 10 kg/cm² whichever is more.

Pressure shall be maintained for a period of at least thirty minutes without any drop.

A test register shall be maintained and all entries shall be signed and dated by Contractor (s) and Project Manager.

- 4.19.2 In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the Contractor during the defects liability period without any cost.
- 4.19.3 After commissioning of the water supply system, Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

4.20 Measurement

- a) CPVC or G.I. pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of
- b) all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to wall or other standard supports.
- c) Jointing with teflon tape, white lead and insertion gasket of appropriate temperature grade.
- d) Cutting holes, and chases in walls, floors, any pipe support required for pipes below ground & making good the same.
- e) Excavation, back filling, disposal of surplus earth and restoring the ground & floor in original condition.

4.21 Pipe Supports.

Fabricated and galvanised supports shall be measured by weight. Weight for each type of clamp shall be calculated on basis of the quantity of structural and MS used from the theoretical weight calculated on basis of the components theoretical weight of the sections.

- 4.21.1 Rate quoted for supports & hangers shall be inclusive of:-

- a) Expandable anchor fastens.
- b) Galvanising of all supports & hangers.
- c) Cutting holes in walls, ceilings on floors and making good where permitted.
- d) Nuts, bolts and washers for fixing and assembling.
- e) Wooden/PVC pipe saddles for vertical or horizontal runs.

4.21.2 Valves

Gunmetal, cast iron, butterfly and non return valves and puddle flanges shall be measured by numbers and shall include wheels/caps, GI nuts, bolts, washers and insertion gasket.

4.21.3 Painting/pipe protection/insulation

Painting/pipe protection/insulation for pipes shall be measured per linear metre over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.

Section V Garden Irrigation System

Scope of Work

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to install garden hydrants and sprinklers and drip Irrigation water supply system as required by the drawings, specified hereinafter and as given in the Schedule of Quantities (BOQ).

6.1.1 Without restricting to the generality of the foregoing, the water supply system shall include the following:-

- a) Connections from the water supply system to all hydrants, sprinklers and drip irrigation points.
- b) Garden hydrants, surface sprinklers & pipe emitters.
- c) Excavation and refilling of pipes trenches.
- d) Control valves, masonry chambers and other appurtenances.
- e) Connections to all pumps & appliances.

6.2 The System

- 6.2.1 The garden hydrant and sprinkler irrigation system will be new and fully working system in the complex.
- 6.2.4 System components shall be pipes, valves, controllers, various types of sprinklers and drip irrigation lines with emitters as approved by the Project Manager.

6.3 General requirements

- 6.3.1 All materials shall be new of the best quality conforming to specifications. ' All works executed shall be to the satisfaction of the Project Manager.
- 6.3.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 6.3.3 Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.
- 6.3.4 Pipes shall be laid in a manner as to provide as far as possible easy accessibility for repair and maintenance. Pipes under roads shall be laid in RCC pipe sleeves.
- 6.3.5 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

6.4 HDPE Pipes and Fittings.

- 6.4.1 Garden hydrant mains shall be HDPE pipes conforming to IS: 4984 of class specified. If class is not mentioned in the schedule of quantities the same shall be Material Grade PF100, *unless other*

materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ.

6.4.2 Fittings for HDPE pipes shall be injection molded fitting suitable for thermal weld joints. Fittings must have suitable provision for expansion and shall be rated for the same working pressure as the pipeline, *unless other materials like uPVC schedule 40 or uPVC as per IS 4985 in accordance to specifications given above are specified in the BOQ.*

6.4.3 Thermal Joints shall be made in an approved manner as recommended by the manufacturer.

6.4.4 Provide flanges at intervals of 20-25 m. for all pipes 65 mm dia and above.

6.4.5 Provide suitable adapters for connection between pipes & valves.

6.4.6 Provide cement concrete supports and anchor blocks at all bends, tees and other locations as directed by the Project Manager. Connections at garden hydrant outlet, near valves must also be anchored.

6.4.7 **Drip Irrigation Pipes**

Pipes shall be LLDPE pipes of UC 7510 resin conforming to ASAE S-435 standard.

6.4.8 **G.I. Pipes & Fittings**

Vertical connection for garden hydrant points shall be galvanised steel tubes to IS12:1239 (medium class) with matching malleable iron fitting of approved make.

6.5 **Sprinklers**

Pop-up Sprinklers Pop-up sprinklers shall be underground with rugged plastic high impact case with precision jet spray guide arm control with brass head, Sprinklers shall be suitable for pressure and coverage given in the schedule of quantities.

SECTION VI - EXTERNAL SEWERAGE & EXTERNAL RAIN WATER DISPOSAL

1. SCOPE OF WORK

- 1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all the drainage system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.
- 1.2 Without restricting to the generality of the foregoing, the drainage system shall include:-
 - a) Sewer lines including excavations, pipe lines, manholes, drop connections and connections to the municipal or existing sewer.
 - b) Storm water drainage, excavation, pipe lines, manholes, catch basins and connections to the existing municipal storm water drain.

2. GENERAL REQUIREMENTS

- 2.1 All materials shall be of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.
- 2.2 Drainage lines and open drains shall be laid to the required gradients and profiles.
- 2.3 All drainage work shall be done in accordance with the local municipal bye-laws.
- 2.4 Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.
- 2.5 Location of all manholes, etc. shall be got confirmed by the Engineer-in-Charge before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Engineer-in-Charge.

3. EXCAVATION

- 3.1 Alignment and grade: The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in-Charge.
- 3.2 Excavation in tunnels: The excavation for sewer works shall be open cutting unless the permission of the Engineer-in-Charge for the ground to be tunneled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer-in-Charge may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

- 3.3 **OPENING OUT TRENCHES:** In excavating the trenches, etc. The solid road metalling, pavement, kerbing, etc. And turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully sifted. The surface of all trenches and holes shall be restored and maintained to the satisfactions of the Engineer-in-Charge and of the owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence of trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-Charge shall order to the contrary. The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Engineer-in-Charge.
- 3.4 **OBSTRUCTION OF ROADS:** The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Engineer-in-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.
- 3.5 **REMOVAL OF FILTH:** All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.
- 3.6 **EXCAVATION TO BE TAKEN TO PROPER DEPTHS:** The trenches shall be excavated to such a depth that the sewer shall rest on concrete as described in the several clauses relating there to and so that the inverts may be at the levels given in the sections. In bad ground, the Engineer-in-Charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, graven or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra at rates laid down for such works in the schedule, if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-Charge the extra depth shall have to be filled up with concrete at the Contractor's own costs and charges to the requirements and satisfactions of the Engineer-in-Charge.
- 3.7 **REFILLING:** After the sewer or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and up to 75 cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer-in-Charge shall otherwise direct.

- 3.8 **CONTRACTOR TO RESTORE SETTLEMENT AND DAMAGES:** The Contractor shall, at his own costs and Charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and Charges, repair and make good any damage done to buildings and other property. If in the opinion of the Engineer-in-Charge he fails to make good such works with all practicable dispatch, the Engineer-in-Charge shall be at liberty to get the work done by other means and the expenses thereof shall be paid by the Contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.
- 3.9 **DISPOSAL OF SURPLUS SOIL:** The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.
- 3.10 **TIMBERING OF SEWER AND TRENCHES:**
- a) The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be closed, timbered in loose or sandy strata and below the surface of the sub soil water level.
 - b) All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.
 - c) The Contractor shall be held responsible and will be accountable for the sufficiency of all timbering, bracings, sheeting and piling used as also for, all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.
- 3.11 **SHORING OF BUILDINGS:** The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.
- 3.12 **REMOVAL OF WATER FROM SEWER, TRENCH ETC:**
- a) The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed of by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.
 - b) If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the full width of the trench shall be filled with concrete by the Contractor at his own expenses and charges to the requirements of the Engineer-in-Charge.

- 3.13 **WIDTH OF TRENCH:** The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.
- 3.14 **RECOMMENDED WIDTH OF TRENCHES AT THE BOTTOM SHALL BE AS FOLLOWS:-**

1.	100 mm dia pipe	55 cms
2.	150 mm dia pipe	55 cms
3.	225-250 cms dia pipe	60 cms
4.	300 mm dia pipe	75 cms

Maximum width of the bed concrete shall also be as above. No additional payment is admissible for widths greater than Specified.

4. SALT GLAZED STONEWARE PIPES

- 4.1 Stoneware pipes shall be of first class quality salt glazed and free from rough texture inside and outside and straight. All pipes shall have the manufacturers name marked on it and shall comply to I.S. 651-1971 approved makes Perfect or Burn.
- 4.2 Laying and jointing of stoneware salt glazed pipes
- Pipes are liable to be damaged in transit and out withstanding tests that may have been made before dispatch each pipe shall be examined carefully on arrival at site. Each pipe shall be rung with a wooden hammer or mallet and those that do not ring true and clear shall be rejected. Sound pipes shall be carefully stacked to prevent damage. All defective pipes should be segregated, marked in a conspicuous manner and their use in the works prevented.
 - The pipes shall be laid with sockets leading uphill and should rest on solid and even foundations for the full length of the barrel. Socket holes shall be formed in the foundation sufficiently deep to allow the pipe jointer room to work right round the pipe and as short as practicable to admit the socket and allow the joint to be made.
 - Where pipes are not bedded on concrete the trench bottom shall be left slightly high and carefully bottomed up as pipe laying proceeds so that the pipe barrels rest on firm ground. If excavation has been carried too low it shall be made up with cement concrete at the Contractor's cost and Charges.
 - If the bottom of the trench consists of rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on cement concrete bed to ensure even bearing.
- 4.3 Jointing of pipes
- Tarred gaskin shall first be wrapped 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 its correct position and the gaskin caulked tightly home so as to fill not more than one quarter of the total length of the socket.

- b) The remainder of the socket shall be filled with stiff mix of cement mortar (1 cement: 1 clear sharp washed sand). When the socket is filled, a fillet should be formed round the joint with a trowel forming an angle of 45 degrees with the barrel of the pipe. The mortar shall be mixed as needed for immediate use and no mortar shall be beaten up and used after it has begun to set.
- c) After the joint has been made any extraneous materials shall be removed from inside of the joint with a suitable scraper of "badger". The newly made joints shall be protected until set from the sun, drying winds, rain or dust. Sacking or other materials which can be kept damp shall be used. The joints shall be exposed and space left all round the pipes for inspection by the Engineer-in-Charge. The inside of the sewer must be left absolutely clear in bore and free from cement mortar or other obstructions throughout its entire length, and shall efficiently drain and discharge.

4.4 Testing

- a) All lengths of the sewer and drain shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 metre head of water. The test pressure shall, however, not exceed 6 meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.
- b) Sewer lines shall be tested for straightness by:
 - (i) inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball should roll down the invert of the pipe and emerge at the lower end,
 - (ii) means of a mirror at one and a lamp at the other end. If the pipe line is straight the full circle of light will be seen otherwise obstruction or deviation will be apparent.
- c) The Contractor shall give a smoke test to the drains and sewer at his own expense and charges, if directed by the Engineer-in-Charge.
- d) A test register shall be maintained which shall be signed and dated by Contractor, Engineer-in-Charge and representative of Architects/Consultants.

- 4.5 Gully traps: Gully traps shall be of the same quality as described for stoneware pipes in clause 5. Gully traps shall be fixed in cement concrete 1:5:10 mix and a brick masonry chamber 30x30 cms inside in cement mortar 1:5 with 15x15 cms grating inside and 30x30 cms SFRC cover as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size (1 cement : 5 coarse sand: 10 stone aggregate 40 mm nominal size).

5. REINFORCED CEMENT CONCRETE PIPES

- 5.1 All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes of specified class. Pipes shall be true and straight with uniform bore, throughout. Cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.
- 5.2 Laying: R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be precast and sufficiently

cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12 mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. Cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge.

- 5.3 Jointing: After setting out the pipes the collar shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools. All joints shall be finished at an angle of 45 degrees to the longitudinal axis of the pipe on both sides of the collars neatly.
- 5.4 Testing: All pipes shall be tested to a hydraulic test of 1.5 m head for at least 30 minutes at the highest point in the section under test. Test shall also be carried out similar to those for stoneware pipes given above .the smoke test shall be carried out by the Contractor, if directed by the Engineer-in-Charge, at the expense and charges of the Contractor. A test register shall be maintained which shall be signed and dated by Contractor,/Engineer-in-Charge and representative of Architects/Consultant.

6. CEMENT CONCRETE AND MASONRY WORKS (FOR MANHOLES AND CHAMBERS ETC.)

6.1 Materials

- a) **Water:** Water used for all the constructional purposes shall be clear and free from oil, acid, alkali, organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered good enough for constructional purpose.
- b) **Aggregate for concrete:** The aggregate for concrete shall be in accordance with I.S.383 and I.S. 515.in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Engineer-in-Charge. The size of the coarse aggregate shall be done as per I.S.383.
- c) **Sand:** Sand for various constructional purposes shall comply in all respects with I.S. 650 and I.S. 2116. It shall be clean, coarse hard and stone, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Engineer-in-Charge as harmful for the construction.
- d) **Cement:** The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I.S.269.
- e) **Mild steel reinforcement:** The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I.S. 432 grade I.
- f) **Bricks:** Brick shall have uniform colour, thoroughly burnt but not over burnt, shall have plain rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Engineer-in-Charge.
- g) **Other materials:** Other materials not fully specified in these specifications and which may be required in the work shall conform to the latest I.S.. All such materials shall be approved by the Engineer-in-Charge before use.

6.2 Cement concrete (plain or reinforced)

- a) Cement concrete pipes bedding, cradles, foundations and R.C.C. slabs for all works shall be mixed by a mechanical mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Engineer-in-Charge. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.
- b) Concrete work shall be of such thickness and mix as given in the Schedule of Quantities.
- c) All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bags at all times. All pipes trenches and foundations shall be kept dry during the curing period.

6.3 Masonry work: Masonry work for manholes, chambers, septic tanks, and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Schedule of quantities in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

6.4 Cement concrete for pipe support:

- a) Wherever specified or shown on the drawings, all pipes shall be supported in bed all round or in haunches. The thickness and mix of the concrete shall be given in the Schedule of Quantities. Width of the bedding shall be as per Para 4.14.
- b) Unless otherwise directed by the Engineer-in-Charge cement concrete for bed, all round or in haunches shall be laid as follows:-

	upto 1.5 m depth	upto 3 m depth	beyond 3 m depth
Stoneware pipes all round in haunches all round in open ground (no sub soil water)	(1:5:10)	(1:5:10)	(1:5:10)
R.C.C or S.W. All round in haunches in haunches in sub soil water	(1:3:6)	(1:3:6)	(1:3:6)
C.I. Pipes all round in haunches in haunches	(1:3:6)	(1:3:6)	(1:3:6)
R.C.C. Pipes all round all round all round or C.I. pipes	(1:3:6)	(1:3:6)	(1:3:6)

- c) R.C.C. pipes or C.I. pipes may be supported on brick masonry or precast R.C.C. or in situ cradles. Cradles shall be as shown on the drawings.
- d) Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

7. MANHOLES AND CHAMBERS

- 7.1 All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) or as specified in the Schedule of Quantities.
- 7.2 All manholes and chambers, etc. shall be supported on base of cement concrete of such thickness and mix as given in the Schedule of Quantities or shown on the drawings. Where not specified, manholes shall be constructed as follows:-

	Size of manhole (all dimensions internal clear in cms)			
	90x80	120x90	90 dia	140 dia
Type	Rect	Rect	Conical	Conical
Maximum depth	150	240	250	500
Average thickness of R.C.C slab	15	15	-	-
Size of cover and frame	60x45	50 dia	50 dia	50 dia
Weight of cover and frame	As per IS: 12592 requirements	As per IS: 12592 requirements	As per IS: 12592 requirements	As per IS: 12592 requirements

- 7.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix. The benching shall have a slope of 10 cms towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coat of neat cement. (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nom. Size)
- 7.4 All manholes shall be plastered with 12/15 mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster.
- 7.5 All manholes with depths greater than 1 m. shall be provided with 20 mm square plastic foot rests set in cement concrete blocks 25x10x10 cms in 1:2:4 mix 30 cms vertically and staggered.
- 7.6 All manholes shall be provided with SFRC covers and frames and embedded in reinforced cement concrete slab. Weight of cover, frame and thickness of slab shall be as specified in the Schedule of Quantities or given above .

8. MAKING CONNECTIONS

- 8.1 Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

9. MEASUREMENT

9.1 Excavation

- 9.1.1 Measurement for excavation of pipe trenches shall be made per linear meter under the respective category of soil classification encountered at site.

- Ordinary soil
- Hard soil (hard moor & soft rock)
- Hard rock requiring chiseling
- Hard rock requiring blasting.

- 9.1.2 Trenches shall be measured between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth up to 1.5 m or as given in the Schedule of Quantities.

- 9.1.3 Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the schedule of quantities and above the rate for depth up to 1.5 m.
- 9.1.4 Timbering and Shoring: Timbering and shoring as described above shall be measured per sq.m and paid for as per the type of timbering of shoring done at site and as per the relevant item in the Schedule of Quantities. Rate for timbering and shoring shall be for all depths and types of soil classifications including saturated soil.
- 9.1.5 Saturated Soil: No extra payment for pumping and bailing out water shall be made for excavation with an average depth of 1.5 m in saturated soil, surface water from rain falls or broken pipes lines, or sieves and other similar sources. An extra rate as quoted in the schedule of quantities shall be paid for excavation in saturated soil for pipe trenches above average depth of 1.5 m. No payment is admissible for water collected from surface sources and broken pipe lines or sewers.
- 9.1.6 Refilling, Consolidation and Disposal of Surplus Earth: Rate quoted for excavation of trenches shall be inclusive of refilling, consolidation and disposal of surplus earth within a lead of 200 m.
- 9.2 Stoneware Pipes/RCC/C.I. pipes: Stoneware R.C.C./C.I. pipes shall be measured for the finished length of the pipeline per linear metre ie.
- a) Lengths between manholes shall be recorded from inside of one manhole to inside of other manhole.
- b) Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole. Rate shall include all items given in the schedule of quantities and specifications.
- 9.3 Gully Traps: Gully traps shall be measured by the number and rate shall include all excavation, foundation, concrete brick masonry, cement plaster inside and outside, C.I. grating and sealed cover and frame.
- 9.4 Cement Concrete for Pipes: Cement concrete in bed and all round or in haunches shall be paid per running metre between the outside wall of manholes at bottom of the trench. No additional payment is admissible in respect of concreting done for widths greater than specified, for shuttering or centering and concreting in sub soil water conditions.
- 9.5 Manholes:
- a) All manholes shall be measured by numbers and shall include all items specified above and necessary excavation, refilling & disposal of surplus earth.
- b) Manholes with depths greater than specified under the main item shall be paid for under "extra depth" and shall include all items as given for manholes. measurement shall be done to the nearest cm. Depth of the manholes shall be measured from top of the manhole cover to bottom of channel.
- 9.6 Making Connections: Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Schedule of Quantities and specifications.

Section VII Fire Hydrant System and Sprinkler System

1 Scope of work

- 1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install wet riser fire hydrant and sprinkler system as required by the drawings and specified hereinafter or given in the Schedule of Quantities.
- 1.2 Without restricting to the generality of the foregoing, the work shall include but not limited to the following:-
- a) Piping for wet riser hydrant systems and for yard hydrants.
 - a) Landing valves, canvas hose pipes, hose reels, hose cabinets & connections to mains.
 - b) Fully automatic sprinkler system
 - d) Isolation valves, non-return valves, installation valves, flow control switches and accessories.

2. General

- 2.1 All materials shall be new of the best quality conforming to the specifications and subject to the approval of the Project Manager.
- 2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- 2.3 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 2.4 Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings and walls.
- 2.5 Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.
- 2.6 The rules and regulations of Local Fire Authority as per the statutory regulations applicable for obtaining the occupation certificate from the Local Development / Fire Authority.
- 2.7 Drawings issued with the tenders are schematic and indicate the concept. Contractor shall make his shop drawings on basis of Architectural and Interior design drawings issued by the Engineer-in-Charge. Work will be executed only as per approved shop drawings.
- 2.8 It is the contractor's responsibility to ensure the competence of design to meet the above requirements.

3 Pipes

All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. pipes conforming to IS : 1239 Heavy Class

4 Pipe Fittings

Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. and all such connecting devices that are needed to complete the piping work in its totality.

Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints.

Forged steel fittings of approved type with "V" groove for welded joints.

Fabricated fittings shall be not being permitted for pipe diameters 50 mm and below. When used, they shall be fabricated, welded and inspected in workshops whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler System under the supervision of Project Manager. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

5 Jointing

5.1 Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

5.2 Welded (65 mm dia and above)

Joints between M.S. pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints are not acceptable.

5.3 Flanged

- a) Flanged joints shall be provided on:
- b) Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.
- c) Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.
- d) For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as per good engineering practice.
- e) Flanges shall be as per I.S. with appropriate number of G.I. nuts and bolts, 3 mm insertion neoprene gasket complete.

5.4 Unions

Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

6 Excavation

- 6.1 Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1.2 meter or as shown on drawings.
- 6.2 Wherever required contractor shall support all trenches or adjoining structures with adequate timber supports.
- 6.3 On completion of testing and pipe protection, trenches shall be refilled with excavated earth in 15 cms layers and consolidated.
- 6.4 Contractor shall dispose off all surplus earth within a lead of 200 m or as directed by Project Manager.

5 Anchor Thrust Blocks

- a) Contractor shall provide suitably designed anchor blocks in cement concrete to encounter excess thrust due to water hammer & high pressure.
- b) Thrust blocks shall be provided at all bends & tees & such other location as determined by the Project Manager.
- c) Exact location, design, size and mix of the concrete block shall be approved by the Project Manager prior to execution of work.

7 Valves

7.1 Gunmetal Valves

8.1.1 Valves 65 mm dia & below shall be heavy gunmetal full way valves or globe valves conforming to I.S. 778-1971 class II with female screwed ends. Valves shall carry I.S. certification mark.

7.1.2 All valves shall be approved by the Project Manager before they are allowed to be used on work.

7.2 C.I. Butterfly Valves/Sluice Valves

7.2.1 All valves 80 mm dia and above shall be C.I. double flanged butterfly valves. Each sluice valve shall be provided with wheel for valves in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with cap tops.

7.2.2 Butterfly valves shall be of best quality conforming to I.S.13095 of class specified and sluice valves shall conform to IS: 780.

7.3 Non-return valves (Check Valves)

Non-return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

7.4 Air valves

25 mm dia screwed inlet cast iron single acting air valve shall be provided on all high points in the system or as shown on drawings.

7.5 Orifice Flanges

Orifice flanges fabricated from 6 mm thick stainless steel plate shall be provided to reduce pressure on individual hydrants to restrict the operating pressure to 3.5 kg/cm² and allow a discharge of 560 lpm. The contractor shall submit design of the orifice flanges for approval before installation.

7.6 Drain Valve

50 mm dia black steel pipe to IS: 1239 (heavy class) with 50 mm gunmetal fullway valve shall be provided for draining any water in the system in low pockets.

7.7 Pressure Gauge

Pressure gauge shall be provided near all connections to hydrant system and isolation valves of sprinkler system and where required. Pressure gauge shall be 100 mm dia gunmetal Bourden type with gunmetal isolation cock, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate level and height for easy readability.

8 Hydrant/valve chambers

8.1 Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

8.2 Valve chambers shall be of following size:-

for depths 100 cms and beyond 120x120 cms.

9 Fire brigade connections

As shown on drawings separate gunmetal 2-3 way collecting head Fire brigade connection each with two or three 63 mm instantaneous type inlets with built in check valves and 150 mm dia inlet/outlet connected to the fire and sprinkler main as given in BOQ shall be provided. Both shall be installed on a stand post and provided with horizontal C.I. reflux valve and location to be approved by Project Manager. Etched gunmetal label plates with 80 mm high letters shall be fixed along with necessary enclose cabinet. The plates should be firmly fixed to the FB connection and any support system.

10 Fire hydrants

10.1 External hydrants

10.1.1 Contractor shall provide stand post type external hydrants. The hydrants shall be controlled by a cast iron sluice valve installed in underground lockable chambers. Hydrants shall have instantaneous type 63 mm dia outlets. The hydrants valve shall be single outlet conform to I.S.5290 with C.I duck foot bend and flanged riser of required height to bring the hydrant to correct level above ground.

10.1.2 Contractor shall provide for each external fire hydrant two numbers of 63 mm dia. 15 m long controlled percolation type hose pipes with gunmetal male and female instantaneous type couplings machine wound with G.I. wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with M.S. certification), gunmetal branch pipe with nozzle to I.S. 903.

10.2 Internal hydrants

10.2.1 Contractor shall provide on each landing and other locations as shown on the drawings one single headed gunmetal oblique landing valves with 63 mm dia outlet mounted on a common 80 mm inlet conforming to I.S.5290-1969. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

10.2.2 Instantaneous outlets for fire hydrants shall be of standard pattern approved and suitable for fire brigade hoses.

10.2.3 Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric linen hose pipes with gunmetal male and female instantaneous type coupling machine wound with G.I. wire (hose to I.S. 636 Type 2 and couplings to I.S. 903 with I.S. Certification), fire hose reel conforming to IS:884, gunmetal branch pipe with nozzle I.S. 2871 and Fire man's axe conforming to IS: 926.

10.2.4 Each hose box shall be conspicuously painted with the letters "FIRE HOSE".

11 Fire hose reels

Contractor shall provide standard fire hose reels with 20 mm dia high pressure Dunlop or equivalent rubber hose 36.5 m long with gunmetal nozzle and control valve, shut off valve, all mounted on circular hose reel of heavy duty mild steel construction and cast iron brackets. Hose reel shall be connected directly to the wet riser. Hose reel shall conform to IS: 884-1969 and rubber hose to IS: 5132.

12 Hose Cabinets

12.2 All internal fire hydrants shall be enclosed in M.S. glazed cabinet. Hose cabinets shall be fabricated from 16 gauge M.S. sheet of fully welded construction with hinged double front door partially glazed with locking arrangement stove enameled fire red paint with "FIRE HOSE" written on it prominently. (Sizes are as given in the Bill of Quantities).

13 Pipe protection

- a) All pipes above ground and in exposed locations shall be painted with one coat of zinc chromate primer and two or more coats of synthetic enamel paint of approved shade.
- b) Pipes in chase or buried underground shall be painted with two coats of zinc chromate primer and wrapped with one layer of 4 mm thick PYPKOTE multilayer sheet as per

standard manufacturer's specifications.

14 Pipe Supports

2.16.1 All pipe clamps and supports shall be galvanised steel. When fabricated from M.S. steel sections, the supports shall be factory galvanised before use at site. Welding of galvanised clamps and supports will not be permitted.

2.16.2 Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fastners or equivalent). The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

4.4 Pipe Spacing Table

S.No.	Pipes & Position	<----- Pipe commercial dia. ----->							
		15/20	20/25	32/40	50	75/80	100/110	150/160	200
1	Vertical								
1.1	GI /MS	2.4	2.4	3	3.6	4.5	4.5	5.4	5.4
1.2	CI Pipes IS 1729/3989	x	x	<----- 3 m ----->					
1.3	CI Heavy Duty IS 1536	x	x	<----- 3.6 m ----->					
1.4	uPVC SWR Systems	x	x	0.5	0.7	0.9	0.9	1.0	
1.5	uPVC Water Supply								
1.6	Polybutylene	<--- As per manufacturer's Recommendations --->							
1	Horizontal								
1.1	GI /MS	2.0	2.0	2.4	3.0	3.6	4.0	4.5	4.5
1.2	CI Pipes IS 1729/3989			<----- 3 m ----->					
1.3	CI Heavy Duty IS 1536					3.0	3.6	3.6	4.5
1.4	uPVC SWR Systems				1.2	1.8	1.8	1.8	
1.5	uPVC Water Supply								
1.6	Polybutylene	<-As per manufacturer's recommendations-->							

15 Cables

15.1 Contractor shall provide control cables from supervisory valves and switches to the annunciation panels.

15.2 All control cables shall be copper conductor PVC insulated armoured and PVC sheathed 1100 volt grade.

15.3 All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

15.4 All cable joints shall be made in an approved manner as per standard practice.

15.5 Cable Trays

15.6 All cables shall be routed in approved locations in coordination with all other services in a proper manner.

16 Cable Trays

- 16.1 All cables shall be routed in approved locations in coordination with all other services in a proper manner.
- 16.2 Cable trays shall be of galvanized steel and hung from the ceiling by galvanised rods supported by appropriate size and type of expandable expansion fasteners drilled into the slabs and walls by an electric drill.

17 Measurement

- 17.1 Mild steel pipes shall be measured in linear metres of the finished length correct upto one cm. and shall include all fittings, flanges, welding, jointing, clamps for fixing to walls or hangers, anchor fasteners, painting and testing complete in all respects.
- 17.2 Sluice and fullway valves, check valves, installation valves, air valves & flow switches shall be measured by numbers and shall include all items necessary and required for fixing and as given in the specifications and bill of quantities.
- 17.3 Fire hydrants, hose reels, fire brigade connections, orifice flanges shall be measured by number and include all items given in the specifications and bill of quantities.
- 17.4 Fire hose and boxes specified shall be measured by number and include all items given in specifications and Bill of Quantities.
- 17.5 Cables and cable trays shall be measured in linear metre correct upto cm shall include clamps, hangers, anchor fasteners complete in all respects.

Section VIII Hand Appliances

1 Scope of work

- 1.1 Work under this section shall consist of furnishing all labour, material, appliances and equipment necessary and required to install fire extinguishing hand appliances.
- 1.2 Without restricting to the generality of the foregoing the work shall consist of the following:-
- Installation of fully charged and tested fire extinguishing hand appliances CO₂ foam, dry chemical powder type as required by these specifications and/drawings.

2 General requirements

- 2.1 Fire extinguishers shall conform to the following Indian Standard Specifications and shall be with ISI approved stamp as revised and amended up to date :-
- 2.2 Fire extinguishers shall be installed as per Indian Standard "Code of Practice for Selection, Installation and Maintenance of Portable First Aid Appliances" I.S.2190-1962.
- 2.3 Hand appliances shall be installed in readily accessible locations with the appliance brackets fixed to wall by suitable anchor fasteners.
- 2.4 Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.
- 2.5 All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

3 Measurement

Fire extinguishers shall be measured by numbers and include installation and all items necessary and required and given in the specifications.

Section IX Fire Pumps & Ancillary Equipment

1. Scope of Work

- 1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel engine driven pumps as required by the drawings and specified hereinafter or given in the schedule of quantities.
- 1.2 Without restricting to the generality of the foregoing, the pumps and ancillary equipment shall include the following:-
 - a) Pressure gauges with isolation valves & piping,.
 - b) M.S. pipes, valves, suction strainers, delivery and suction headers & accessories.
 - c) Foundations, vibration eliminator pads and foundation bolts.

2 General Requirements

- 2.1 Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations.
- 2.2 Pumps and motors shall be truly aligned by suitable instruments.
- 2.3 All pump connections shall be standard flanged type with appropriate number of bolts. In case of non standard flanges companion flanges shall be provided with the pumps.
- 2.4 Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- 2.5 Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The Contractor shall provide facilities to the Project Manager or their authorised representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the DPLs.
- 2.6 Each pump shall be provided with a pressure gauge, isolation cock and connecting piping, bleed and block valve.
- 2.7 Adequate vibration eliminating pad and connectors for each pump shall be provided.
- 2.8 The Contractor shall submit with this tender a list of recommended spare parts for two years of normal operation and quote the prices for the same.

3 Fire Pumps

3.1 Pumping Sets

- 3.1.1 Pumping sets shall be single stage horizontal centrifugal single outlet with cast iron body and cast iron impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease lubricated bearings.
- 3.1.2 Pumps shall be connected to the drive by means of spacer type love joy couplings which shall be individually balanced dynamically and statically.
- 3.1.3 The coupling joining the prime movers with the pump shall be provided with a sheet metal guard.
- 3.1.4 Pumps shall be provided with approved type of mechanical seals.
- 3.1.5 Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.

- 3.1.6 The pump shall meet the requirements of the Tariff Advisory Committee and the unit shall be design proven in fire protection services.

4 Electric drive

- 4.1 Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.
- 4.2 Motors for fire protection pumps shall be atleast equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- 4.3 Motors shall be wound for class B insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fibre insulated.
- 4.4 Motors for fire pumps shall meet all requirements and specifications of the Tariff Advisory Committee.
- 4.5 Motors shall be suitable for 415 \pm 10% volts, 3 phase 50 cycles a/c supply and shall be designed for 38°C ambient temperature. Motors shall conform to I.S. 325.
- 4.6 Motors shall be designed for two start system.
- 4.7 Motors shall be capable of handling the required starting torque of the pumps.
- 4.8 Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.
- 4.9 Speed of the motor shall be compatible with the speed of the pump.

5 Vibration Eliminators

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufactures details.

6 Measurements:

- 6.1 Fire pumps shall be measured by numbers and shall include all items as given in the specifications and schedule of quantities.
- 6.2 sluice valves, non return valves, vibration eliminators, flanges and suction strainer shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications.
- 6.3 Pump headers, shall be measured per linear metre and shall include all items given in the specifications and schedule of quantities.

Section X Commissioning and Guarantees

1 Scope of work

Work under this section shall consist of pre-commissioning, commissioning, testing and providing guarantees for all equipment, appliances and accessories supplied and installed by the contractor under this contract.

2 General requirements:

- 2.1 The rates quoted in this tender shall be inclusive of the works given in this section.
- 2.2 Contractor shall provide all tools equipment, metering and testing devices required for the purpose.
- 2.3 On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

3 Pre-commissioning

- 3.1 On completion of the installation of all pumps, piping, valves, pipe connections, and water level controlling devices the contractor shall proceed as follows:-

A Fire protection system:

- i) Check all hydrant valves and close if any valve is open. Also check that all suction and delivery connections are properly made.
- ii) Test run and check rotation of each motor and correct the same if required.

B Pipe work

- i) Check all clamps, supports and hangers provided for the pipes.
- ii) Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specifications. If any leakage is found, rectify the same and retest the pipes.

4 Commissioning & testing

A. Fire hydrant system

- 1 Pressurise the fire hydrant system by running the main fire pump and after attaining the required pressure shutoff the pump.
- 2 Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts out at the pre-set pressures. If necessary adjust the pressure switch for the jockey pump. Close bye-pass valve.
- 3 Check each landing valve, male and female couplings and branch pipes for compatibility with each other. Any fitting which is found to be incompatible and does not fit into the other properly shall be replaced by the contractor. Landing valves shall also be checked by opening and closing under pressure.

B. Handing over

- 1. All commissioning and testing shall be done by the contractor to the complete satisfaction of the Project Manager, and the job handed over to the Project Manager, or his authorised representative.

2. Contractor shall also handover, to the Project Manager, all maintenance & operation manuals and all other items as per the terms of the contract.

C. Guarantees

1. The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.
2. The form of warranty shall be as approved by the Project Manager.
3. The warranty shall be valid for a period of one year from the date of commissioning and handing over.
4. The warranty shall expressly include replacement of all defective or under capacity equipment. Project Manager may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.
5. The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Project Manager.

Section XI Electrical Installations

1 **Scope:**

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of electric control panels, wiring and earthing of all pump room equipment, components and accessories, including supply, installation and wiring of remote control-cum-indicating light panel.

2 **General:**

Work shall be carried out in accordance with the Specifications, Local Rules, Indian Electricity Act 1910 as amended upto date, and rules issued thereunder, Regulations of the Fire Insurance Company and relevant BIS Code of Practice.

3 **Wiring System:**

All power wiring shall be carried out with 1100 volts grade PVC insulated, armoured overall, PVC sheathed aluminium conductor cables for sizes above 6 mm². For sizes 6 mm² and below the power wiring shall be of copper conductor only. Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using 650 volts PVC insulated copper conductor wires in race ways or in conduit. Minimum size of control wiring shall be 1.5 mm² PVC insulated copper conductor wires. Minimum size of conductor for power wiring shall be 4 mm² 1100 volts grade PVC insulated copper conductor wires in conduit.

4 **Construction Features:**

The control panel shall be metal enclosed sheet steel cubicle, indoor type, dead front, floor mounting/wall mounting type. The control panel shall be totally enclosed and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. Control panels shall be arranged in multi-tier formation. All doors and covers shall be suitable for double padlocking. All mild steel sheets used in the construction of control panels shall be 14 SWG thick for floor mounted and 16 SWG for wall mounting and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with Plumber metal.

All panels and covers shall be properly fitted and square with the frame and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of control panels. Base channel of 75 mm x 75 mm x 5 mm thick shall be provided at the bottom. Minimum clear space of 200 mm between the floor of control panel and bottom most unit (MCB or Bus Bar) shall be provided.

The control panels shall be of adequate size with a provision of 25% spare space to accommodate possible future additional switch gear. Knockout holes of appropriate size and number shall be provided in the control panels in conformity with the location of incoming and outgoing conduits / cables. All equipment such as meters and indicating lamps etc. shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from top of the control panel. Clamps shall be provided to support the weight of the cables. All power wiring inside the control panel shall be colour coded and control wiring ferruled for easy identification. Circuit diagram showing the arrangement of circuits shall be pasted on the inside of panel door and covered with transparent plastic sheet and all labelling shall be provided in engraved anodized aluminium/bakelite strips on the front face of the panel board.

5 **Circuit Compartment:**

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the 'ON' position. Safety interlocks shall be provided to prevent the breaker or contactor from being drawn out when the breaker is in 'ON' position. The door shall not form an integral part of the draw out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6 Instrument Accommodation:

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar.

7 Bus Bars and Bus Bar Connections:

The bus bar and interconnections shall be of aluminium and of rectangular cross sections suitable for full load current for phase bus bars, and half rated current for neutral bus bar and shall be extensible on either side. The bus bars and interconnections shall be insulated with PVC sleeve / tapes and shall be color coded. Alternatively special insulating paints/materials may be used for the purpose.

All bus bars shall be supported on unbreakable, non hygroscopic insulated supports at regular intervals, to withstand the forces arising in case of short circuit in the system. All bus bars shall be provided in separate chamber and properly ventilated. All bus bars connections, in main control panels shall be done by drilling holes with cadmium plated/hot dipped galvanized bolts, nuts and washers.

All bus bars connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts.

All connections between the bus bar and breaker and between breaker and contactor shall be through copper strips of proper size to carry rated current and shall be insulated with PVC sleeves.

8 Raceways:

A horizontal race way with screwed covers shall be provided at the top to take interconnecting control wiring between different vertical sections.

9 Cable compartments:

Cable compartment of adequate size shall be provided in the control panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables.

10 Indications

10.1. 'ON' lamps shall be provided on all outgoing feeders.

10.2. Cable alley and bus chamber shall be identified on all panels.

11 Rubber Mat

Rubber mat shall be provided to cover the full length of front of all panels and rear of panels where back space shall be available for working from the rear.

12 Materials:

All materials shall be of the best quality complying with the BIS (Bureau of Indian Standards) specifications. Materials used shall be subject to the approval of the CLIENT's site representative and samples of the same shall be furnished where required.

12.1 Moulded Case Circuit Breaker

MCCB shall comprise of switching mechanism, contact system are extinguishing device and the tripping unit, Contained in a Compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stress.

Switching mechanism shall be of Quick Make- Quick Break type and the trip command shall override all other commands. MCCB shall employ maintenance free contact system to minimize the let thru energies while handling abnormal currents.

The handle position shall give positive indication of 'ON' 'OFF' or tripped.

MCCB shall conform to IS- 2516 (Part I & II/Sec.1) 1985.

12.2 **MINIATURE CIRCUIT BREAKER**

Miniature circuit breakers shall be quick make and break type, and shall conform to Relevant Indian Standards. The housing shall be heat resistant and having high impact strength. The fault current shall not be less than 9 KA at 230 V and shall be BIS approved. MCBs shall be flush mounted and shall be provided with trip free manual operating lever and 'ON' and 'OFF' indications. The contacts shall be provided to quench the arc immediately. MCB shall be provided with magnetic thermal releases for over current and short circuit protection. The over load or short circuit device shall have a common trip bar in the case of DP, TP and TPN miniature circuit breakers.

12.3 **Rotary Switches:**

Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism with stop as required. Rotary switches shall have HRC fuse fittings of appropriate rating.

12.4 **Selector Switch**

Where called for selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

12.5 **Starters**

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant BIS Codes. All Star Delta and ATS Starters shall be fully automatic.

Starter contactors shall have 3 main and 2 Nos. NO/NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta/Reduced Voltage Starters. The insulation for contactor coils shall be of class "B".

Operating coils of contactors shall be suitable for 230/415 $\pm 10\%$ volts AC, 50 cycles supply system. The contactors shall drop out when voltage drops to 90% of the rated voltage. The housing of the contactors shall be heat resistant and having high impact strength. Each starter shall have thermal overload protection on all three phases.

12.6 **Over Load Relays**

Contactors shall be provided with a three element, positive acting ambient temperature compensated time lagged hand-reset type thermal over load relays with adjustable setting. Hand-reset button shall be flush with the front door for resetting with starter compartment door closed. Relays shall be directly connected for motors upto 35 HP capacity. C.T operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

12.7 **Current Transformers**

Current transformers shall be of accuracy class I and suitable VA burden for operation of the connected meters and relays. These shall be resin bonded and epoxy coated.

12.8 **Single Phase Preventer**

Single phase preventer shall be provided as per Schedule of Quantities and shall be in conformity with relevant BIS Standards. Single phase preventer shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

12.9 Time Delay Relays

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connections.

12.10 Indicating Led (22 mm dia) and Metering

All meters and indicating lamps shall be in accordance with BS 37 and BS 39. The meters shall be flush mounted and drawout type. The indicating lamp shall be of LED type. Each main panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three Nos. CTs of suitable ratio with three way and off selector switch, phase indicating lamps and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 amps fuse. Other indicating lamps shall be backed up with fuses as called for.

12.11 Toggle Switch

Toggle switches where called for, shall be in conformity with relevant BIS Codes and shall be of 5 amps rating.

12.12 Push Button Stations

Push button stations shall be provided for manual starting and stopping of motors/equipment as called for. Green and Red colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for 'Stop' push buttons. The push button contacts shall be suitable for 6 amps current capacity.

12.13 Conduits

Conduits shall be of mild steel and shall be Hard drawn, stove enameled inside and outside with minimum wall thickness of 1.6 mm for conduits upto 32mm diameter and 2 mm wall thickness for conduits above 32 mm diameter. GI pull wires shall be installed in the conduit while laying the conduit.

12.14 Cables

M.V. cables shall be PVC insulated aluminium conductor and armoured cables conforming to BIS Codes. Cables shall be armoured and suitable for laying in trenches, duct, and on cable trays as required. M.V Cables shall be termite resistant. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

12.15 Wires

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

13 CABLE LAYING:

Cable shall be laid generally in accordance with BIS Code of Practice. Cables shall be laid on 14 gage perforated MS sheet cable trays and cable drops/risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimise the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls/trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable 1.1 KV cable shall be buried 600 mm below ground level.

14 WIRE SIZES:

For all single phase/3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminium conductor wires of adequate size. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminium conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

The minimum size of control wiring shall be 1.5 mm² PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes:

- i. Upto 5 HP motors/5 KW heaters. 3 x 4 mm² Cu conductor wires.
- ii. From 6 HP to 10 HP motors 3 x 6 mm² Cu conductor wires.
6 KW to 7.5 KW heaters.
- iii. From 12.5 HP to 15 HP motors. 2 Nos. 3 x 6 mm² Cu conductor wires.
- iv. From 20 HP to 25 HP motors. 2 Nos. 3 x 10 mm² Al conductor armoured cables.
- v. From 30 HP to 35 HP motors. 2 Nos. 3 x 16 mm² Al conductor armoured
cables.
- vi. From 40 HP to 50 HP motors. 2 Nos. 3 x 25 mm² Al conductor armoured cables.
- vii. From 60 HP to 75 HP motors. 2 Nos. 3 x 50 mm² Al conductor armoured cables.
- viii. 100 HP motors. 1 No. 3 x 150 mm² Al conductor armoured cables.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors.

	TYPE OF STARTER	CONTACTOR CURRENT CAPACITY	OVERLOAD RELAY RANGE
5 HP Motors	D O L	16 amps	6-10 amps
7.5HP Motors	D O L	16 amps	10-16 amps
10 HP Motors	D O L	32 amps	13-21 amps
12.5HP Motors	Star Delta	16 amps	10-16 amps
15 HP Motors	Star Delta	25 amps	10-16 amps
20 HP Motors	Star Delts	32 amps	13-21 amps
25 HP Motors	Star Delta	32 amps	13-21 amps
30 HP Motors	Star Delta	40 amps	20-32 amps
35 HP Motors	Star Delta	40 amps	20-32 amps
40 HP Motors	Star Delta	40 amps	28-42 amps
45 HP Motors	Star Delta	63 amps	28-42 amps
50 HP Motors	Star Delta	63 amps	28-42 amps
60 HP Motors	Auto Transformers	125 amps	45-70 amps Reduced Voltage.
75 HP Motors	-do-	125 amps	90-150 amps
100 HP Motors	-do-	200 amps	operated Relay

- 15 **Earthing:** shall be copper strips/wires the main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25 mm x 3 mm copper tapes. All single phase metal clad switches and control panels be earthed with minimum 2 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with two numbers distinct and independent copper wires/tapes as follows:

- i. Motors upto and including 10 HP rating 2 Nos 3 mm dia copper wires.

- | | |
|--------------------------------------|----------------------------------|
| ii. Motors 12.5 HP to 40 HP capacity | 2 Nos.4 mm dia copper wires. |
| iii. Motors 50 to 75 HP capacity | 2 Nos 6 mm dia copper wires. |
| iv. Motors above 75 HP. | 2 Nos 25 mm x 3 mm copper tapes. |

All switches shall be earthed with two numbers distinct and independent copper wires/tapes as follows:

i.	3 phase switches and control panels upto 60 amps rating.	2 Nos 3 mm dia copper wires.
ii.	3 phase switches and control panels 63 amps to 100 amps rating.	2 Nos 4 mm dia copper wires.
iii.	3 phase switches and control panels 125 amps to 200 amps rating.	2 Nos 6 mm dia copper wires.
iv.	3 phase switches, control panels, bus ducts, above 200 Amps rating	2 Nos 3 mm x 25 mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The over-lapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be riveted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance and properly tinned.

- 16 **Drawings:** Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of Project Manager/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.
- 17 **Testing:** Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.
- 18 **Painting:** All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.
- 19 **Label and Tags**
Engraved PVC labels shall be provided on all incoming and outgoing feeders switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Manager.
- 20 All panels to have provision for padlocking and all MCCB's/MCB's to have provision for locking in off position.
- 21 **Measurement of Electrical Control Panels:** Panels shall be counted as number of units. Quoted rates shall include as lump sum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for inter-locking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate for panel shall also include all accessories, switchgear, fuses, contactors, indicating meters and lights as per the specifications.

Section XII Specification for Water Supply, Flushing/ Irrigation Pumps & Equipment

1. Scope of work

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to supply, install and commission the water supply and drainage pumps as described hereinafter and given in the schedule of quantities and/or shown on the drawings.

2. General requirements

- 2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of Project Manager.
- 2.2 All equipment shall be of the best available make manufactured by reputed firms.
- 2.3 All equipment shall be installed on suitable foundations true to level and in a neat workmanlike manner.
- 2.4 Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- 2.5 Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.
- 2.6 Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side.
- 2.7 All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

3.0 System of Water Supply

- 3.1 The water supplied by the authorities will be stored in the domestic U.G. tank.
- 3.2 Water from this U.G. tank shall be pumped to O.H. Tanks at terrace of each building by separate pumps.
- 3.3 Each toilet and kitchen shall be fed with water from terrace tanks by gravity.

Specifications for Pumps

4 Water Transfer Pumps

- 4.1 Water supply pumps shall be suitable for clean filtered water. Pumps shall be single stage, monobloc vertical/horizontal, centrifugal pumps with cast iron body and cast iron impeller, stainless steel shaft and mechanical seal and coupled to a TEFC electric motor. Each pump should be operating to a curve required by the operating conditions.
- 4.2 All parts in contact with water shall be corrosion resistant stainless steel DIN-Nr.1.4401.
- 4.3 Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 2900 RPM nominal speed.
- 4.4 Each pumping set shall be provided with 100-mm dia gunmetal "Borden" type pressure gauge with gunmetal valve and connecting piping.
- 4.5 Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Project Managers..

6 Submersible pumps

- 6.1. Submersible pumps for clear water transfer shall be single stage, submersible centrifugal Pump of closed coupled construction with C.I. casing and C.I. impeller connected to a fully submersible water/oil cooled motor.
- 6.2. Stuffing box shall be provided with mechanical seals
- 6.3. Each pump shall be provided with water cooled squirrel cage induction motor suitable for 380- 415 volts, 3 phase, 50 cycles AC power supply.
- 6.4. Each pump shall be provided with liquid level controller for automatic operation of the pump between predetermined levels. Operation of level controller shall be similar to as discussed in subsequent paras below.
- 6.5. The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.
- 6.6. Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

7 Pipe & Fittings (for Headers and Connections)

- 7.1. Pump suction and delivery headers shall be Galvanized iron pipes/MS heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer's instructions.

7.2 Vibration Eliminators

All suction and delivery lines as shown on the drawings shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

7.3 Valves

7.3.1 Butterfly Valves

Butterfly Valves shall be cast iron body with following details:-

- a) Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.
- b) The shaft be EN-8 Carbon Steel with low friction nylon bearings.
- c) The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.
- d) Built in flanged rubber seals.
- e) Actuator to level operated for valves above ground and T Key operated for valves below ground.
- f) Built in flanges for screwed on flanged connections.

Manufacturer's details on fixing and installation will be followed.

7.3.2 Non Return Valves (NRV)

- a) Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.
- b) NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform to the relevant BIS code.

8 Painting and cleanup

- a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.
- b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.
- c) Provide painted identification legend and direction arrows on all equipment and piping as directed by engineer-in-charge.
- d) On final completion of the work, contractor should cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

9. Cables

- 9.1. Contractor shall provide all power and control cables from the motor control centre to various motors, level controllers and other control devices.
- 9.2. Cables shall conform to I.S. 1554 and Carry ISI mark.
- 9.3. Wiring cables shall conform to IS 694.
- 9.4. All power and wiring cables shall be aluminum conductor PVC insulated armoured and PVC sheathed of 1100 volts grade.
- 9.5. All control cables shall be copper conductor PVC insulated armoured and PVC sheathed 1100 volts grade.
- 9.6. All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.
- 9.7. All cable joints shall be made in an approved manner as per standard practice.

10. Earthing

All equipment installed by the contractor shall be suitably earthed by making proper connection by means of G.I. Wires to the main earthing system laid by the electrical contractors.

11. Motor control centres

- 11.1. Switchboard cubicles of approved type shall be fabricated from 16 gauge M.S. Sheet with dust and vermin proof construction. It shall be painted with stove enamelled

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paint of approved make and shape. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following:- (switchgear as given in the schedule of quantities).

- a) Incoming main switch fuse unit of required capacity.
- b) Isolation switch fuse unit, one for each motor.
- c) Fully automatic DOL/star delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps.
- d) Single phasing preventer of appropriate rating for each motor.
- e) Rotary duty selector switch.
- f) Panel type ampere meters one for each motor.
- g) Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.
- h) Neon phase indicating lamps and indicating lamp for each motor.
- i) Rotary switch for manual or auto operation for each pump.
- j) Fully taped separate aluminium bus bars of required capacity for normal and emergency supply where specified.
- k) The panel shall be prewired with colour coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switch board panel.

11.2 All switch gears and accessories shall be approved make.

11.3. Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers.

12 Measurement

12.1 General

12.2 Unit rate for individual items, e.g. Pumps, MCC and level controller are for purposes of payments only. Piping, headers, valves, accessories, cabling and MCC to be measured separately in this contract only.

12.3 All items must include all accessories fittings as described in the specifications, BOQ and shown on the drawings.

12.4 Piping Work

12.4.1 Suction and delivery headers for each pumping system shall be measured per linear meter of finished length and shall include all items as given in the schedule of quantities. Painting shall be included in rate of headers.

12.4.2 G.I. pipes between various equipment's shall be measured per linear meter of the finished length and shall include all fittings, flanges, jointing, clamps for fixing to walls or hangers and testing. Flanges shall include 3 mm thick insertion rubber gasket, nuts, bolts and testing.

12.4.3 Water Tank, Vibration eliminators, "Y" strainers, butterfly valves, slim non return valves shall be measured by numbers and shall include all items as given in the schedule of quantities and specifications.

Section XIII Installation, Commissioning & Guarantees

1. Installation

- 1.1. Contractor shall supply three copies of foundation drawings giving weight, vibration and other loads required for the proper designing of the foundations.
- 1.2. All equipment shall be installed in a true workman like manner true to level and grade in accordance with the best current practice.
- 1.3. Contractor shall employ sufficient and proper equipment for lifting and placing of heavy equipment and in a manner which shall not strain or cause damage to the existing structures. If any damage is done, the same shall be made good to the satisfaction of the Project Manager without any additional cost.
- 1.4. All equipment and pipes shall be painted with one coat of red oxide before dispatch to the site.

2. Commissioning

- 2.1. On completion of the work in all its aspects, the contractor shall start up the equipment in a manner normally done for the continuous operation for a period of not less than 48 hours and shall rectify and adjust the equipment for leakages and balancing the system.
- 2.2. After satisfactory commissioning of the plant, the contractor shall conduct performance tests on the equipment to satisfy the Project Manager that all equipment is performing to the rated outputs. Any or all equipments shall be rectified or replaced if the same is are not performing in accordance with the specifications.

3. Guarantees

- 3.1. On completion of the work contractor shall submit a guarantee covering the quality and performance of all materials supplied and installed under the contract. This guarantee shall cover each and every material whether manufactured by the contractor or not.
- 3.2. Contractor shall specify a suitable procedure to test the rated performance of the equipments and shall provide all necessary equipments, gauges etc. for conducting such tests.
- 3.3. The guarantee shall cover a period of one year from the date of installation and handing over.

4. Completion

- 4.1. On completion of the job, the contractor shall hand over to the Project Manager the following:-
- 4.2. One flow chart drawn in ink on thick paper and mounted in a glass frame showing the flow diagram of the process including legend showing valves to be

normally open or closed and instructions for back washing, operation and maintenance of chlorination & other chemical feeding pumps and other equipments.

- 4.3 Five sets of operating and maintenance instructions with spare parts list and their manufactures and/or suppliers.
- 4.4 Five sets of catalogues and drawings for all equipment supplied.

Section XIV

Technical Information

Please furnish full details separately

All information should be on this format

-----PUMPS-----	

S. No.	Description
	Domestic water
	Irrigation

1.	Design basis
1.1	Quantity/ No. of units offered
1.2	Capacity lit/lpm
1.3	Flow Range
1.4	Pumping Head (where applicable)
1.5	Make & Model No.
1.6	Power
1.7	Pump Type
1.8	Material (body)
1.9	Material (Impellers)
1.10	Material (shafts)
2.	Accessories
3.	Valves
3.1	Type
3.2	Material (body)
3.3	Material (Internal parts)
3.4	Material (Lining)
4.	Pipes
4.1	Type

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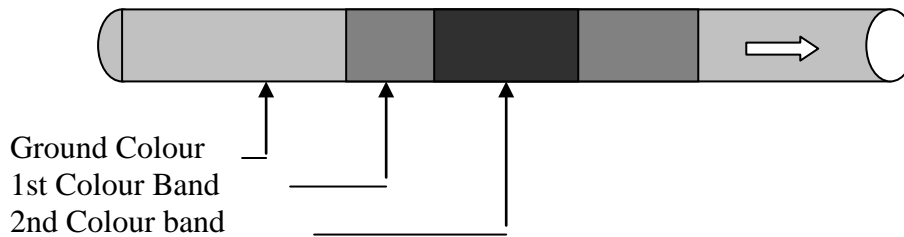
4.2 Material

4.3 Max. working pressure

4.4 Max. test pressure

Section XV Pipe Colour Code

This Colour Code is as per I.S. 2379.



Proportional width of band 4:1

Note:-Arrow indicating the direction of flow.

Pipe lines	Ground Colour	1st Colour	2nd Colour
1. Drinking water (all cold water lines after filter)	Sea green	French blue	Signal red
2. Treated water (soft water)	Sea green	Light orange	
3. Domestic hot water	Sea green	Light grey	
4. Drainage Sewer /SWD	Black		
5. Fire services	Fire red		

This Colour Code is as per I.S. 2379.

Final design for colour coding will be of CLIENT only

Section XVI: LIST OF APPROVED MAKES

<u>S.No</u>	Item	Approved Makes
<u>1</u>	Pressure Reducing Valve (PRVs)	HONEYWELL
<u>2</u>	Traps/ Wastes/Shower traps	McALPINE/NEER/CHILLY
<u>3</u>	Pan connectors	McALPINE/NECO/NEAR
<u>4</u>	Concealed cistern	TECE/VIEGA/GROHI
<u>5</u>	Shower drains (trapped/untrapped)	McALPINE/NECO/NEAR
<u>6</u>	Pressure Reducing Valve (PRVs)	HONEYWELL/APPOLO/JETRANGE
<u>7</u>	Cpvc pipes/fittings and valves	ASTRAL/AJAY/ASHIRWAD/SUPREME
<u>8</u>	G.I. Pipes /M.S.Pipes IS 1239/3589	JINDAL HISSAR/PRAKASH SURYA
<u>9</u>	uPVC pipes and Fittings	SUPREME/JAIN/PRINCE/FINOLEX
<u>10</u>	Spun cast iron pipes & fittings IS 3989	NECO/KAPILASH
<u>11</u>	Sand Cast Iron Pipe and Fittings IS 1729	SRIF/SKF/NECO
<u>12</u>	G.I.Fittings (Malleable cast iron)	ZOLOTO/SANT/UNIK
<u>13</u>	Check Valves (Dual Slim type)	SANT/ZOLOTO/ADVANCE
<u>14</u>	Butterfly Valve	SANT/ZOLOTO/ADUDCO
<u>15</u>	Ball valves (15 to 40mm)	SANT/ZOLOTO/ADUDCO
<u>16</u>	Stoneware Pipes & Gully - IS 651	ANAND/PERFECT
<u>17</u>	RCC Pipes IS 458	PRAGATI/SUPER WIRE/ISI
<u>18</u>	C.I. Manhole cover & frame IS 1726	NECO/SRIF/SKF/RIF
<u>19</u>	F.R.P. Manhole Cover, Grating, Catch basin cover	Products unlimited/NECO/REF
<u>20</u>	Hot Water Insulation	SUPERLON/A-FLEX
<u>21</u>	Anti corrosive tape for pipe protection	PYPKOTE/MAKPOLYKOTE/NECO/NEER
<u>22</u>	Garden Irrigation System	JAIN/HARVEL
<u>23</u>	Anticorrosive Bitumastic Paint	ISI
<u>24</u>	Epoxy Paint	ISI
<u>25</u>	Hydro-Pneumatic System	
<u>I</u>	Pumps	Mather Platt/GRUNDFOSS/SINTECH/WILO
<u>li</u>	PLC	AS PER MANUFACTURERS SPEC'S
<u>lii</u>	Pressure Vessel	AS PER MANUFACTURERS SPEC'S
<u>Iv</u>	Pressure Sensor	AS PER MANUFACTURERS SPEC'S
<u>26</u>	Clear Water Pumps	Mather Platt/GRUNDFOSS/SINTECH/WILO
<u>27</u>	Submersible Drainage Pumps	Mather Platt/GRUNDFOSS/SINTECH/WILO
<u>28</u>	Filter/Softener	APEX/THERMAX/ION EXCHANGE/PENTAIR
<u>29</u>	Electrical Switchgear & Starters	L&T OR EQUIVALENT

<u>30</u>	Cable Trays	SLOTCO OR EQUIVALENT
<u>31</u>	1100 Volt Grade XLPE Cables	ISI
<u>32</u>	PVC Insulated Copper Wires	ISI
<u>33</u>	Vibration Eliminator Pads & Connections	RESISTOFLEX/DUNLOP
<u>34</u>	Suction Strainer/Pot Strainer	VENUS/LEADER/EMERALD/ZOLOTO
<u>35</u>	Meters, Indication Lamp	ENERCON OR EQUIVALENT
<u>36</u>	Forged Steel Fittings	VS/SAINT
<u>37</u>	Pressure Gauge	FIEBIG/GURU
<u>38</u>	Fire Accessories	SAFEGUARD/Omex/MINIMAX
<u>39</u>	Sprinklers	HD/TYCO/VIKING
<u>40</u>	Alarm Valve	HD/SPRAYSAFE
<u>41</u>	Fire-pumps	Mather Platt/GRUNDFOSS/SINTECH/WILO
<u>42</u>	Electrical Panels	IMPACT ENGINEERS/ELEGANT
<u>43</u>	Hot Water Generator	THERMAX/RADIP CONTROL
<u>44</u>	Solar heater	SOLARHART/TATABP OR EQUIVALENT
<u>45</u>	Fire Extinguisher	SAFEGUARD/Omex/MINIMAX
<u>46</u>	Sanitary fixtures & fittings	
<u>i</u>	Sanitary ware	ROCA/JAQUAR/PARRYWARE/Hindware
<u>ii</u>	CP Fittings	ROCA/JAQUAR/PARRYWARE/Hindware
<u>47</u>	Bathroom Accessories	U-TECH/TOSHI/JAQUAR/PARRYWARE
<u>48</u>	Sensor Bathroom Accessories	U-TECH/TOSHI/JAQUAR/PARRYWARE
<u>49</u>	STP/ETP	BS ENVIRO/ ENWECO

66. TECHNICAL SPECIFICATIONS FOR INTERNAL ELECTRICAL WORKS

LIST OF INDIAN STANDARDS (IS)

Latest edition of following standards shall be referred

IS: 325	Three phase induction motors
IS: 374	Ceiling fans and regulators (3rd revision)
IS: 398 (Part-I)	Aluminium stranded conductors
IS: 398 (Part-II)	Aluminium conductors, galvanized steel reinforced
IS: 694	PVC insulated Electric cable for working voltage upto and including 1100 volts.
IS: 732	Code of practice for electrical wiring and installation
IS: 900	Code of practice for installation and maintenance of induction motors
IS: 1255	Code of Practice for installation and maintenance of Power Cables upto and including 33 kV rating (Second Revision).
IS: 1258	Bayonet lamp holders(Third revision)
IS: 1293	Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.
IS: 1554 (Part-I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS: 1554 (Part-II)	PVC insulated (Heavy Duty) electric cables for working voltages from 3.3 kV to 11 kV.
IS: 1646	Electrical installation fire safety of buildings (general) Code of practice.
IS: 1885	Glossary of items for electrical cables and conductors
IS: 1913	General and safety requirements for fluorescent lamps luminaries Tubular.
IS: 1944 (Part-I & II)	Code of practice for lighting of public through fares
IS: 2071 (Part-I to III)	Methods of high voltage testing
IS: 2147	Degree of protection provided by enclosures for low voltage switchgears and control gears
IS: 2148	Double compression cable glands
IS: 2208 & IS: 9224 (Part – I & II) (IEC: 269)	Cartridge fuses for voltages upto and including 650 V.
IS: 2268	Electric call bell and buzzers
IS: 2309	Protection of building and allied structures against lightning
IS: 2418	Tabular fluorescent lamps for general lighting service
IS: 2440	Guide for day lighting of building

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IS: 2544 IS: 2551	Porcelain post insulators for systems with nominal voltages greater than 1000 volts. Danger notice plate.
IS: 2667	Fittings rigid steel conduits for electrical wiring
IS: 2705 (Part-I to IV)	Specifications for current transformer
IS: 3043	Code of practice for earthing.
IS: 3070	Lightning arrester for alternating current system
IS: 3419	Fittings for rigid non-metallic conduits
IS: 3427	AC Metal enclosed switch gear and control gear for rated voltages above 1 KV and upto and including 52 KV.
IS: 3480	Flexible steel conduits for electrical wiring.
IS: 3639	Fittings and accessories for power transformers
IS: 3837	Accessories for rigid steel conduit for electrical wiring.
IS: 3854	Switches for domestic and similar purpose
IS: 3961	Current ratings for cables
IS: 4004	Application guide for surge arrestors for AC system
IS: 4012	Specifications for dust proof electric light fittings
IS: 4013	Specifications for dust tight electric light fittings
IS: 4146	Application guide for voltage transformers
IS: 4160	Interlocking switch socket outlets
IS: 4615	Switch socket outlets.
IS: 5039	Specifications for distribution pillars upto 1100 volt AC
IS: 5133 (Part -I)	Boxes for the enclosure of electrical accessories.
IS: 5216 (Part-I & II)	Guide for safety procedures and practices in electrical work.
IS: 5424	Rubber mats for electrical purposes.
IS: 5578 & 11353	Marking and arrangement of bus bars
IS: 5819	Guide for short circuit rating of high voltage PVC cables
IS: 5987	Code of practice for selection of switches
IS: 7098 - (Part - II)	Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS: 8130	Conductors for insulated electric cables and flexible cords
IS: 8623 (Part -I, II & III)	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.

IS: 8828	Miniature Circuit Breakers
IS: 9224 (Part - IV)	Fuses for protection of semiconductors
IS: 9537 (Part-I & II)	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS: 9537 (Part-III)	PVC rigid conduits
IS: 10028 (Part-I, II & III)	Selection, installation and maintenance of transformers
IS: 10118 (Part-I, II, III & IV)	Selection, installation and maintenance of switchgear and control gear
IS: 10322 (Part-IV)	Luminaries – method of tests
IS: 10322 (Part-V/ Sec-1)	Particular requirement – General purpose luminaries
IS: 10322 (Part-V/ Sec-2)	Particular requirement – Recessed luminaries
IS: 10322 (Part-V/ Sec-3)	Particular requirement – Luminaries for road and street lighting
IS: 10322 (Part-V/ Sec-4)	Particular requirement – Portable general purpose luminaries
IS: 10322 (Part-V/ Sec-5)	Particular requirement – Flood lighting
IS: 10810	Methods of test for cables.
IS: 12360	Voltage bands for electrical installation including preferred voltages and frequency
IS: 12640	Earth Leakage Circuit Breakers
IS: 12729	Switchgear and control gear for voltage exceeding 1000 volts
IS: 12943	Single compression cable gland
IS: 13021(Part-I)	Electronic ballasts for fluorescent lamps – General & safety requirements
IS: 13021(Part-II)	Electronic ballasts for fluorescent lamps – Performance requirements
IS: 13021(Part-III)	Luminaries – Screw and screw less termination
IS: 13703	Low voltage fuses upto 1000 volts
IS: 13947	Degree of protection provided by enclosures for LV switchgear and control gear.
IS: 13947	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.
IS: 15652	Insulating mats for electrical purposes.
IS: 1651 & 1652	Stationary cells and batteries lead acid type.
IEEE: 32	Standard requirements, terminologies, test procedures for neutral grounding resistors
IEEE: 241	Recommended practice for power systems in commercial buildings

IEEE: 446-1987	Recommended practices for emergency & standby power systems
IEEE: 450-1975	Recommended practices for maintenance, testing of lead acid batteries
IEEE: 472	Practices and requirements for surge withstand capability test.
IEEE: 519 – 1992	Practices and requirements for harmonic control in electrical power systems
IEEE: 1100	Practice and requirements for powering and grounding electronic equipment
IEC	Semiconductor convertor standards
IEC: 60140-1	Safety
IEC: 60140-2	Electro Magnetic Compatibility
IEC: 60140-3	UPS performance
BS: 2709 (IEC: 119)	Recommended practices for electrical performance of Semiconductor Rectifiers (Metal Rectifiers)
BS: 4417 (IEC: 146)	Recommended practices for Semiconductor Rectifier equipment
BS: 9720	Recommended practice for custom built transformer and inductors of assessed quality
ANSI: C 34.2	Practices and requirements for semiconductor power rectifiers
ANSI: C 37.90	Relay and relay system associated with electrical power apparatus
NEMA PE-1 1983	Uninterrupted Power System Standards

APPENDIX

ABBREVIATIONS

The following abbreviations have been used in the accompanying Specifications, drawings and Schedule of Quantities.

CU	Stands for copper.
GI	Stands for Galvanized Iron (Mild Steel)
V	Stands for Volts
KV	Stands for Kilo Volts
HV	Stands for High Voltage (3.3 KV and above)
MV	Stands for Medium Voltage (110 V, 230 V, 415 V, 600 V, 110 V)
LV	Stands for Low Voltage (32 V & Below)
HT	Stands for High Tension
LT	Stands for Low Tension
PVC	Stands for Polyvinyl Chloride
AMP	Stands for Amperes
KWH	Stands for Kilowatt Hours
KW	Stands for Kilo Watts
BIS	Stands for Bureau of Indian Standards
IS	Stands for Indian Standards
IEC	Stands for International Electrotechnical Commission
IEE	Stands for Institution of Electrical Engineers - London
IEEE	Stands for Institution of Electrical & Electronics Engineers
NEC	Stands for National Electrical Code
ACB	Stands for Air Circuit Breaker
RCCB	Stands for Residual Current Circuit Breaker
MCB	Stands for Miniature Circuit Breaker
MCCB	Stands for Moulded Case Circuit Breaker
SP	Stands for Single Pole
DP	Stands for Double Pole
TP	Stands for Triple Pole

TPN	Stands for Triple Pole and Neutral
4 Pole	Stands for 3 phase and neutral of same capacity (size)
MDB	Stands for Main Distribution Board
SDB	Stands for Sub Distribution Board
FDB	Stands for Final Distribution Board
MCC	Stands for Motor Control Centre

APPENDIX

SCHEDULE OF TECHNICAL DATA

A. UPS SYSTEM (To be filled by the Bidder)

- 1. Nominal rating (kVA) :**
- 2. Power Factor :**
- 3. Normal AC supply input :**
 - a. Input voltage
 - b. Frequency :
 - c. Input current THD :
 - d. @ 100 % Load
 - e. @ 50 % Load
 - f. Input power factor :
 - g. Magnetized sub- cycle in rush current :
 - h. Converter Walk-in time :
- 4. Bypass system input**
 - a. Nominal input voltage :
 - b. Frequency 50Hz/ 60Hz \pm 10% :
- 5. Output**
 - a. AC Output voltage :
 - b. Voltage regulation :
 - c. Transient Voltage Regulation :
 - i. AT 100% step load change :
 - ii. At loss or return of AC Input :
 - iii. At load transfer from bypass to inverter :
 - d. Time to recover from transient to normal voltage :
 - e. Frequency :
 - f. Over load duration (Minutes)
 - i. @ 100 % load
 - ii. @ 125 % load
 - iii. @ 150 % load

- g. Output voltage THD
 - i. @100 % linear load :
 - ii. @100 % Nonlinear load :

6. Batteries

- a. Backup time :
- b. Type of batteries :
- c. Ageing Factor (%) :
- d. PF considered for battery calculation :
- e. Lead content in battery :

7. Efficiency

- a. Without Isolation Transformer :
- b. With Isolation Transformer :

8. Operating Conditions

- a. Operating Temperature :
- b. Noise Level :
- c. Operating altitude :

9. Dimensions in MM

- a. UPS System
 - i. Length (mm) :
 - ii. Width (mm) :
 - iii. Height (mm) :
- b. Batteries
 - i. Length (mm) :
 - ii. Width (mm) :
 - iii. Height (mm) :

10. Operating Weights

- a. UPS Systems :
- b. Batteries :

11. Heat Dissipation

- a. UPS system
 - @ 100 % load :
 - @ 75 % load :
 - @ 50% load :
- b. Batteries :

12. Power Cabling

- a. Cable sizes :
- b. Cable entry :

13. Protection

14. Operating Conditions

- a. Operating Temperature :
- b. Noise Level :

15. BMS Compatibility

- Type of Protocol :

16. Protections & Display

17. Additional Feature

- a. Battery Management System - :
- b. Battery Monitoring System - :
- c. SMS/ Email alerts - :
- d. Bypass Enable/ Disable :
- e. Static Switch Enable/ Disable :

TECHNICAL SPECIFICATIONS INTERNAL ELECTRICAL WORKS

A. ELECTRICAL SYSTEM

1. INTERNAL WIRING

1.1 System of Wiring

The system of wiring shall consist of PVC insulated copper stranded conductor flexible LSZH (Low Smoke Zero Halogen)/ FRLS wires in metallic/ nonmetallic (Rigid heavy Duty ISI - marked fire retarded PVC Conduits of minimum 2mm Wall thickness and Sizes starting from 20 mm diameter) conduits and shall be concealed or surface mounted above false ceiling as called for.

1.2 General

Prior to laying and fixing of conduits, the contractor shall mark the conduit route, carefully examine the working drawings prepared by him and approved by the Consultant indicating the layout, satisfy himself about the noninterference in the route, sufficiency of number and sizes of conduits, location of junction boxes, sizes and location of switch boxes and other relevant details. Any discrepancy found shall be brought to the notice of the Owner's site representative. Any modifications suggested by the contractor should get written approval before the actual laying of conduits is commenced.

In laying of conduits it is important that not more than two right angle bends are provided for each circuit without a pull box. No junction box shall be provided in the entire length of conduit run for drawing of wires. Only switch outlets, lighting fixture outlets, equipment power outlets and socket outlets shall be considered for drawing of wires.

1.3 Metal Conduits & Accessories

1.3.1 Conduits

Conduits and Accessories shall conform to latest edition of Indian Standards IS: 9537 part 1 & 2. 16/ 14 (16 gauge upto 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed MS conduits as specified on schedule of quantities shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS: 2667, IS: 3837 and IS: 5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Note: *Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan.*

1.3.2 Joints

All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberised bushes shall be used in the conduit entry and exit from DBs, switch boxes etc., so that wires are protected from damage to insulation of the incoming and outgoing wires

1.3.3 Recessed or Exposed Conduits

All conduits shall be as per Schedule of Quantities.

1.3.4 Flexible Conduits

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip shall have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature upto 150 deg. C and intermittent temperature upto 200 deg. C. The flexible conduit shall be corrosion resistant as per IS: 3480 & BS: 731.

1.4 PVC Conduit and Accessories

PVC Conduit

Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty with minimum wall thickness of 1.6/ 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All conduits used shall be ISI-marked and shall not be less than 20 mm diameter.

PVC conduit shall be used for all concealed/ embedded installation.

PVC Conduit Accessories

Accessories used for conduit shall be of an approved brand and type complying with relevant IS code.

All accessories used shall be of standard white or black colour, identical to conduit used.

Plain conduits shall be joined by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.

PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.

Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

1.5 Bends in Conduit

Where necessary, bends or diversions may be achieved by means of bends and/ or circular cast iron boxes with inspection cover and with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non-uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enamelling/ Galvanising of the Conduit are not damaged.

1.6 Fixing of Conduits

All conduits shall be installed so as to avoid exposure to steam, hot water or any other process pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, rodents and insects, insects or any other foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 1000 mm and on either side of couplers or

bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/ Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface to the entire satisfaction of Owner

1.7 Switch outlets and Junction Boxes

All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 1.2 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in SOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall generally be of 50 mm depth subject to maximum depth of 65 mm.

1.8 Inspection Boxes

50 mm dia inspection boxes and pull boxes shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

1.9 Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided along with the laying of recessed conduit.

1.10 Conductors

All PVC insulated stranded copper conductor flexible, as specified in SOQ, wires shall conform in all respects to Standards as listed under sub-head Indian Standards and shall be IS approved and ISI marked.

1.11 Bunching of Wires

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate. Each Power/ Light Circuit's Neutral shall be individual per Circuit and shall not be looped from any other Circuit.

1.12 Drawing Conductors

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid nonmetallic or PVC Conduits are given below:

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	7	12	16	--	--
2.5	5	10	14	--	--
4	4	8	12	--	--
6	3	6	8	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/ reduced for convenience in connecting into terminals. The terminals shall have sufficient cross sectional area to take all strands and it's connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/ connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

Conductors having nominal cross sectional areas exceeding 10 sq.mm. shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts with brass washers shall be used for all connections. Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring license to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians'/ Wireman's/ Cable Jointer's license to Owner.

All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring, PVC insulated wires of 1100 volts grade shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/ wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper. Separate neutral to be pulled for each circuit.

1.13 Joints

All joints shall be made at main switches, distribution boards socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

1.14 Mains and Sub-Mains

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and calculations shall be submitted for verification. An independent earth wire of the proper rating shall be provided for every single phase sub-main. For every 3-phase sub-main, 2 No. earth wires of proper rating shall be provided along with the sub-main. The earth wires shall be drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance. Where ever necessary, powder-coated 1.6 mm thick sheet steel covering (also called trunking) shall be provided to cover the group of conduits and cables entering and exiting the Wall mounted/ Floor mounted SDBs, DBs and FDBs so that the Installation looks neat. The colour of such sheet steel covering (trunking) shall be matching with the colour of the SDBs, DBs and FDBs

1.15 Load Balancing

Balancing of circuits in three phase installation shall be as planned by the Consultants in the tender drawings and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

1.16 Colour Code of Conductors

Colour code shall be maintained as indicated by the Consultant for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green with yellow band shall be for earthing.

2 SWITCHES, RECEPTACLES (MODULAR), LIGHTING FIXTURES

2.1 Switches

All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat M S strips/ plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load on each switch shall be restricted to maximum **800 watts & maximum 1500 watts per circuit**. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

2.2 Socket Outlet

Socket outlets shall be of the three pin. The switch controlling the socket outlet shall be on the phase wire of the circuit and not more than two socket outlets of 16 amps shall be connected on one circuit. An earth wire shall be provided along with the circuit wires and shall be connected to earthing screw inside the box. All sockets shall be shuttered type.

- a. Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.
- b. The switch controlling the socket outlet shall be on the 'Live' side of the line.
- c. 6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level as desired by the Architect. The switch for 6 and 16 amps, socket outlet shall be kept along with the socket outlet. However, in special case, if desired by the Architect the 6 amp. Socket outlet can be placed at the normal switch level.

16 amps socket outlet in the kitchen of the residential or commercial buildings shall be fixed at any convenient height above working platform or as specified in drawings/ schedule of equipment.

In a room containing a fixed bath or shower, there shall be no socket outlet and there shall be no provision for connecting a portable appliance. Any stationary appliance connected permanently in the bath room shall be controlled by an isolator switch or circuit breaker having outlets at such location where water/ moisture does not effect. Generally, switches and outlets shall be planned at a minimum distance of 1.5 Metre away from any water supply outlet, so that splashed water may not affect the live installation.
- d. Where socket outlets are placed at lower level, they shall be enclosed in a suitable metallic box with the system of wiring adopted or shutter type sockets shall be provided as specified.
- e. In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.
- f. Conductors connecting electrical appliance with socket outlet shall be flexible twin cord with an earthing cord which shall be secured by connecting between the earth terminal of plug and the metallic body of the electrical appliance.
- g. Where use of shutter type of interlocking type of socket is required for any special installation, the items should be separately and specifically listed in the Schedule of Quantities of that particular work.

2.3 Switches & Receptacle Finishes

- i. The finish of switches, receptacles and cover plates shall be as follows:
 - Guestrooms and guestroom bathrooms shall have polished stainless steel or as specified by Interior Designer.
 - Public Area shall be oil rubbed bronze or other depending on wall finishes, as approved by Interior Designer.

- Services area shall be satin finish brushed stainless steel.
- Exterior weatherproof switches and receptacles shall be stainless steel finish.

2.4 Lighting Fixtures & Accessories

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

2.4.1 Scope:

Scope of work under this section shall include inspection at suppliers/ manufacturer's premises at site, receiving at site, safe storage, transportation from point of storage to point of erection, erection and commissioning of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting etc. as required.

2.4.2 Standards:

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following:

General and safety requirements for Luminaries:

Part-1 Tubular fluorescent lamps	-	IS – 1913 (Part-1)
Industrial lighting fittings with metal reflectors	-	IS - 1777
Decorative lighting outfits	-	IS - 5077
Bayonet lamp holders	-	IS - 1258
Bi-pin lamp holders for tubular fluorescent lamps	-	IS - 3323
Electronic Ballasts for fluorescent lamps – General & Safety requirement	-	IS – 13021 (Part-1)
Electronic Ballasts for fluorescent lamps – Performance requirement	-	IS – 13021 (Part-2)
Ballast for HP MV lamps	-	IS - 6616
Tubular Fluorescent lamps	-	IS - 2418 (Part-1 to 4)
Luminaries – General requirement	-	IS – 10322 (Part-1)
Luminaries – Constructional requirement	-	IS – 10322 (Part-2)
Luminaries – Screw and Screw less termination	-	IS – 10322 (Part-3)
Luminaries – Methods of Tests	-	IS – 10322 (Part-4)
Particular requirement – General purpose Luminaries	-	IS – 10322 (Part-5/ Sec-1)
Particular requirement – Recessed Luminaries	-	IS – 10322 (Part-5/ Sec-2)
Particular requirement – Luminaries for Road and Street lighting	-	IS – 10322 (Part-5/ Sec-3)
Particular requirement – Portable General purpose Luminaries	-	IS – 10322 (Part-5/ Sec-4)
Particular requirement – Flood Lighting	-	IS – 10322 (Part-5/ Sec-5)
High pressure mercury vapour lamps	-	IS – 9900 (Part-1)
Tungsten filament general electric lamps	-	IS - 418

2.4.3 Light Fittings-General Requirements:

- a) Fittings shall be designed for continuous trouble free operation under atmospheric conditions without reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.
- b) Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ ballasts.
- c) All fittings shall be supplied complete with lamps. All mercury vapour and sodium vapour lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Outdoor type fittings shall be provided with weather proof junction boxes (IP-55) and IP-54 Control gear boxes. All fluorescent and CFL fittings shall be provided with electronic ballast as per schedule of quantities.
- d) Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires upto 4 sq.mm. The internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.
- e) All hardware used in the fitting shall be suitably plated or anodized and passivated.
- f) Earthing: Each lighting fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earthing terminal so as to ensure satisfactory earthing continuity throughout the fixture.
- g) Painting/ Finish: All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burns.
- h) The housing shall be powder coated/ stove-enamelled or anodised as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.
- i) Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

2.4.4 Light Fittings – Special Requirements

Box Channel Type Industrial Fittings

Box type slim line channel must be in screw less construction manufactured from M.S. CRCA sheet steel powder coated with MS CRCA cover, powder coated white. Light reflection surface in Box/ Channel type fittings shall be in a POLYESTER PRECOATED STEEL having a reflection factor of not less than 80%. SCREWLESS DESIGN & CONSTRUCTION Light fixtures shall be preferred due to their ease of maintenance, especially for box/ channel for box/ channel type fixtures.

Moisture Proof Industrial Fittings

Surface mounted totally enclosed moisture proof fixtures must be in polycarbonate body and diffuser with transparent prismatic interior and smooth exterior and frosted end. Fixture must be completely sealed with polyurethane double gasket to achieve IP 65 protection. Fixture is complete with CRCA steel white powder coated/ enameled finish reflector.

18 W/ 36 W Fluorescent and 36 W CFL Low Glare Light Fittings

Recessed mounted, modular fluorescent lighting fixture made of CRCA Sheet steel powder coated (white) housing, electro chemically brightened and anodised reflector, three dimensional cross louvers with concave contours, fresnel top at louver saddle to increase efficiency. The luminance of <200 cd/ M² at 63 degree viewing angle in all directions so as to confirm Cat-2 classification of CIBSELG3

Highbay Industrial Fittings

Industrial High bay luminaries shall be provided with pressure die cast housing along with all accessories, orthocyclically wound opien construction ballast, capacitor & semi parallel ignitor connected to terminal block and mounted on the gear plate. The gear shall have side entry for ease in maintenance. The spun aluminium reflector is suitable for narrows well as wide beam distribution as specified in schedule of quantities. The luminaries will be suitable for metal halide lamp HPI BU + 250 W which has 25500 lumens or similar 400W lamp and 2. 5 minutes restrike time (when operate with son gear).

2.4.5 Accessories for Light Fittings - Reflectors

The reflectors shall be made of CRCA sheet steel/ aluminium/ Silvered glass/ Chromium plated sheet copper as specified. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/ vitreous enameled/ epoxy coating finish. Aluminium used for reflectors shall be anodized/ epoxy stove enameled/ mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches/ blisters and shall have a smooth and glossy surface having optimum light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

2.4.6 Lamps

2.4.6.1 TLD

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of 85. The lamp must comply to ROSH (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully re-cyclable. The lamp should be low on maintenance with life of 40 K hours in case of electromagnetic ballast and 65 K hours in case of HF ballast upto 10% failure. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Colour spectrum of light shall be equivalent to "PHILIPS color 84 or color 86 color 82 or "OSRAM color 21 or color 11 or color 41 (as required at site)".

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

T 5 – High Efficiency Eco-Friendly Lamps

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D standard lamp, 26% less than TL-D/ 80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for operation with electronic gear and well suited for dimming.

Maximum lumen output to be reached at approx. 35°C in free burning position. T-5 lamp can be ignited from -15°C to + 50°C. Lamp should be fully recyclable and must comply to ROSH (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lumens/ W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

- 2.4.6.2 Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & standers and for HF electronic control gear. CFL lamp shall be non-integral type of OSRAM/ GE/ PHILIPS/ Havells Sylvania only.

2.4.7 High Frequency Electronic Ballast

High frequency electronic ballast shall be used with fluorescent/ Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply to the following:

- IEC 927, IEC 928 for $\leq 10\%$ total harmonic distortion.
- EMI/ RFI – Confirming to FCC/ VDE Class A/ B.
- Line Transient as per IEEE C62. 41.
- Ballast Crest Factor C1. 7%.
- No Stroboscopic Effect
- Constant Wattage/ Light output between $240\text{ V} \pm 10\%$.
- Circuit protection for surge current and inrush current.
- Short circuits, open lamp protection
- $\text{PF} > 0.99$ for fluorescent/ T5 lamp and 0.95 for CFL.
- Deactivated lamp protection
- Suitable for use with single and twin lamps
- RFI $< 30\text{ MHz}$ EN 55015
- Total Harmonic Distortion (THD) $\leq 10\%$
- Immunity to interference EN 61547
- Safety EN 60928/ IEC 928/ IS 13021 (Part I)
- Performance EN 60929/ IEC 929/ IS 13021 (Part II)
- Vibrations & Bump tests IEC 68-2-6 FC/ IEC 9001
- Quality Standard ISO 9001
- Environmental Standard ISO 14001
- DC Operation EN 60924
- Emergency Lighting Operation VDE 0108

Total System consumption (lamps + ballast) for

1 x 36 W TLD, shall not exceed 36 W

1 x 28 W T-5, shall not exceed 28 W

1 x 35 W T-5, shall not exceed 35 W

1 x 14 W T-5, shall not exceed 14 W

1 x 18 W CFL, shall not exceed 18 W

1 x 36 W CFL, shall not exceed 36 W

Tenderer's Signature and Stamp

3. MEDIUM VOLTAGE 1.1 KV GRADE XLPE/ PVC CABLES

3.1 General

The MV cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Standard Specifications and cable manufacturer's instruction.

3.2 Material

The MV cables shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed and HR PVC/ FRLS PVC outer sheath of 1100 volts grade as asked for in the schedule of quantities. Cables upto 10 sq. mm shall be with copper conductor and 16 sq. mm and above shall be with aluminium conductor.

3.3 Technical Requirements:

- 3.3.1 All XLPE Aluminium/ Copper Power cables shall be 1100 Volts grade, multi core constructed as per IS: 7098 Part-I of 1988 as follows:
- a) Stranded Aluminium/ Copper conductor in case of 10 sq. mm and above whereas solid conductor in case of 10 sq. mm. and below.
 - b) Cores laid up
 - c) The inner sheath should be bonded over with thermo-plastic material for protection against mechanical and electrical damage.
 - d) Armouring should be provided over the inner sheath to guard against mechanical damage. Armouring should be Galvanized steel wires or galvanized steel strips. (In single core cables used in A. C. system armouring should be non-magnetic hard aluminium Wires/ Strips. Round steel wires should be used where diameter over the inner sheath does not exceed 13 mm; above 13 mm flat steel armour should be used. Round wire of different sizes should be provided against specific request.)
 - e) The outer sheath should be specially formulated heat resistant black PVC compound conforming to the requirement of type ST2 of IS: 5831-1984 extruded to form the outer sheath.
- 3.3.2 Conductor shall be of electrolytic Aluminium/ Copper conforming to IS: 8130 and are compact circular or compact shaped.
- 3.3.3 Insulation shall be of XLPE type as per latest IS general purpose insulation for maximum rated conductor temperature 70 degree centigrade.
- 3.3.4 In Inner sheath laid up cores shall be bonded over with thermoplastic material for protection against mechanical and electrical damage.
- 3.3.5 Insulation, inner sheath and outer sheath shall be applied by extrusion and lapping up process only.
- 3.3.6 Armouring shall be of galvanized steel wire/ flat.
- 3.3.7 Repaired cables shall not be used.
- 3.3.8 Current ratings of the cables shall be as per IS: 3961.
- 3.3.9 The XLPE insulated cables shall conform to latest revision of IS and shall be read along with this specification. The Conductor shall be stranded Aluminium/ Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified by red, yellow, blue and black colouring of insulation.

- 3.3.10 The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.
- 3.3.11 Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.
- 3.3.12 Cables shall be supplied in non-returnable wooden drums as per IS: 10418.

Both ends of the cables shall be properly sealed with PVC/ Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

- 3.3.13 The product should be coded as per IS: - 7098 Part-I as follows: -

Aluminium Conductor	A
XLPE Insulation	2X
Steel round wire armour	W
Steel strip armour	F
Steel Double round wire armour	WW
Steel Double strip armour	FF
Non-magnetic (Al.) round wire armour	Wa
Non-magnetic (Al.) strip armour	Fa
PVC outer sheath	Y

3.4 Fire Survival Cables

Aluminium conductor armoured *Fire Survival* cable with (EPR) Ethylene Propylene rubber insulation as per BS 7846: 2009 & IEC-60502: 2004 Part-1 (Armoured), Retain circuit integrity as per BS 6387 C.W.Z (armoured), BS-8491: 2008, BS 8434-2: 2009 (armoured), (Resistance to fire at 950° C for 3 hours)

3.5 Inspection

All cables shall be inspected by the contractor upon receipt at site and checked for any damage during transit.

3.6 Joints in Cables

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing. This apportioning shall be got approved by the Owner's site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type joints shall be made. The location of such joints shall be got approved from the Owner's site representative and shall be identified through a marker.

3.7 Jointing Boxes for Cables

Cable joint boxes shall be installed with heat shrinkable sleeve and of appropriate size, suitable for XLPE armoured cables of particular voltage rating.

3.8 Jointing of Cables

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the

weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

3.9 Cable End Terminations

Cable end termination shall be done in cable terminal box using crimping sockets and proper size of glands of double compression type

3.10 Bonding of Cables

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armour clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that no undue stress is passed on to the cable conductors.

3.11 Cable Installation

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

3.11.1 Laying of Cables on Cable Trays

The relative position of the cables, laid on the cable tray shall be preserved and the cables shall not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables shall be tagged for identification with aluminum tag and clamped properly at every 20M. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by "VIPER CABLE RETARD".

3.11.2 Laying of Cables in Ground

The width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be workout by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches: The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be leveled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be removed by 'Flaking' i. e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be protected

by second class bricks before back filling the trench. The buried depth of uppermost layer of cable shall not be less than 750mm.

Back Filling: The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

3.12 Cables inside Building

Cables inside buildings shall be laid on the cable trays. All cables passing through walls shall run through GI Pipes sleeves of adequate diameter 50 mm apart maintaining the relative position over the entire length.

3.13 Route Marker

Route marker shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.

Route marker shall be of cast iron painted with aluminum paint. The size of marker shall be 100 mm dia with “Cable” and voltage grade inscribed on it.

3.14 Cable Trays

Ladder type Cable Trays shall be of Hot dip Galvanized type, perforated cable trays shall be of pregalvanized and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below:

Cable trays shall be galvanized as per Specification given under 3. 14.

- a. 1500 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/ C
Suspenders 2 No. 40 x 40 x 5 mm GI angle 1500 mm C/ C with base support of 40 x 40 x 5mm GI angle.
- b. 1200 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/ C
Suspenders 2 No. 40 x 40 x 5 mm GI angle 1500 mm C/ C with base support of 40 x 40 x 5mm GI angle.
- c. 1000 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/ C
Suspenders 2 No. 40 x 40 x 5 mm GI angle 1500 mm C/ C with base support of 40 x 40 x 5mm GI angle.
- d. 750 mm wide
Runners 20 x 75 x 20 x 2. 5 mm
Rungs 20 x 30 x 20 x 2. 5 mm 250 mm C/ C
Suspenders 2 No. 32 x 32 x 5 mm GI angle 1800 mm C/ C with base support of 40 x 40 x 5mm GI angle.

- e. 600 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/ C
Suspenders 2 No. 32 x 32 x 5 mm GI angle 1800 mm C/ C with base support of 40 x 40 x 5mm GI angle.
- f. 450 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/ C
Suspenders 2 No. 25 x 25 x 4 mm GI angle 1800 mm C/ C with base support of 40 x 40 x 5mm GI angle.
- g. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.
 - i. 600 x 40 x 40 x 2 mm thick
 - ii. 450 x 40 x 40 x 2 mm thick
 - iii. 300 x 40 x 40 x 2 mm thick
 - iv. 150 x 40 x 40 x 2 mm thick

Note: Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

3.15 Specification for Hot Dip Galvanizing Process

(for Mild Steel Used For Earthing, Cable Trays Or Junction Boxes For Electrical Installation.)

General Requirements

I. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

II. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS: 6745-1972 shall be 400 g/ sqm.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters. Mild steel flats/ wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

3.16 Fire retardant Cable Paint & Fire Barrier

The fire retardant paint/ barrier shall be listed by independent test agencies such as UL, FM or OPL and be tested to, and pass the criteria of ASTM E 814 (UL1479) standard test method for fire test through-penetration fire stops and ASTM E 1996 (UL 2079) standard test method for fire resistive joint system.

3.16.1 Fire Retardant cable Paint

The Fire resistant cable coating/ painting shall be intumescent/ ablative, water based compound. The coating shall expand up to 10 times, supplied in a manufacturer seal container indicating manufacturing and expiry dates. The coating material shall be non-toxic, asbestos free, & halogen free and shall have good mechanical strength. The colour of paint shall be white and density of coating shall be 1.3kg/ ltr, coating shall have a snap time of 30 minutes, the expansion shall begin at 230 deg. C and it shall have an oxygen index of 41%.

Coating shall be applied by ordinary paint brush after cleaning the cables of dust and oil deposition. A minimum textured finish of 3 mm wet film thickness shall be achieved by applying the material in 2-3 layers leaving intervals of 2 to 8 hours depending upon the moisture and thickness, moisture and temperature hours between each coat.

3.16.2 Fire Barrier sheet for floor and wall sealing

The framing & fixing part of fire barrier sheet shall be very simple & directly fixed around walls & floors by help of anchored bolts & washer. For 2 hour fire rating the fire barrier sheet shall be minimum 7.62 mm thick and shall be cut as per the profile of penetration and opening. The small gap left around the penetration shall be closed with fire rated soft & mouldable putty. Fire barrier must be design on the intumescent technology to seal larger penetration through the fire rated walls & floors. Fire barrier must be a composite construction with the quality incorporated with organic/ inorganic fire resistive elastomeric sheet with specific gravity of 1.6 gm/ cubic centimeter.

3.17 Testing of Cables

Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team.

- a) Insulation Resistance Test.
- b) Continuity resistance test.
- c) Sheathing continuity test.
- d) Earth test. (in armoured cables)
- e) Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative.

- a) Insulation Resistance Test(Sectional and overall)
- b) Continuity resistance test.
- c) Sheathing continuity test.
- d) Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner's site representative, results will be noted and signed by all present and record be maintained.

4 (A) DISTRIBUTION PANELS/ BOARDS

Main Distribution Panels, Sub-Distribution Panels and Final Distribution shall be covered under this section. Panels/ Boards shall be suitable for operation on 3 Phase/ single phase, 415/ 240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by an approved manufacturer. **CPRI certificate shall be made available.**

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 Construction Features

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/ wall mounting type and shall be form 3b construction. The Distribution panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Distribution panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self-threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum **operating** clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest operating height.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/ conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4.2 Bus Bar Connections

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium/ copper as indicated in the bill of quantities complying with requirement of IS: 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper/ aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 0.8 A/ sq. mm for aluminium and **1.4 A/ sq. mm** for copper busbars.

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

4.2.1 Temperature - Rise Limit

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

All main distribution panels and sub distribution panels shall be provided with MCCB of appropriate capacity as per Single Line Diagram. All final Distribution boards shall be provided with Miniature Circuit Breakers. Final Single Phase Distribution boards shall be connected to the incoming supply through double pole MCB units & earth leakage circuit breakers. All wiring for final distribution boards shall be concealed behind 5 mm thick bakelite sheet or M S sheet cover. All Distribution boards shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

4.3 Cable Compartments

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/ bottom. Adequate supports shall be provided in cable compartment to support cables.

4.4 Air Circuit Breakers (ACB)

- 4.4.1 The ACB shall conform to the requirements of IEC 60947-2/ IS 13947-2 and shall be type tested & certified for compliance to standards from CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V \pm 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i. e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breakers shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/ OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

4.4.2 Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/ Test/ Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features shall be incorporated:

- a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
- b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.
- c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
- d. All Switchgear module front covers shall have provision for locking.
- e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

4.4.3 Protections

The breaker should be equipped with micro-controller based, communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall generally have following features and settings **however for exact requirement of protection releases, reference shall be made to SOQ:**

- a. True RMS Sensing

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

- b. Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/ Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics:

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self-powered

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimizes the damage to the system. To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release shall meet the EMI/ EMC requirements.

h. The setting range of release shall be generally as follows:

Type of Protection	SETTINGRANGE OF RELEASE	
	PICK-UP CURRENT	TIME DELAY
Long Time	<p>0. 4 to 1. 0 times I_n (I_r)</p> <p>Steps: 0. 4, 0. 5, 0. 55, 0. 60, 0. 65, 0. 70, 0. 75, 0. 80, 0. 85, 0. 90, 0. 95, 1. 00.</p> <p>Operating Limit: 1. 05 to 1. 2 times I_r</p>	<p>0. 5 to 30 sec at 6 I_r</p> <p>Steps 0. 5, 1, 2, 4, 6, 8, 12, 18, 24 and 30 secs</p> <p>Tolerance: Corresponding to $\pm 10\%$ of current.</p>
Short Time	<p>2 to 10 times I_r</p> <p>Steps: 2, 3, 4, 5, 6, 7, 8, 9 & 10</p> <p>Tolerance: $\pm 10\%$</p>	<p>20 ms to 600 ms</p> <p>Steps 20, 60, 100, 160, 200, 260, 300 400, 500 and 600 ms</p> <p>Tolerance: $\pm 10\%$ or 20ms whichever is higher</p>
Instantaneous	<p>2 to 12 times I_n</p> <p>Steps: 2, 3, 4, 6, 8, 10, 12</p> <p>Tolerance: $\pm 10\%$</p>	
Ground Fault	<p>0. 2 to 0. 6 time I_n</p> <p>Steps: 0. 2, 0. 3, 0. 4, 0. 5, 0. 6</p> <p>Tolerance: $\pm 10\%$</p>	<p>100 ms to 400 ms</p> <p>Steps: 100, 200, 300, 400ms</p> <p>Tolerance: $\pm 10\%$ or 20 ms whichever is higher.</p>

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Trip Circuit supervision with PS class CT's.
- Undercurrent, (for DG set only)
- Reverse power (for DG set only)
- Phase sequence reversal

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT should be Rogowsky type with measurement precision of 1%.
- Release should be self-powered.
- Release should have facility to select different type of IDMTL protection (DT, SIT, VIT, EIT, HVF) for better co-ordination with HT Breaker/ Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)

All O/ G ACBs shall have following functions.

Protection

- The ACB control unit shall offer the following protection functions as standard:
- Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay; instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively on a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- A LED bargraph shall simultaneously display the load level on the three phases.
- A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

4.4.4 Safety Features

- i. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- ii. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- iii. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.
- iv. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- v. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- vi. Draw out breakers should not close unless in distinct Service/ Test/ Isolated positions.
- vii. The insulation material used shall conform to Glow wire test as per IEC60695.
- viii. The ACB shall provide in built electrical and mechanical anti-pumping.
- ix. All EDO ACB's Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.
- x. Main breakers sized 3200 Amps and above shall be electrically operated air circuit air circuit breaker with solid state adjustable trip units or as described in the bill of quantities and drawings.

4.5 Moulded Case Circuit Breaker (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/ IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI/ ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC – 60947 - 2, 1989/ IS: 13947 - 2. The breaker as supplied with ROM should meet IP54 degree of protection.

4.5.1 Current Limiting & Coordination

- The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let-through energy curves for all.**

4.5.2 Protection Functions

- MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (adjustable thermal for overload and fixed magnetic for short-circuit protection) trip units .
- Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings.
- Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility etc.)
- All Microprocessor components shall withstand temperatures up to 125 °C.
- Protection settings shall apply to all poles of circuit breaker.

4.5.3 Testing

- a) Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished.
- b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

4.5.4 Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

- a) Handle interlock to prevent unnecessary manipulations of the breaker.
 - b) Door interlock to prevent the door being opened when the breaker is in ON position.
 - c) Defeat-interlocking device to open the door even if the breaker is in ON position.
- The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.
 - All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.
 - The trip command shall override all other commands.

4.6 Motor Protection Circuit Breaker (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1, 2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4. MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB

shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV.

The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc. by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC.

All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly coordinated motor-starter. This combination shall enable type 1 or type 2 co-ordinations of the protective devices conforming to IEC 60947-4-1. Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory). The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C)

4.7 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/ IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/ 415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/ IEC and the manufacturer shall publish the values. MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

4.8 Residual Current Circuit Breaker Current Operated Type (RCCB)

4.8.1 System of Operation

Residual Current Circuit Breaker shall conform to IEC 61008. RCCB shall work on the principle of core balance transformer. The incoming shall pass through the toroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/ 415 volts AC and shall have a minimum of 10, 000 electrical operations.

4.8.2 Mechanical Operation

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing/ opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

4.8.3 Neutral Advance Feature

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall break last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

4.8.4 Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB/ RCCB and the operating handle shall move to the "OFF" position.

4.9 Earthing

Earthing shall be provided as per IS: 3043-1987.

4.10 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/ outside shall be as per BOQ confirming to IS Code No. 5.

4.11 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.12 Meters

- i. All voltmeters and indicating lamps shall be through MCB's.
- ii. Meters and indicating instruments shall be flush type.
- iii. All CT's connection for meters shall be through Test Terminal Block (TTB).
- iv. CT ratio and burdens shall be as specified on the Single line diagram.

4.13 Current Transformers

Current transformers shall be provided for Distribution panels. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

4.14 Potential Free Contacts

Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

4.15 Indicating Panel

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/ MPCB as per relevant fault level and toggle switch.

4.16 Testing

Testing of panels shall be as per following codes:

- a. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
- b. IS: 13947: 1993 Degree of protection.
- c. IS: 5578 & 11353: 1985 Arrangement of bus bars.

4.17 Wiring

In wiring a distribution panel it shall be insured that total load of various distribution panel and/ or consuming devices is divided evenly between the phases and number of ways as per Consultants drawing. All power and control wiring shall be FRLS.

4.18 Anti-Condensation Space Heaters

1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by humidistat and protected by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space heater with humidistat shall be provided in each cable alley of main distribution boards and sub distribution boards.

4.19 Installation

Installation of all LT panels shall include but not limited to the following to complete the installation, testing and commissioning:

- a) Transporting materials from stores to exact location of installation.
- b) Supply and installation of required base frame made of MS angle or channel sections and duly painted with black paint.
- c) Positioning, aligning, fixing, assembling, and installation of LT panel issued free of cost by Client after carrying out proper cleaning and inspection.
- d) Site supervision, testing for proper functioning/ operation, and pre-commissioning tests.

4.20 Commissioning and Onsite Testing

- a) All switchboards shall be tested for dielectric test with 1000V megger.
- b) All earth connections shall be checked for continuity.
- c) All busbar connections shall be checked and tightened properly.
- d) All cable terminations and terminal shrouding shall be checked if they are properly done.
- e) The operation of protective devices shall be tested by secondary injection test.
- f) The operation of circuit breaker shall be tested for all interlocks.
- g) Functional test shall be done for all ACBs, MCCBs and other components.

- h) Indicating lamps and meters shall be checked for proper working.

4.21 Spare Demand & Capacity

All panel boards shall have spare circuits and respective spare feeder capacity for future growth loads. In general, a minimum of spare or bussed spaces shall be provided as follows:

- Branch Circuit Panels : 20 %
- Power & Distribution Panels : 15 %
- Main Switchboard : 10 %

In general, feeder to branch panel boards shall be based on the demand requirements as follows:

- Individual branch circuit panel : 100% of the full capacity
- Lighting distribution boards : 80% of full capacity
- Power troughs, starter racks etc. : 90% of the full capacity.

(Full capacity indicates actual connected load plus nominal spare capacity for future)

4.22 Motor Starters

- Reduced voltage, star-delta or autotransformer starters shall be used to reduce in rush currents for motors greater than 37 kW (50 HP). Local code requirements shall be followed if they are more stringent.
- Motor starters for chillers are to include voltmeter and ammeter, as well as number of starts counter and elapsed timer.
- Group motor starters into motor control centres as required.

4.23 Disconnect Devices

Provide suitable disconnect switches at all motors located out of sight of their controllers. Similarly provide disconnect devices for kitchen and laundry equipment. Additionally provide a disconnect device for the computer room/ EPABX room in the event of fire, to shut down all power quickly and avoid short circuits when water is present.

4(B) FINAL DISTRIBUTION BOARDS (FDB's)

Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/ single phase, 415/ 240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 kV/ Sec. All Distribution Boards shall manufactured by a manufacturer listed in Appendix-II.

FDB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

4.1 Construction Features

FDB's shall be made out of 1.6 mm thick high quality CRCA sheet steel and shall be pre-treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor/ outdoor installation, wall mounting free standing type, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sq.m tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self-threading screws shall not be used in the construction of FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB's in conformity with the location of cable/ conduit connections. Detachable sheet steel gland plates shall be provided at the top/ bottom to make holes for additional cable entry at site if required.

Final Distribution Boards shall comprise of the following:

- 4.1.1 A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.
- 4.1.2 Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc. neutral bus bars & earthing bus bars required in the circuit. All busbars in the FDB shall be insulated type.
- 4.1.3 Service cable/ interconnection shall be part of the Distribution Boards.
- 4.1.4 The board shall be installed at a height such that the operating is within reach of the normal human height i. e. 1.2 to 1.8 meters from finish floor level.
- 4.1.5 Degree of protection shall be IP-52 for indoor application and IP-55 for outdoor application.
- 4.1.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.
- 4.1.7 Phase segregation to be maintained in all three phase distribution boards.
- 4.1.8 Earthing shall be provided in each FDB's.
- 4.1.9 Two (2) No. spare empty 25 mm conduits from the distribution board and terminated above the false ceiling.

4.2 Miniature Circuit Breaker (MCB)

For specifications refer Section 4A, clause 4.7

4.3 Residual Current Circuit Breaker Current Operated Type (RCCB)

For specifications refer Section 4A, clause 4.8

4.4 Earthing

Earthing shall be provided as per IS: 3043-1987.

4.5 Painting

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/ outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No. 5.

4.6 Labels

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

4.7 Testing

Testing of panels shall be as per following codes:

- i. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.
- ii. IS: 13947: 1993 Degree of protection

4.8 Wiring

In wiring a distribution panel it shall be insured that total load of various distribution panel and/ or consuming devices is divided evenly between the phases and number of ways as per drawing.

6. POWER FACTOR CORRECTION SYSTEM

6.1 Scope

Design, manufacture, supply, erection, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement to the desired value of 0.95 lagging power factor as per specification given below:

6.2 Standard

Unless otherwise stated below, the capacitor shall comply with the following standards (and their latest amendments): IS 13340-1993, IS 13341-1992, IEC 60831-1+2

6.3 Rating

50 kVAr/ 25 kVAr/ 12.5 kVAr capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

6.4 Enclosure

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. It shall be completely made of CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shade/ s to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The front portion shall house the switchgear and the rear portion shall house capacitors and series reactors. The enclosure is to be suitably sized to accommodate all the components, providing necessary air clearance between live and non-live parts, providing necessary working clearance.

6.5 APFC Relay/ Controller

Microprocessor based APFC relay (Intelligent VAr controller) shall sense the PF in the system and automatically switch ON/ OFF the capacitor unit or stage to achieve the preset target PF. The controller shall have the following features:

- Digital settings of parameters like PF, Switching time delay, Step limit etc.
- Indication of PF, preset parameters.
- Minimum threshold setting of 1% of CT current.
- No-volt release.
- Protective shut down in case of harmonic overload.
- Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc.

6.6 Capacitor Unit

Each basic unit of mixed dielectric extra low loss/ Metalized Poly Propylene (MPP) capacitor shall be built with a number of elements. These elements shall be combination of capacitor tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable impregnant or Film Foil capacitor manufactured using Poly propylene film placed between 2 layers of metal foil and winding. The elements shall be connected to the external bus bars through these leads in a series parallel connection to form a three phase unit.

The capacitor units shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M S sheet steel of polyster paint coated finish. Each standard unit shall be provided with internal fuses (operation coordinated with case-rupture characteristics to avoid rusting).

Total Harmonic Distortion (THD) of upto 5% on voltage and current waveforms shall not affect the life of capacitors. $660 \pm 10\%$ variation in line voltage shall not affect the life of the capacitors.

6.7 Capacitors

- General specifications: 3 phase, delta connected, 50 Hz.
- Voltage: Shall be designed for minimum 480V and shall withstand system over voltage, increased voltage due to series reactor and harmonics.
- Capacitor type: Super heavy duty with double side metalized capacitor tissue paper. Oil impregnated and self-healing type with bi-axially oriented polypropylene film shall be fitted with pressure sensitive disconnecter in each individual capacitor cell.
- Overvoltage +10% (12h/ 24h), + 15% (30m/ 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
- Over current: $2.5 \times I_n$
- Peak Inrush current withstand: $350 \times I_n$
- Total watt-losses including discharge resistors: $< 0.45 \text{ W/ kVAr}$.
- Temperature category: -25 deg. C to 70 deg. C.
- Capacitor shall be self-heating type and oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type, must be properly treated and de-gasified, so as not to have any degeneration properties and shall be non-oxidizing.
- The design shall be modular for simple mechanical assembly, no extra accessories/ metal parts to be required. Unit must be free standing with an IP 41 protection level.

6.8 Discharge Resistance

Capacitors shall be provided with permanently connected discharge resistors so that residual voltage of capacitors is reduced to 50 volts or less within one minute after the capacitors are disconnected from the source of supply.

6.9 Terminals

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified.

6.10 Earthing

Two separate earthing terminals shall be provided for earth connection of each bank.

6.11 Testing

The reactor shall be tested `using a separate source voltage test of 3 KV (coil to core) for one minute as per IEC 76/ 3. The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high operating temperature.

6.12 Switchgear & Protection

Incomer switchgear shall be TP&N breaker appropriate rating (**minimum 1.8 times** the normal current to take care of inrush switching current). Suitable contactor for each step shall be used and must be capable of capacitor switching duty at each step for short circuit protection.

Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures upto 125 deg. C.

Internal wiring between main bus-bars, breaker, contactor and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

6.13 Control Circuit & General Protection

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of the control circuit shall be done by using 1.5 sq. mm, 1100 V grade, PVC insulated, multi-stranded copper control FRLS wire.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

6.14 Testing

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate.

Installation

- i. Capacitors banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.
- i. All interconnections in the control panel shall be checked before commissioning.
- ii. Cable end boxes shall be sealed after cable connections to prevent absorption of moisture.
- iii. 15 mm thick rubber matting of an approved make over a 100 mm high Timber platform shall be provided in front of the full length of the capacitor bank and control panel.

6.15 Testing & Commissioning

- i. Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.
- ii. Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute.
- iii. Each discharge resistor shall be tested for its working.

7. EARTHING

7.1 Earthing

The system shall be TNS with four wire supply system (R, Y, B, N and 2 No. E) brought from the main LT Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc. shall be bonded to earth.

All earthing shall be in conformity with IS: 3043 1987, and the basic system of earthing shall be TNS.

7.2 Earthing Conductors

Earthing conductors shall be of copper/ GI as mentioned in schedule of quantities and shall be protected against mechanical injury and corrosion.

7.3 Sizing of Earthing Conductors

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq. mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq. mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with PVC insulated copper wire.

7.4 Connection of Earthing Conductors

Main earthing conductors shall be taken from the earth connections at the main LT panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be brazed in case of copper and by welding bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed. The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class quality and neat workmanship. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with **earthing** strip welded to grid and bolted at equipment ends.

7.5 Prohibited Connections

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 1 ohm.

All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding/ bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

7.6 Earthing

The following must always be ensured in earthing system.

- All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths etc.
- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure.

7.7 The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

7.8 Resistance to Earth

The resistance of earthing system shall not exceed 1 ohm.

7.9 Specification for Hot Dip Galvanizing Process

General Requirements

I. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

II. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS: 6745-1972 shall be 400 g/ sq. mtr.

The weight of coating expressed in grams per square metre shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs, rust stains bulky white deposits, blisters.

Mild steel flats/ wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing. Jointing of earthing tape shall be by welding. All joints and cut ends shall be properly painted with aluminium paint.

7.10 CONVENTIONAL PLATE ELECTRODE

7.10.1 Copper Earth Electrode

Earthing electrode shall be 900 x 900 x 3.15 mm thick or 600 x 600 x 3.15 mm thick tinned copper plate electrode as required, with 2 No. 50 x 6 mm copper strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber with concrete base and CI heavy duty 560 mm dia manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit up to permanent moisture level and as per soil condition but not less than 3 meters and back filling as required as per IS3043.

7.10.2 GI Earth Electrode

Earthing electrode shall be 900 x 900 x 6.3 mm thick or 600 x 600 x 6.3 mm thick GI plate electrode as required, with 2 No. 50 X 6 mm GI strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber with concrete base and CI heavy duty 560 mm dia manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit upto permanent moisture level but not less than 3 meters and back filling as required as per IS3043.

7.11 Maintenance free Earthing Electrode System/ Chemical Earthing

In maintenance free earthing copper bonded earthing rod electrode shall be of 14.35 mm in diameter and 3 meter length. The rod shall be placed in a 150 mm dia augured hole in the ground and then surrounded by ground enhancement material in either a dry form or pre mixed in slurry. Once set, ground enhancement material becomes hard and as such holds positively to the rod as well as surrounding ground.

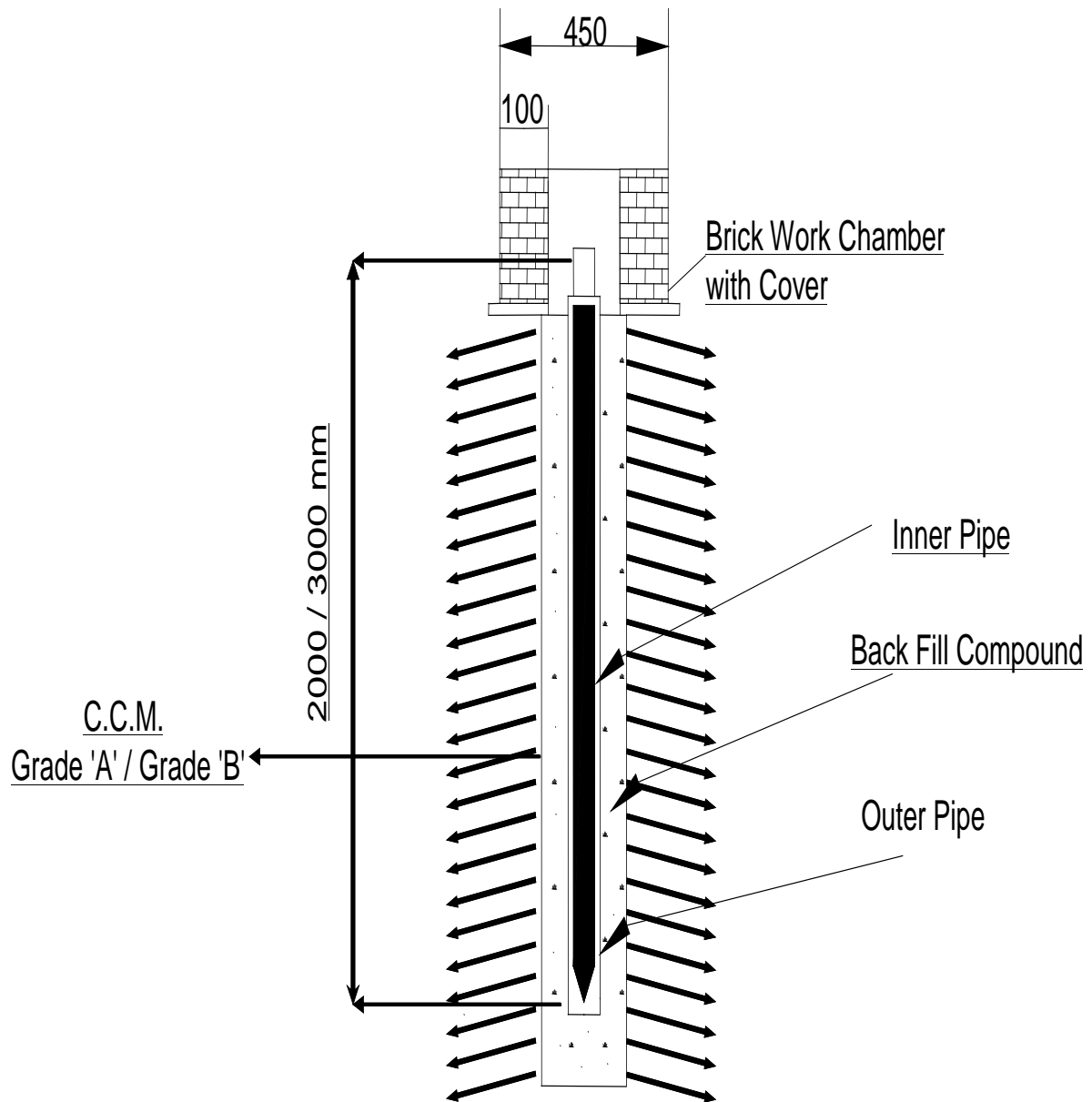
Earth rod offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core (Design feature that prevents the ingress of moisture and subsequently the integrity of the rod).

Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.

Ground enhancement material shall be as per IEEE-80 clause 14.5d with a resistivity of less than 0.12 ohm-meters. The ground enhancement material shall be permanent and not leach any chemicals in to the ground. The pH value of the ground enhancement material shall be 6.9 to 7.2 of 100 gm/ lit @ 20 deg C.

Minimum 30 Kg of ground enhancement material shall be provided for each earth electrode.

Inspection chamber shall be of 400 x 500 mm with concrete base CI manhole cover with frame painted with bitumastic paint. 2 No. of 50 x 6 mm cross section & 300 mm long copper strip to be clamped with copper clad rod electrode have sufficient no. (But not less than 4) of 10 mm GI nuts & bolts for connection to the equipment/ interconnection to the other pits to form equip-potential bonding.



S.E.E. T - 39, Dia. 80 mm.

SCALE: NOT TO SCALE

“ASHLOK - SAFE EARTHING ELECTRODE”

7.A Lightning Protection System (Conventional Type)

7.1 General

Installation of Lightning Protection System shall be strictly in accordance with IS:2309-1989.

7.2 Zone of Protection

The zone of protection of a lightning conductor defines the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle called as protective angle. For the purpose of providing an acceptable degree of protection the protective angle of termination network shall be considered as 45°. Between two or more vertical conductors of equal height spaced at a distance not exceeding twice their height, the protective angle within the space bounded the air termination shall be taken as 60° to the vertical, while the protective angle away from the conductor will be taken as 45° to the verticals.

7.2 Material and Dimensions

The materials of lightning conductor, down conductors, earth termination etc. shall be copper / GI as per schedule of quantities and shall be protected against corrosion.

All air terminations and down conductors shall be of copper / GI as per schedule of quantities and shall conform to IS : 2309-1989.

7.3 Joints and Bonds

The lightning protective system shall have as few joints as far as possible. Wherever joints in the conductor are necessary they shall be mechanically and electrically effective, and shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner.

7.4 Earth Terminations

Each down conductor shall have an independent earth termination. All the earth termination shall be interconnected and shall be capable of isolation for testing.

7.5 Earth Electrode

Earth pits shall be installed in accordance with IS : 3043-1987.

The resistance of earthing system shall not exceed 1 ohm.

7.6 Air Terminations Mesh (On the Terrace)

As an alternative to vertical air termination, grid of horizontal air termination may also be provided as per IS 2309. Often combination of both may be provided when structure to be **protected for high** ratio of length to height. Air termination mesh shall be provided not greater than 10mx20m. Down conductor shall be not more than 10 m apart where the building height in more than 20 m.

7.7 Down conductor

In order to reduce probability of damage it is often necessary to have several parallel current paths. As recommended by IEC 62305 & IS 2309 equal spacing of down conductors , 25 x 3 mm Copper \ AL \ GI external strip, around the building perimeter

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated earth pit shall be connected to the other earth pits in the earthing grid.

7.8 Alternatively, steel reinforcement can be used as down conductor in line with IEC 62305 & IS 2309

Steelwork within reinforced concrete structures is considered to be electrically continuous , provided that major part of interconnections of vertical & horizontal bars are welded, clamped or overlapped a minimum of 20 times their diameter and bound or otherwise securely connected.

While using structural reinforcement as down conductor,

1. Preferably outer columns which are straight from terrace up to the ground floor shall be used as down conductor. Steel bars in this column should be welded \ bolted with proper overlapping at every floor to ensure, proper continuity throughout.
2. At ground level steel bars shall be taken out & welded \ bolted to the GI tape, and the tape will be carried out till the earthing pit at ground
3. Also at terrace level steel bars will be taken out & to the connected to the Air terminal

This method is allowed by IS \ IEC , however requires close coordination with structural agency & monitoring during construction work to ensure proper bonding of steel bars at every level.

In this case responsibility matrix, may be worked out as under –

Sr	Description	Responsibility
	Design stage	
1	System proposal with details like, identification of column, recommended overlapping to ensure continuity, typical details for taking out reinforcement at various levels, bonding details etc,	MEP consultant
2	Integration of all above details in the arch & GFC structural design to be followed for construction.	Arch & structural consultant

Sr	Description	Responsibility
	Construction Stage	
3	Direct Supervision on site to ensure proper overlapping, workman ship to ensure continuity. Proper log of continuity at every floor level before & after pouring of concrete	Project manager \ Electrical Contractor
4	Ensure proper method to take out reinforcement at various levels for connection with AT & EP network & bonding with structure of curtain wall.	Project manager \ Electrical Contractor

For buildings utilizing steel reinforcement as as down conductor, the electrical continuity if reinforcing bars shall be determined by electrical testing between uppermost part & ground level. The over all electrical resistance should not be greater than 0.2 ohms measured using test equipment suitable for this purpose.

For high rise building more than 60 mtr height, horizontal conductors at every 20 mtr for top 20 % of building height is recommended to take care of side flashes

Conductive components of building cladding shall be bonded to the down-conductor at the top and bottom ends & every 20 m (for top 20 % of building height , in case of high rise building)

7.9 Fasteners

Conductors shall be securely fixed to the building to be protected by fasteners which shall be not more than 1.20 meter apart for horizontal run and 1.0 meters for vertical run.

8.B LIGHTING & SURGE VOLTAGE PROTECTION

8.1 Scope

This specification describes the electrical and mechanical requirements for a high energy Transient Voltage Surge Suppressor (TVSS). The specified TVSS/ SPD system shall be connected in parallel to the facility's electrical main incoming (main LT panel) as well as final distribution boards, shall provide effective high energy surge current diversion, and shall be suitable for application in ANSI/ IEEE C62.41 Category A, B and C environments or IEC 61643-1 Class I, II and III.

8.2 Codes & Standards

The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

IEC 61643-1: Surge Protective Devices connected to low voltage power distribution systems.
Underwriters Laboratories: (UL 1449, 2nd edition) Standard for Transient Voltage Surge Suppressors.
International Standards Organization (ISO) Company certified ISO9001 for manufacturing, design and service and the applicable portions of the American National Standards Institute and Institute of Electrical and Electronic Engineers standards (ANSI/ IEEE 1100, C62.11, C62.41, C62.45)

8.3 Electrical Requirements

A. Nominal system operating voltage

The single phase TVSS system shall be suitable for installations operating between 220VAC and 240VAC.

The three phase TVSS system shall be suitable for installations operating between 380VAC to 415VAC, Star (Y) Configuration: 3 Phase 4 Wire Plus Ground or Delta Configuration: 3 phase 4 wire including Ground.

B. Maximum Continuous Operating Voltage (MCOV):

The maximum continuous operating voltage of the complete TVSS, as well as all components in the suppression path shall be greater than 125% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS over voltages (swell conditions).

C. Operation Frequency:

The operating frequency range of the system shall be 50 or 60 Hz.

D. Protection Modes:

Note: L = Line, G = Ground, N = Neutral

The SPD shall provide protection in all modes (L-N or L-L, L-G and N-G where applicable)

E. Surge Current Capacity:

Location	Class	Surge Current
Main Service Entrance	Class C	200/ 400 KA
Main Distribution Feeders	Class B	100/ 160 KA
Sub distribution Panels	Class A	50 KA

F. Short-circuit Withstand Capability:

The TVSS shall be able to carry the power short circuit current until it is interrupted by external over-current disconnect or by the backup over current protection. The minimum Short Circuit Withstand of the TVSS shall be according to the table below:

Class	Minimum Short Circuit Withstand Capability
Class C	200KA
Class B	35 to 65KA
Class A	14KA

G. Over current Protection (fusing)

All components, including suppression, filtering, and monitoring components, shall be individually fused at the component level with the fuses rated so as not to impede maximum specified surge current capacity. The fuse shall be capable of opening in less than one millisecond and clear both high and low impedance faults.

H. Clamping Voltage:

The TVSS shall able to clamp the voltage:

System Voltage	Max Let Through Voltage
120, 120/ 208 or 120/ 240	400 volts
208, 240, 277, 230/ 400 or 277/ 480	800 volts
346, or 346/ 600	1200 volts
480	1500 volts
600	2000 volts

I. Response Time:

The typical response time of all suppression components shall be <0.5 ns.

J. Noise Attenuation

The filter shall provide insertion loss with a maximum of 40dB to 50dB from 10 kHz to 100 MHz with data obtained utilizing the 50 ohm Insertion Loss Methodology from MIL-STD-220A.

8.4 Environmental Requirements

- A. Operating Temperature : -40 to +85 C (-40 to +187 F)
- B. Relative humidity : 0% to 95%
- C. Audible Noise : The unit shall not generate any appreciable noise. 40 DB for RFI and EMI noise attenuation
- D. Operating Altitude : 0 to 14,000 feet above sea level.
- E. Magnetic Fields : The unit shall not generate any appreciable magnetic fields, and shall suitable for use directly inside computer rooms.
- F. Connection type : Parallel
- G. Protection lvl in kV : Based on level of protection
- H. Status indication : LED type dry contacts

9. **AUXILIARY EQUIPMENT FOR SUB-STATION**

9.1 Battery Charger Unit

i **General**

The battery charger shall be Float cum Boost type SCR controlled. The charger shall have selector switch for Auto Float – Boost/ Manual Float/ Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

ii. **Construction Feature**

Float cum Boost charger and DC Distribution Board shall be housed in sheet steel cubicle with panels of 1.6 mm thickness, louvers for ventilation glands plate will be provided for cable entry from bottom. The cubicle shall be painted in Siemens grey shade RAL-7032. The battery charger is divided into two compartments. The upper compartment houses the battery charger with all the necessary controls. The lower compartment is suitable for housing the batteries.

iii. **Performance**

The D. C output voltage of Float/ Boost charger shall be stabilized within $\pm 2\%$ for AC input variation of $230\text{ V} \pm 10\%$, frequency variation of $50\text{ Hz} \pm 5\%$ and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response SCR control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float/ Manual Float/ Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float/ Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

iv. **Components**

The battery charger shall essentially comprise of the following

1 No. double pole ON/ OFF MCB at AC input.

1 No. pilot lamp to indicate charger ON.

1 No. Main Transformer: Double wound, naturally air cooled, having copper winding.

1 set single phase full wave bridge rectifier consisting of 2 No. diodes and 2 No. SCRs, liberally rated, mounted on heat sinks and complete with resistor/ condensor network for surge suppression.

1 No. rotary switch to select auto float/ manual float/ manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.

1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at $\pm 2\%$ of time set value for AC input voltage variation of $230\text{ V} \pm 10\%$, frequency variation of $\pm 5\%$ from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.

1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.

1 No. DC ammeter and toggle switch to read charger output current and battery charge/discharge current.

1 No. moving coil DC voltmeter to read the DC output voltage.

2 Sets of potentiometer to adjust the output voltage during manual/ auto float and boost modes.

1 No. double pole ON/ OFF MCB for Charger Output (24 V DC Rating).

2 Sets of DC output terminals. 1 set for the load and the other set for the battery.

Alarm Annunciation: Visual and audible alarm with manual accept reset facility shall be provided for the following:

- a. AC mains fail
- b. Charger Fail
- c. Load/ Output overvolt.

Rating

AC Input	: 230 V \pm 10% AC 50 Hz single phase.
DC Output	: To float/ boost charge 24 V/ 200 AH batteries and also supply a continuous load.
Current Rating	: 30.0 Amps
Float Mode	: 27.0 V nominal (Adjustable) between 24-28.0 V.
Boost Mode	: 28. 2 V nominal (Adjustable) between 24-29.0 V.
Voltage Regulation	: \pm 2% for AC input variation of 230 V \pm 10%. Frequency Variation of 50 Hz \pm 5% and DC load variation 0-100%
Ripple	: Less than 5%

v. **DC Distribution Board**

It shall be provided in the charging cubicle, it will comprises of the following:

Incoming	: 1 No. 63 A DP MCB
Outgoing	: 10 No. 16 A DP MCB

9.2 Safety Equipment

Danger Plate

Danger plate shall be provided on HV and MV equipment. MV danger notice plate shall be 200 mm x 150 mm made of mild steel atleast 2 mm thick with vitreous enameled white on both side and with inscription in red colour on front side.

Fire Extinguishers

Portable CO₂ conforming to IS: 2878-1976, and dry chemical conforming to IS: 2171-1967 shall be provided in the Sub-station.

Insulating Mats for Electrical Purpose

Materials:

Insulating Mats shall be in compliance with IS-15652-2006/ IEC 61111-2002-06.

The insulating mats shall be made of Elastomer (a generic term that includes rubber, latex and elastomer compounds that may be natural or synthetic or a mixture of both) for use as floor covering for the protection of workers on AC and DC installation with the system voltage upto 66 kV AC and 240 volts DC.

Classes and max use voltages of insulation mats shall be as follows:

<u>S. No.</u>	<u>Class</u>	<u>AC (rms)</u>	<u>DC (volts)</u>	<u>Thickness</u>	<u>Tolerance</u>
i)	A	3.3	240	2.0 mm	+ ₋ 10%
ii)	B	11	----	2.5 mm	+ ₋ 10%
iii)	C	33	----	3.0 mm	+ ₋ 10%
iv)	D	66	----	3.5 mm	+ ₋ 10%

Mats shall be resistant to acid and oil and low temperatures and shall be identified by therespective class symbol.

Thickness of mats for different classes, physical properties, dielectric properties and all other specification shall be as per IS: 15652-2006. be free from blisters, pin holes, cracks, embedded foreign matters and other defects.

10. INSTALLATION OF HT PANEL & TRANSFORMER

HT Panel & Transformer shall be installed and commissioned as per the requirements of IS (latest edition) and regulations of local authorities.

10.1 Handling

HT Panel & Transformer and all its accessories shall be handled carefully in its upright position as indicated on the packing case. Lifting lugs and jacking pads shall be used for lifting of the HT Panel & Transformer. While using jacking pads utmost care shall be taken in proper application of jacks. Where HT Panel & Transformer is dragged or pulled on sleeper or rollers the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

10.2 Storage

HT Panel & Transformer shall be stored under shelter in place free from fire and explosion hazards, care should be taken to see that moisture would not contaminate inside the panel & tank.

10.3 Cabling & Earthing

Cables shall be terminated at cable boxes only after IR values measured and found to be in order for both equipment and cables. Cable termination shall be carried out with utmost care and ensuring adequate clearance as applicable in the relevant standards. The neutral of the transformer shall be connected to two separate earth tapes of size detailed in the dwg. The body of the HT Panel & Transformer shall also be provided with effective earthing as per the drawings and specifications.

10.4 Inspection

Inspection/ tests will be carried out by the client/ consultant or their representatives at manufacturers place or any other approved testing laboratories, if required. The manufacturer shall provide all the required facilities to carry out the inspection. All routine tests specified in IS or any other tests required by the client/ consultant shall be conducted on the HT Panel & Transformers at no extra cost in the presence of the client/ consultant or their representatives.

10.5 Pre – Commissioning Tests

Pre-commissioning test as per enclosed format shall be carried out by the supplier/ contractor at site in presence of the client/ consultant or their representatives at no extra cost.

10.6 Mounting & Erection

The HT Panel & Transformer shall be lifted by lugs or shackles or by any other suitable means (such as dragging on roller) and mounted on the concrete plinth prepared for the purpose care shall be taken to see that transformer is not tilted during lifting and erection of transformer. The rollers shall be checked to prevent movement of the transformer after being positioned on the plinth. Adequate and necessary clearance from walls, other equipment etc. shall be provided as indicated in the drawings and as per regulation of local inspection authorities.

Phasing out test with 415 volts applied to HV windings and voltage across LV winding being checked. Measurement of neutral and body earth resistance with earth testing megger. The values shall not exceed 1 to 2 Ohms as required.

Functioning of thermometer, oil level indicator shall be checked and adjusted, if necessary. The transformer devices shall be checked and adjusted, if necessary. The transformer shall be charged only after the above tests are conducted and approval of local authorities is obtained. The earthing of neutral and body of the transformer shall be done as per I. E. regulations and the requirements and of local authorities.

However, general mode of earthing arrangements is indicated on the drawings. The contractor shall supply all the material and labour for erection and commissioning of HT Panel & transformers.

11. 11/ 33 kV GRADE XLPE CABLE

11.1 General

Cables shall be aluminum conductor, cross linked polyurethane construction and shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Standard Specifications and cable manufacturer's instructions.

11.2 Material

a. **Conductor**

The Conductor shall be made from electrical purity aluminum stranded wires compacted together.

b. **Insulation**

High quality TROPOTHEN - X (XLPE) unfilled insulating compound of natural colour shall be used for insulation. Insulation shall be applied by extrusion process and shall be chemically cross linked in continuous vulcanization process.

c. **Shielding**

Cables shall be provided with conductor shielding as well as insulation shielding and shall consist of extruded semi-conducting compound, additionally insulation shield shall be provided with semi-conducting and metallic tape shield over the extruded insulation shield. XLPE insulation and outer core shielding shall be extruded in one operation.

d. **Armouring**

Armouring shall be applied over the inner sheath and shall comprise of flat steel wires (strips).

e. **Outer Sheath**

Tough outer sheath of heat resisting PVC compound shall be extruded over the armouring in case of armoured cables or over extruded over the armouring in case of armoured cables or over inner sheath in the case of unarmoured cables.

11.3 Tests

Cables shall be type tested and routine tested in accordance with IS: 7098 (Part II).

a. Conductor resistance test.

b. Partial discharge test.

c. High Voltage test.

The following tests shall be carried out at site for insulation between phases and between phase and earth before and after cable laying.

a. Insulation Resistance Test.

b. Continuity resistance test.

c. Sheathing continuity test.

d. Earth test.

e. High Voltage test.

Cables shall be laid with a clearance of at least 75 mm between two cables.

11.4 End Termination of HT Cable

Pre-moulded cable terminations for XLPE cable shall be used as per manufacturer's instructions. The steel cone of M-seal Push-On shall consist of highly track resistant insulating section vulcanized to a semi-conducting section. The pad material shall have cold-flow properties and shall be flame retardant.

Each end terminal shall undergo Hi Pot Test.

11.5 Laying of HT Cables

Direct in Ground

The work shall involve excavation of trench and laying of cable(s) as indicated in drawing and Schedule of Quantities.

The depth of the excavation shall not be less than 1050 mm for 11/ 33 kV plus radius of cable, from the upper surface of ground. Where more than one multicore cable is laid in the same trench, a horizontal inter spacing of 250 mm shall be left in order to reduce mutual heating and also to ensure that fault occurring on one cable will not damage the adjacent cable.

Cable shall be laid in cement pipes encased in concrete or Hume pipes at all road crossing. Cables shall be laid in trenches over rollers placed inside the trenches. After the cable has been properly laid and straightened, it shall be covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over this sand cushion. Again, the cable shall be covered with a 80 mm layer of sand. Over the sand a layer of cable protection tiles shall be placed by overlapping 50 mm on either side. Trenches shall then be back-filled with earth and shall be consolidated. Suitable cable markers made of cast iron with aluminium paint indicating the voltage grade and direction of run of the cables shall be installed at regular intervals.

11.6 RCC/ Masonry Trench

For laying of HT cable in RCC/ Masonry trench refer detail on sub-station layout drawing and IS-1255-1983.

11. CABLING FOR VOICE SYSTEM

11.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous installation hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

11.2 Applicable Documents:

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

- 1) This Technical Specification and Associated Drawings
- 2) ANSI/ TIA/ EIA 568-B **C** Commercial Building Telecommunications Cabling Standard – March 2001 – **Aug 2009**
- 3) ANSI/ EIA/ TIA-569-A - **ANSI/ TIA-569-C** Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998 – **Sept 2009**
- 4) ANSI/EIA/TIA-606 - **ANSI/TIA-606-B** Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993 – **2010**
- 5) ANSI/TIA/EIA-607 - **ANSI/NECA/BICSI- 607-2010** Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994
- 6) **ANSI/TIA-568-C.2 for Category 6 channel.**
- 7) **All products must be RoHS / ELV compliant**

11.3 Backbone Wiring

General

The function of the backbone wiring shall be to provide interconnections between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system. The backbone wiring shall consist of the transmission media, intermediate and main cross connects, and mechanical terminations for interconnection of telecommunications closets, equipment rooms and entrance facilities. The backbone wiring shall include transmission media in the building.

The backbone wiring shall use the star topology wherein each telecommunications closet shall be wired to a main cross connect / patch panel or an intermediate cross connect then to a main cross-connects / patch panel. There shall be no more than two hierarchical levels of cross connects / patch panel in the backbone wiring. Interconnections between any two telecommunications closet shall pass through three or fewer cross-connects / patch panel.

Bridged taps shall not be permitted as part of the backbone wiring.

One of the following types of cables shall be used for backbone wiring as defined in schedule of quantities.

1. 100-ohm UTP multiplier backbone cable.
2. 62.5 / 12.5 um optical fiber cable. – **50/125 um optical fiber cable**

The contractor has to assure that cross talk coupling between individual, unshielded twisted-pairs shall not affect the transmission performance of multi-pair cables.

11.4 Horizontal Wiring

General

The horizontal wiring shall be the portion of the tele communications wiring system that will extend from the work area telecommunications outlet to the telecommunications closet. The horizontal wiring shall include the telecommunications outlet in the work area, mechanical termination for the horizontal cables, and cross-connections located in the telecommunications closet.

The horizontal wiring shall be capable of handling the following minimum services.

1. Voice telecommunications.
2. Premises switching equipment.

The horizontal wiring shall be a star topology with each work area telecommunications outlet connected to a telecommunications closet. Horizontal wiring shall preferably contain no more than one transition point between different forms of the same cable type.

Bridged taps shall not be permitted as part of the horizontal wiring.

The maximum horizontal distance shall be limited to 90 meters (295 ft) independent of media type i.e. the cable length from the mechanical terminating of the media in the telecommunications closet to the telecommunications outlet in the work area shall be limited to this distance. This horizontal distance includes cabling required from the telecommunications outlet to the work station. Horizontal cable shall be limited to one of the following types as listed out in the schedule of quantities.

1. Four-pair 100-ohm unshielded twisted pair (UP - **UTP**) cables.
2. 62.5 / 12.5 um optical fiber cable. – **50/125 um optical fiber cable**

Grounding Considerations

Grounding system shall be an integral part of the telecommunications wiring system. In addition to helping protect personnel and equipment from hazardous voltages, the grounding system shall reduce the effect of electromagnetic interference ((EMI) to and from the telecommunications wiring system.

Grounding & Bounding shall meet the NEC , **NFPA780, IEEE & ANSI** requirements and practices or local authorities or codes whichever impose a more stringent requirement.

The following shall be considered for the grounding system.

Installation conforms with proper practices and requirements.

Each telecommunications closet shall have an appropriate grounding access.

Grounding shall be available for cross-connect frames, patch panel racks, telephone and data equipment and equipment required for maintenance and testing.

11.5 Backbone Wiring Distances

Telecommunications Closet to Main Cross-Connect

The maximum backbone distance between the main cross-connect patch panel and the mechanical termination in the telecommunications closet shall be as follows:

For 62.5 / 125 ohms – **50/125 um** optical Fiber cable the distance between Telecommunication closet and main cross connect / patch panel shall not exceed 2000 mts. (**550 mtr for 1Gbps**)

For 100 ohm UTP cable, maximum distance between telecommunication closet and main cross connect / panel shall be 800 mts.

Telecommunications equipment which connect directly to main or intermediate cross-connects / patch panel shall done via cables of 30 m or less.

11.6 Telecommunications Closet

A telecommunications closet shall be defined as an area within the building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. There shall be no upper limit on the number of telecommunications closets which may be provided within the building. The telecommunication closet shall have following three possible configurations.

Horizontal Backbone Connection

The telecommunications closet shall contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In such a case the telecom closet shall provide facilities (space, power, grounding etc.) for the passive (cross-connect) / patch panel or active devices or both used to interconnect the two system.

Backbone Wiring System Interconnection

The telecommunications closet may contain the intermediate cross-connect / patch panel or main cross connect / patch panel for different portions of the backbone wiring system. In this usage, the telecommunications closet shall provide facilities for the passive or active devices or both used to interconnect two or more portions of the backbone wiring system.

Entrance Facilities

A telecommunications closet may be used to contain the demarcation point or an interbuilding entrance facility. In this usage, the telecommunications closet shall provide facilities for the active and / or passive devised required interconnecting the demarcation point or interbuilding entrance facility or both to the telecommunication wiring system.

The design of the telecommunications closet shall be as per the requirements of EIA/TIA-569. - ***ANSI/TIA-569-Cof 2010 & ISO/IEC 18010:2002. Information Technology—Pathways and Spaces for Customer Premises Cabling.***

11.7 Equipment Room

The equipment room shall be defined as an area within the building where telecommunications systems shall be housed along with the mechanical termination of one or more portions of the telecommunications wiring system. Equipment room shall be considered to be distinct from telecommunications closets because of the nature or complexity of the equipment they contain. Any or all of the functions of a telecommunications closet shall be alternatively provided by an equipment room.

11.8 Cable Specifications

11.8.1 UTP Cabling System

11.8.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum - TIA/ANSI – 568-C.2 & ISO/IEC 11801 Category 6 Cabling system

a.	Network Supported	10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet
b.	Warranty	25-year systems - performance warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs – Site certificate to be issued for 25 years.
c.	Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel along with the UL and ETL verification report

11.8.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 - TIA/ANSI – 568-C.2 & ISO/IEC 11801

a.	Material:	Solid Copper cable
b.	Conductors	23 AWG solid bare copper or better with OD of approx 6.2mm
c.	Insulation	Polyethylene
d.	Jacket	Flame Retardant PVC
e.	Pair Separator	Cross-member fluted Spline
f.	Approvals	UL Listed &UL Verified, ETL Verified ETL verified to TIA / EIA Cat 6 as per TIA/EIA 568-C.2
g.	Operating temperature	-20 Deg. C to +60 Deg. C
h.	Frequency tested up to	Minimum 600 MHz
i.	Packing	Box of 305 meters
j.	Delay Skew	45ns MAX. – 35ns Max
k.	Impedance	100 Ohms + / - 15 ohms, 1 to 600 MHz.
l.	Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR

11.9 Category 5 Riser Cable

This cable shall consist of solid copper conductors insulated with expanded polyethylene covered by a PVC sheet. The core shall be covered with a layer of plastic tape and overlaid with a corrugated PVC plastic. it shall be suitable to be used without conduit. The cable shall meet. EIA/TIA -568 – **ANSI/TIA 568-C**, C S A T -529, IEEE 802.3 & 10 B A S E -T. The pair sizes shall be as per the schedule of quantities. The cable shall meet the following specifications.

a.	Maximum DC Resistance	26.5 ohm per 100 ft.
b.	Maximum D C Unbalanced Resistance	17%
c.	Mutual Capacitance at 1 kHz	16 nF per 1000 ft.

11.10 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier **after implementation by certified engineer**. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA / **ANSI** standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years **after site certification** and shall cover the system performance, **Product Warranty and** application assurance and the costs of the supply of components and installation.

12. CABLING FOR DATA SYSTEM

12.1 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany required to supply, and to install a complete cabling infrastructure supporting data and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labor, supervision, tooling, materials, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any, and, all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

12.2 Applicable Documents

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The list of documents below (or the latest revisions) has bearing on the desired cabling infrastructure are incorporated into this specification by reference:

- 1) This Technical Specification and Associated Drawings
- i. ANSI/TIA/EIA 568-B Commercial Building Telecommunications Cabling Standard – March 2001 – **TIA/ANSI 568-C Commercial Building Telecommunications Cabling Standard – Aug 2009**
- 3) ANSI/EIA/TIA-569-A **ANSI/TIA-569-C** Commercial Building Standard for Telecommunications Pathways and Spaces - February, 1998 – **Sept 2009**
- 4) ANSI/EIA/TIA-606 **ANSI/TIA-606-B** Administration Standard for the Telecommunications Infrastructure of Commercial Buildings - February, 1993 - **2010**
- 5) ANSI/TIA/EIA-607 - **ANSI/NECA/BICSI- 607-2010** Commercial Building Grounding and Bonding Requirements for Telecommunications - August, 1994
- 6) **ISO/IEC 11801 Ed.2:2002. Information Technology—Generic Cabling for Customer Premises.**
- 7) **ANSI/TIA-568-C.2 for Category 6 channel.**
- 8) **All products must be RoHS / ELV compliant**

12.3 Cabling System and Component Specifications

12.3.1 UTP Cabling System

21.3.1.1 Unshielded twisted pair cabling system, TIA / EIA 568-B.1 addendum - TIA/ANSI – 568-C.2 & ISO/IEC 11801 Category 6 Cabling system

Networks Supported	10 / 100 Ethernet, 155 Mbps ATM, 1000 Mbps IEEE 802.3ab Ethernet, and proposed Cat 6 Gigabit Ethernet
Warranty	25-year systems - performance warranty; Warranty to cover Bandwidth of the specified and installed cabling system, and the installation costs – Site certificate to be issued for 25 years.
Performance characteristics to be provided along with bid	Attenuation, Pair-to-pair and PS NEXT, ELFEXT and PSELFEXT, Return Loss, ACR and PS ACR for 4-connector channel along with the UL and ETL verification report

12.3.1.2 Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 - TIA/ANSI – 568-C.2 & ISO/IEC 11801

Material:	
Conductors	Solid Copper cable
Insulation	23 AWG solid bare copper or better with OD of approx 6.0mm
Jacket	Polyethylene
Pair Separator	Flame Retardant PVC
Approvals	Cross-member fluted Spline. UL Listed & UL Verified, ETL Verified
Operating temperature	ETL verified to TIA / EIA Cat 6 as per TIA/EIA 568-C.2
Frequency tested up to	-20 Deg. C to +60 Deg. C
Packing	Minimum 600 MHz
Delay Skew	Box of 305 meters
Impedance	45ns MAX. – 35ns Max
Performance	100 ms + / - 15 ohms, 1 to 600 MHz.
characteristics to be provided along with bid	

12.3.2 UTP Jacks

<u>Type</u>	<u>PCB based, Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 -TIA/ANSI – 568-C.2 & ISO/IEC 11801</u>
Durability	
Modular Jack	750 mating cycles minimum
Wire terminal	200 termination cycles
Accessories	Strain relief and bend-limiting boot for cable Integrated hinged dust cover
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold – 50 micron Gold over 100 micron nickel Plating
Approvals	UL listed and UL Verified, ETL Veified
Performance Characteristics to be provided with bid	Attenuation, NEXT, PS NEXT, FEXT and Return Loss

12.3.3 UTP Jack Panels

<u>Type</u>	<u>24-port, PCB based, Unshielded Twisted Pair, Category 6, , TIA / EIA 568-B.2 -TIA/ANSI – 568-C.2 & ISO/IEC 11801</u>
Ports	24
Port arrangement	Modules of 6-ports each, arranged 1port x 6. – Individually replaceable keystone jacks port.
Category	Category 6
Circuit Identification Scheme	Icons on each of 24-ports
Port Identification	9mm or 12mm Labels on each of 24-ports (to be included in supply)
Height	1 U (1.75 inches)
Durability	
Modular Jack	750 mating cycles
Wire terminal (110 block)	200 termination cycles
Accessories	Strain relief and bend limiting boot for cable
Materials	
Housing	Polyphenylene oxide, 94V-0 rated
Wiring blocks	Polycarbonate, 94V-0 rated
Jack contacts	Phosphorous bronze, plated with 1.27micro-meter thick gold – 50 micron Gold over 100 micron nickel Plating

Panel	Black, powder coated steel
Approvals	UL listed and UL Verified, ETL Veified
Termination Pattern	TIA / EIA 568 A and B;
Performance Characteristics	Attenuation, NEXT, PS NEXT, FEXT and Return Loss
to be provided along with bid	

12.3.4 **Faceplates**

<u>Type</u>	<u>1/ 2 / 4-port, White surface box</u>
Material	ABS / UL 94 V-0
No. of ports	One / Two / Four ports with shutter

12.3.5 **Workstation / Equipment Cords**

<u>Type</u>	<u>Unshielded Twisted Pair, Category 6, TIA / EIA 568-B.2 - TIA/ANSI – 568-C.2 & ISO/IEC 11801</u>
Conductor	24 AWG 7 / 32, multi stranded copper
Length	7-feet 1 & 2 meter
Plug Protection	Matching colored snag-less, elastomer polyolefin boot
Warranty	25-year component warranty – UL & ETL Verified & UL Listed
Category	Category 5 – 6
Cable	Individual cable pair separated by PE Former
Plug Housing	Clear polycarbonate
Terminals	Phosphor Bronze, 50 micron gold plating over selected area and gold flash over remainder, over 100 micron nickel underplate
Load bar	PBT polyester
Jacket	PVC
Insulation	Flame Retardant Polyethylene

12.4 Warranty

Owner seeks warranty for the installed cable plant from the OEM equipment supplier **after implementation by certified engineer**. Bidder shall ensure that the OEM norms for supply, installation, testing and documentation as specified by the OEM supplier shall be adhered to, provided those are in line with TIA / EIA / **ANSI** standards and Owner requirement specifications. The warranty shall be provided by the OEM vendor to Owner and shall be administered in India. The duration of the warranty shall be for a minimum of 25 years **after site certification** and shall cover the system performance, **Product Warranty and** application assurance and the costs of the supply of components and installation.

13. CABLING FOR TV SYSTEM

- 13.1 The Co-axial cable shall be of wide band type with operation capability upto 500 MHz.
- 13.2 The ageing resistance of the co-axial cable shall comply with DIN 47252, Part 2, i.e. max. 5% increase in attenuation at 200 MHz. measured by artificial ageing (14 days at 80 deg. C)
- 13.3 Cables shall meet or exceed the following specifications.

Construction	RG-6 MATV Type	RG-11 MATV Type
a. Center Conductor	18 AWG tinned copper	14 AWG tinned copper
b. Dielectric	Foam Polyethylene Nom. dia 0.180	Foam Polyethylene Nom. dia 0.280
c. Shield	Foil - 0.003 AL. Tape Braid - 34 AWG 4 end AL. 60% coverage dia 0.212	Foil - 0.003 AL. Tape Braid - 34 AWG 6 end AL 60% coverage dia 0.314.
d. Jacket	Black PVC flame retardant dia over jacket 0.272 ± 0.008 Min. spot 0.023	PVC flame retardant dia over jacket 0.405 ± 0.010 Min. spot 0.032.

Electrical Properties

a. Dielectric Strength	Conductor to shield 2000 VDC	Conductor to shield 1500 VDC
b. Capacitance	16.2 PF / FT, Nom	16.2 PF / FT. Nom
c. Impedance	75.0 ± 3.0 ohms	75.0 ± 3.0 ohms.
d. Attenuation	DB/100 ft. 0.65 DB @ 5 MHZ 0.76 DB @ 10 MHZ 0.96 DB @ 20 MHZ 1.98 DB @ 100 MHZ 4.21 DB @ 450 MHZ 4.80 DB @ 550 MHZ 6.49 DB @ 1000 MHZ	DB/100 ft. 0.35 DB @ 5 MHZ 0.94 DB @ 50 MHZ 1.28 DB @ 100 MHZ 1.78 DB @ 200 MHZ 2.20 DB @ 300 MHZ 2.75 DB @ 450 MHZ 4.30 DB @ 1000 MHZ
e. Velocity of propagation	82.0% Nom	82.0% Nom
f. DCR	35.47 ohms / 1000 ft.	14.29 ohms / 10000 ft.
g. SRL	30 DB (10 MHz to 300 MHz)	20 DB (5 to 450 Mhz)

13.4. DIRECTIONAL COUPLERS

These shall be of Ultra Wideband type and of hybrid circuit design.

These shall have a near flat frequency response over the entire operating range.

These shall have an aluminium cast housing for high frequency radiation resistance.

These shall have 'F' sockets for all input, output and branch ports.

The Tapoffs shall be available in one way, two way and four way configurations.

The splitters shall be available in two way, three way and four way configurations.

The Tapoffs shall be available in different tap values ranging from 11 dB, 15 dB, 20 dB, 25 dB and 30 dB.

These shall meet or exceed the following specifications:

		Tap off	Splitters
a.	Tap Loss	11-30 dB	--
b.	Through Loss	0.5-4 dB	4..0 - 8.0 dB
c.	Isolation	> 22 dB	> 22 dB
d.	Screening factor	> 50 dB	> 50 db

12. EXTERNAL/ STREET LIGHTING POLES

12.1 M. S. Tubular Poles

12.1.1 7 Meter High Pole with Ladder Bars

7 meter high (5.75 meters above and 1.25 meters below ground shall be M.S. step tubular pole in 3 steps (bottom part shall be 4 meters high, 114.3 mm outer dia and 3.65 mm wall thickness, middle part shall be 1.5 meter high, 88.9 mm outer dia and 3.25 mm wall thickness, top part shall be 1.5 meters high, 76.1 mm outer dia and 3.25 mm wall thickness) with 300 mm x 300 mm x 6 mm thick base plate. Foundation for the pole shall be of cement concrete in 1: 2: 4 ratio. (1 part cement, 2 parts, coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq. mm PVC insulated copper conductor wire from the terminals block to the fixture and 2 No. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

12.1.2 4.5 Meter High Pole

4.5 meter high (3.6 meter above and 0.9 meter below ground) shall be 75 mm dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base plate. Foundation for the pole shall be of cement concrete in 1: 2: 4 rates (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq. mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 No. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

12.2 Cast Aluminium Poles

Design & Construction

Ornamental cast aluminum pole shall be made out of cast aluminum as per requirements of IS: 202 (1993). Casting of all pole Sections shall be accurately done from permanent moulds and cores of the design submitted to Achieve uniformity in all design aspects in internal and external shape of the unit. All sections shall be free from defects like blow holes, porosity, hard spots, cracks, Hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole shall be free from welding of any kind used to repair it. The casted sections shall be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts shall be maintained throughout a lot for random replacements of sections if and when required. All the threaded joints shall be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

Aesthetic appearance

All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

Material

Cast aluminum material used for casting pole unit shall be Grade FG-220 type, as described in IS: 202 and shall have minimum tensile strength of the order of 200 N/ mm. sq.

Pre-treatment

Each and every casted piece shall be subject to Sand blasting at a pressure of 10-15 kg force to remove all its external dirt and sand remains etc. .

Painting and Finishing

Entire unit shall be given an extensive three stage treatment with PU based two pack Zn-Ph primer and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint shall be MRF make or equivalent.

Thickness of the coating

A minimum of 80 microns of coating thickness shall be achieved on the final piece.

Mounting arrangement

Pole unit shall be grouted using 4 No. anchor bolts of size M-16 x 450 mm confirming to 6.8 Gr. as per IS 2062. Pole unit shall be grouted on a foundation made out of 1: 3: 6 concrete cement after excavating the earth with proper cable sleeves etc. . laid in the foundation itself.

Dimensions of the unit

Total height	=	3000 mm
Dia of base plate	=	380 mm
Pitch Circle Dia	=	335 mm

Description of top bracket/ arms

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two No. bolts outreach not less than 400 mm.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc.

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 No. 6 amps SP MCB including 2.5 sq.mm. PVC insulated copper conductor wires from the terminal block to the fixture and 2 No. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

12.3 Galvanized Octagonal Poles

Design

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM/ Hr. as per IS 875. The top loading i. e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982.

Pole Shaft

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i. e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

Door opening

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Material

Octagonal Poles	HT Steel Conforming to grade S355JO
Base Plate	Fe 410 conforming to IS 226/ IS 2062
Foundation Bolts	EN. 8 grade

Welding

The welding shall be carried out confirming to approve procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

Pole sections

The Octagonal Poles shall be in single section (upto 11 mtr). There shall not be any circumferential weld joint.

Galvanization

The poles shall be hot dip galvanized as per IS 2629/ IS 2633/ IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

Xing type

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

Top Mountings

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

Manufacturing

The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Service window

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc.

Electrical connections

Four way connectors shall be provided along with Slide lock and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 No. 32 mm dia GI sleeves of suitable length shall be provided upto the service window. An earth boss is provided on the control plate along with connectors and interrupters.

Galvanized Octagonal Poles Dimensions

HEIGHT	TOP DIA (A/ F)	BOTTOM DIA (A/ F)	SHEET THICK NESS	BASE PLATE DIMENSIONS (LxBxT)	FOUNDATION BOLT			
					BOLT SIZE (NO. x DIA)	PITCH CIRCLE DIA (PCD)	BOLT LENGTH (MM)	PROJECTED BOLT LENGTH
(mtr)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
3	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
4	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
5	70	130	3	200 x 200 x 12	4 x 16 Dia	200	600	80
6	70	130	3	220 x 220 x 12	4 x 20 Dia	205	600	100
7	70	130	3	220 x 220 x 12	4 x 20 Dia	205	700	100
8	70	135	3	225 x 225 x 16	4 x 20 Dia	210	750	100
9	70	155	3	260 x 260 x 16	4 x 24 Dia	250	750	125
10	70	175	3	275 x 275 x 16	4 x 24 Dia	270	750	125
11	90	210	3	300 x 300 x 20	4 x 24 Dia	300	750	125
12	90	240	3	320 x 320 x 20	4 x 24 Dia	325	850	125

13. UNINTERRUPTED POWER SUPPLY

13.1 General

13.1.1 The scope of work for supply and installation of UPS system shall include design manufacture, supply, installation, testing and commissioning of all related equipment together with all accessories and auxiliaries as per specifications.

The system shall be fully operational and shall comply with the specified codes and standards.

The contractor shall be responsible for providing all material, equipment and engineering services specified or which are required to fulfill the intent of ensuring reliability of the total work covered under these specifications within his quoted price.

13.1.2 The contractor shall submit his offer for UPS systems as indicated in the tender document.

13.1.3 All components of the UPS equipment shall have Surge Withstand Capability (SWC) to meet the requirements of ANSI C62.41-1980. ANSI C 37.90A, IEEE Standard 472-1974.

13.1.4 All components of UPS system shall withstand short circuit current without any damage.

13.1.5 Following general requirements shall be met for ensuring proper circuit protection.

- a) Fuses shall not be larger than 125% of the transformer primary circuit current where the secondary circuit fuse protection has not been provided. Where the secondary fuses are sized not larger than 125% of the secondary current of the transformer, fuses shall not be required in the primary circuit, provided the primary feeder fuses are not larger than 250% of the transformer primary current.
- b) All the neutral conductors in three phase UPS systems shall be sized equal to at least 150% of the maximum phase current. In addition, all the isolators and circuit breakers used in three phase UPS system shall also be rated such that the neutral poles shall take at least 150% of the maximum phase current.
- c) All control shall be designed and positioned such that possibilities of inadvertent or accidental operations are eliminated.
- d) All UPS system cabinets, frames and power equipment shall be double earthed.

13.1.6 The UPS design shall ensure that a single component/ device failure shall not result in failure of the entire UPS system. The design of UPS System shall be modular to permit easy maintenance.

13.1.7 The various overload capacities of inverters, static switch, step down transformer as specified herein are the minimum requirements. However, if the Contractor's offered system has better overload capacities for the above devices, the same shall be highlighted by the Bidder in his bid.

13.1.8 The UPS system offered by the contractor shall be suitable for operating continuously at the rated capacity indicated in tender with in ambient temperature 0-40°C and relative humidity of 0 to 95%. Also the UPS system shall be suitable for operation as per full rating upto 1000 meters above sea level without derating. The Contractor shall furnish a certificate towards compliance on ambient conditions permissible.

13.1.9 The UPS system to be supplied by the contractor shall have maximum humming noise level of 65 DB one meter away from the UPS cabinets shall not exceed 69dBA measured 5' from surface of the UPS.

13.1.10 Suppression of Radio Interference shall be provided to meet statutory requirements/ IEC standards.

13.1.11 Detailed literature should be provided showing Quality Assurance Procedure adhered to.

13.1.12 The contractor shall submit detailed item by item compliance statement along with the tender.

13.2 FUNCTIONAL REQUIREMENTS

- 13.2.1 Contractor shall furnish On-Line Uninterruptible Power Supply (UPS) system of continuous duty of the ratings mentioned in Bill of Quantities. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.
- 13.2.2 Contractor shall note that the KVA ratings of the UPS systems shall be guaranteed at 40 deg.C ambient temperature. In case contractor's standard UPS KVA rating are based at a lower temperature, the contractor must consider a derating factor of atleast 1.5% per deg.C for arriving at the specified UPS capacity at 40 deg.C ambient temperature.
- 13.2.3 In case the calculated/ specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of nonstandard rating shall not be acceptable.
- 13.2.4 UPS system supplied by the contractor shall be the latest state of the art technology system fully digitalized using microprocessor controlled full wave rectification and IGBT inverter.
- 13.2.5 Batteries shall be valve regulated lead acid specially ment for UPS application.
- 13.2.6 Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.
- 13.2.7 The monitoring and control system shall be capable of RS485 with MODBUS protocol input software for connecting to customer's computer system for data display and monitoring.
- 13.2.8 All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Contractor as an integral part of the UPS system.
- 13.2.9 The control logic power supply shall have redundant power supply AC input and the system battery as power sources.
- 13.2.10 The UPS systems shall include but not be limited to the following equipment:
- a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries.
 - b. Suitable factory built battery cabinet for housing the batteries, including terminal isolator/ breaker and power disconnect device. The enclosure shall conform to IP 20 as minimum.
 - a. All cables, connectors, accessories like trunking, cable trays, conduits etc. required for connection between battery and the UPS unit.
 - b. All types of structural supports as required for proper structural load distribution within UPS and battery room shall be included.

- c. All equipment shall be housed in individual cabinets.
- d. Battery backup must be given for full resistive load. Battery should be sealed maintenance free type.

13.3. STATIC CONVERTER

13.3.1 General

The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction. The converter equipment shall include all necessary control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The converter shall be a solid state static PWM converter utilizing Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) transistors and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT/ IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The PWM converter shall utilize the above and achieve unity power factor and reduce input current harmonics as given earlier and thus improve the overall power factor of the converter achieving input KVA savings.

During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter. The battery shall not be cycled at any time during this step load changes.

13.3.2 Input Current Limit

The converter logic shall provide input current limiting by limiting the DC output current. Two (2) line-side current transformers shall be employed as a means of sensing the current amplitude. The converter logic shall also be capable of providing auxiliary current limited when the logic is signaled to do so via an external dry contact closure (e.g. UPS fed from generator). The converter shall be capable of supplying overload current in excess to the full load rating. It shall also have sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 95% of full capacity within 10 times the discharge time. The DC output current limit values shall be as follows:

- Rectifier output current (maximum) 100%.
- Rectifier output current (aux.) 25% - 100% variable.

Note: 100% current shall be under the battery recharging mode.

13.3.3 Battery Charge Current Limited

The converter logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.

- Battery charge current limit 10% of battery Ah rate.
- Over-current protection at 120% of above item.

13.3.4 Voltage Regulation

The rectifier/ charger output voltage including variation effects of input voltage does not deviate by more than $\pm 1\%$ of the nominal output voltage, due to the following conditions:

- Form 0 to 100% loading.
- Rectifier input variations of voltage and frequency within the limitations set in Section 3.10.
- Environmental condition variations within the limitations set in Section 3.10.

13.3.5 Automatic Input Current Walk-in

The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a maximum of 3 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

13.3.6 Input Overload Protection

The A/ C input fuses shall be provided at the converter input as a means of overload protection.

The AC maximum current shall be controlled by the Converter.

13.3.7 Equalizing Charge Timer

The UPS logic shall provide an electronic automatic equalize charge timer which shall be selectable 24 hours for Lead Acid type or 8 hour for Alkaline type batteries. The timer circuit, once activated shall provide a high rate equalizing charge voltage to the system battery for the selected time. The circuit shall also be capable of manual activation via the LCD touch panel mounted on the front door. The level of equalizing voltage shall be equal to that stated by the battery manufacturer. Upon completion of the timer count, the converter output voltage shall automatically return to the specified float voltage.

13.3.8 Step Load Change

During any step inverter load change (0-100%), only the converter shall supply 100% current to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

13.3.9 Input Voltage

The converter shall be fed from the Normal Power Supply source.

13.3.10 The converter shall meet the following specifications in addition to other requirements stated herein:

Nominal Voltage	:	415V, 3 Phase, 3 Wire
VoltageRange.	:	+ 15%/- 30% AC
Normal Frequency	:	50 Hz \pm 8 %
FrequencyRange	:	\pm 8% (\pm 4 Hz)
Input Power Factor	:	0.9 lagging or more at full load (PF improvement)
Input Harmonic Current THD	:	3% typical at 100% load 6% maximum at 50% load
Duty	:	Continuous at 40 deg.C
Cooling	:	Forced cooling using fans with thermal relays using a latched cut out for re-setting as protection for cooling fans. Each individual fan shall have its own thermal relay.
Ambient operating temperature range	:	Operating - 0 to 40 deg.C maximum. Storage & Transport -20°C to 70°C
Operating Relative Humidity	:	0-95% non-condensing.

Operating Altitude	:	Altitude Operating: to 3,000 ft. (1,000 meters) above Mean Sea Level. Derated for higher altitude applications.
		Storage/ Transport: to 40,000 ft. (12 200 meters) above Mean Sea Level
Magnetized sub-cycle in rush current	:	Typically 8 times normal full load current
Converter Walk-in time	:	1 through 60 seconds (every 1 second selectable, (0 to 100% rated load)
Input	:	Suitable terminals shall be provided for termination of cables from the AC distribution board.

13.4 STATIC INVERTER

13.4.1 General

The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT/ IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The UPS shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

13.4.2 Voltage Regulation

The inverter output voltage shall not deviate by more than + 1% RMS due to the following steady state conditions:

- a. Form 0 to 100% loading
- b. Inverter DC input voltage varies from maximum to minimum.
- c. Environmental conditions variations within the limitations set in the section 4.8.

13.4.3 Frequency Control

The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source or another UPS module) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set hereunder. The inverter shall operate on self run mode without synchronism if the bypass frequency exceeds the set value. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz \pm 0.01% (or + 0.005 Hz). Automatic adjustment of phase relationship between inverter output and standby bypass source shall be gradual at a controlled slew rate which shall be adjustable at the rate of 0.5, 1.0, 2.0, 3.0 Hz/ second. (default 2.0 Hz/ second).

The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

- a. From 0 to 100% loading.
- b. Inverter DC input varies from maximum to minimum.
- c. Environmental condition variations within the limitations set in section 4.8.

13.4.4 Output Voltage Harmonic Distortion

The inverter output shall limit the amount of harmonic content to the values stated in section 4.9. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

13.4.5 Output Overload Capability

The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 4.8. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

13.4.6 Inverter Current Limit

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components/ fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

13.4.7 Inverter Overload Protection

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.

The inverter fuses shall be the fast acting semiconductor type.

The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

13.4.8 The inverter shall meet the following specifications in addition to other requirements stated herein:

Voltage Input	:	Three Phase UPS: Nominal 360 V DC (Range 290 V to 414 V DC to maximum DC bus voltage during charging the batteries).
Nominal Voltage Output	:	415 V \pm 1% AC 3 Phase, 4 Wire
Inverter Capacity	:	
Voltage Regulation	:	
a. For 0 to 100% loading	:	< \pm 1%
b. Inverter DC input voltage vary from maximum to minimum	:	< \pm 1%
c. Environmental conditions given below	:	< \pm 1%

Transient Voltage Regulation

- a. AT 100% step load change : $< \pm 3\%$
- b. At loss or return of AC input : $< \pm 1\%$
- c. At load transfer from bypass to inverter : $< \pm 3\%$

Time to recover from transient to normal voltage : 20 milli seconds

Wave form

- a. Normal frequency : 50 Hz
- b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled) : $\pm 0.01\%$
- c. Synchronization limits for synchronism between the inverter and standby AC source. : 49 Hz to 51 Hz.
- d. Field adjustment range for above : 50 ± 0.25 Hz to 50 ± 1.5 Hz

13.4.9 Total voltage harmonic distortion : $< 2\%$ THD for 100% linear load
 $< 4\%$ THD for 100% non-linear load

Duty : Continuous

Cooling : Forced cooling using fans.

Ambient operating temperature range : 0 to 40deg.C maximum continuous.

Operating relative humidity : 0-95% non-condensing.

Operating altitude. : Sea level to 1000 meters.

Output : Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board.

13.4.10 Built-in Isolation Transformer

This shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral, hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighboring installation.

Isolation transformer shall be provided at the input side of each UPS and capacity shall be decided as per UPS output. Vendor to provide supporting details regarding capacity of isolation transformer. Technical specifications shall be as per details provided. If isolation transformer is not inbuilt, additional separate cabinet mounted transformer as per specifications shall be provided.

13.4.11 Reverse Phase Sequence Protection

In the event of Phase sequence reversal at the input, UPS system shall continue to work on the main power supply, or UPS systems shall go into battery mode, and shall not trip the UPS system.

13.5 BYPASS AND STATIC TRANSFER SWITCH

13.5.1 A bypass circuit shall be provided as an alternate source of power other than the inveter. A high speed switch and wrap-around contactor shall be used for the critical load during automatic transfers to the bypass circuit. The static switch and wrap-around contactor shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. The wrap-around contactor shall be electrically connected in parallel to the static switch and shall at the same time as the static switch, energize and upon closure, maintain the bypass source. The static switch shall only be utilized for the time needed to energize the wrap-around contactor thus increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed:

- a. Inverter output under voltage or over voltage.
- b. Overload beyond the capability of the inverter
- c. DC circuit under voltage or over voltage
- d. Final end voltage of system battery is reached.
- e. Bypass source present and available
- f. System failure (eg. Logic fail, fuse blown, etc.)

13.5.2 Keeping the above requirements in view, the static switch shall have the following minimum rating.

Capacity continuous equal to 100% of continuous rating of the inverter.
Capacity overload equivalent to overload characteristics specified for UPS.

13.5.3 **Nominal bypass input voltage** : 415 V/ 240 V, 3 phase, 4 wire

VoltageRange : $\pm 10\%$ of nominal

Nominal Frequency : 50 Hz

Frequency range : $\pm 2\%$
Please refer to selectable range of Inverter given in point 4.3 & 4.8

Output Fault Clearing:

Current : 1000%

Duration : 20 milli seconds

Ambient operating temperature : 0 to +40 degree C continuous

Operating relative humidity : 0-95% non-condensing

Operating altitude : Sea level to 1000 meters

Cooling : Natural Convection

Duty : Continuous

13.5.4 Automatic Re-Transfer

In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, perform an automatic re-transfer back to the inverter output. The UPS system logic shall only allow a re-transfer to occur three times within a ten minute period. Re-transfer shall be inhibited on the fourth transfer due to the likelihood of a recurring problem at the UPS load distribution. The re-transfer a load to the inverter shall also be inhibited due to the limitations set in section 5.3.

13.5.5 Manual Transfer

The UPS shall be capable of transferring the critical load to/ from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.

13.5.6 Maintenance Bypass Switch (MBS)

The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wrap-around enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger from high voltage conditions.

13.6 UPS BATTERY SYSTEM

- a. The UPS system shall, as an integral part, provide battery system for backup time as specified in the Schedule (Full Load) standby capacity.
- b. The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating.
- c. The battery system shall be sized to provide backup time as specified in the schedule of quantity when the UPS is supplying 100% rated load at 0.8 load power factor.
- d. An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.
- e. The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar strips and the entire battery system shall be used in IP20 steel cabinet enclosure and shall be similar to the UPS enclosure.
- f. All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.
- g. The UPS shall have a properly rated and sized circuit breaker to isolate it from the battery

13.7 OPERATION

- a. Under normal operation, the UPS load will be fed from the Inverter with the bypass switch inhibited. The Converter, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish the batteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.

- b. The Inverter shall constantly monitor the AC source frequency and shall be in synchronization with the AC input source till the frequency of the AC input source is within synchronizing limit and if the frequency of the standby source exceeds the synchronizing limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz \pm 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronization limit, the Inverter shall automatically synchronize itself with the input A/ C source frequency and use it as a signal for Inverter output frequency control.
- c. Battery Operation:
- i) When the A/ C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilizing the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.
 - ii) If the power failure continues beyond battery backup time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries whereas the Inverter should inhibit automatic start and should be started manually.
- d. Bypass Operation:
- When power is supplied from the Inverter in synchronization with the bypass, it shall accomplish the following:
- i) When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.
 - ii) When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.
 - iii) In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.
 - iv) There should be provision made in the system to prevent, when necessary, asynchronous transfer.
 - v) When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will transfer the load to bypass.
 - vi) A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorised personnel only.

13.8 BATTERY MONITORING SYSTEM

- a. The Battery Monitoring System shall provide for the automatic acquisition, trending, alarming and storage of information from every cell or jar in a battery bank. It will have the interactive ability to first identify and then provide an isolated equalizing charge current to any individual cell or jar that deviates below a user-specified set point, from the cell average, within the same string or bank.
- b. The Battery Monitoring System shall test the relative charge state and health of each individual cell or jar by injecting a DC current, recording the magnitude of this current & comparing it to previous benchmark values. Systems that require battery discharge for testing are not acceptable. The system shall provide estimated backup time remaining during an actual discharge.

- c. The Battery Monitoring System shall monitor and maintain historical files for:
 - Individual cell or jar voltage
 - Total bank voltage
 - Discharge current
 - Ambient and pilot cell temperature
 - Relative current response value
- d. Display shall be via local LCD display, with capability for viewing at a remote terminal. All files shall be written to a fixed solid state disk within the enclosure. All functions shall be accessible via modem using common communications software.
- e. The system shall operate a “form C” relay contact when any parameter is in alarm. Alarm data shall be written to a file in ASCII format for future retrieval.
- f. The system shall be capable of remote communications for remote access to all functions via modem or ANSI terminal.
- g. The Battery Monitoring System shall be capable of monitoring a minimum 264 jars per string, 9 parallel strings per system, 6 cells per jar.
- h. Resolution shall be 12 bit accuracy, with up to 10 per second channel test rate.
- i. Cell voltage measurements must be made to within plus or minus 5 millivolts over the entire operating and temperature range.
- j. Documentation. Manuals and installation documentation for the equipment shall be provided which lists block diagrams, schematics parts list and theory of operating for each unique component of the system. Installation drawings and documentation shall be site specific for each string at this facility. Marked up building drawings shall be provided to show any changes to building wiring including power wiring and communications cables.
- k. The system shall be factory tested fully and completely before shipment.

13.9 CABINET AND ENCLOSURES

- 13.9.1** The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. The enclosure shall be openable using a special tool for internal access. The colour shall be light grey.

13.9.2 Ventilation

Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

Similarly, the backup battery system shall also be housed as described earlier in an IP20 cabinet.

13.10 CONTROL AND MONITORING

- a. The UPS shall utilise state of the art full DDC control software driven Control and Monitoring System.
- b. It shall be provided with LED displays.

Metering should display the following parameters on the control panel

- i. Input AC voltage line-to-line and line-to-neutral for each phase
- ii. Input AC current for each phase
- iii. Input frequency

- iv. Battery voltage
- v. Battery charge/ discharge current
- vi. Output AC voltage line-to-line and line-to-neutral for each phase
- vii. Output AC current for each phase
- viii. Output frequency
- ix. Percent of rated load being supplied by the UPS
- x. Battery time left during battery operation.
- xi. Bypass power available.

Following alarm messages to be displayed at the control panel:

- i. Input power out of tolerance
- ii. Input phase rotation incorrect
- iii. Incorrect input frequency
- iv. Charger in reduced current mode
- v. Battery Charger Problem
- vi. Battery failed test
- vii. Low battery warning (adjustable 1 to 99 minutes)
- viii. Low battery shutdown
- ix. DC bus overvoltage
- x. Bypass frequency out of range
- xi. Load transferred to bypass
- xii. Excessive retransfers attempted
- xiii. Static switch failure
- xiv. UPS output not synchronized to input power
- xv. Input power single phased
- xvi. Input voltage sensor failed
- xvii. Inverter leg over current in X-phase
- xviii. Output undervoltage
- xix. Output overvoltage
- xx. Output overcurrent
- xxi. System output overloaded
- xxii. Load transferred to bypass due to overload
- xxiii. Overload shutdown
- xxiv. Control Error
- xxv. Critical power supply failure

- xxvi. Load transferred due to internal protection
- xxvii. External shutdown (remote EPO activated)
- xxviii. Fan failure
- xxix. Overtemperature shutdown impending
- xxx. Overtemperature shutdown.
- xxxi. Lamp test.
- c. The UPS logic should provide one set of normally open dry contact/ relay output to allow interfacing of UPS operating status to an external system and should be capable of providing, as a minimum, 10 numbers status and, should the UPS manufacturer's standard product does not provide such software, the bidder must add additional equipment and cost for the same.
- e. The UPS shall also have an RS485 port with MODBUS interface card for interfacing to BAS system or client's centralized computer network.
- f. Real time Web based UPS monitoring system with software on remote computer and by SMS/ Email shall be provided for each UPS.
- e. **LCD touch panel (Optional)**
 - i. The UPS shall be provided with an operator friendly large scale LCD touch panel.
 - ii. The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.
 - iii. The touch screen panel shall clearly define specified areas for operational function, execution and message display.
 - iv. It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.
 - v. Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The tenderer should describe in detail the faults that would be displayed under this mode.

13.11 UPS TESTING

- a. The Contractor shall perform the following tests, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator, Measurement Meters etc. shall be the responsibility of the Contractor without any additional cost.
- b. The Contractor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Owner.

14. TESTING

14.1 General

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Engineer-in-charge.

Insulation resistance test.

Earth continuity test.

Earth resistivity test.

Test as per Appendix 'E' of IS: 732 -1989

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

14.2 Insulation Resistance Test

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation shall have an insulation resistance greater than one mega ohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one mega ohms. All equipment's, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix 'E' of IS: 732-1989 shall be done and all record to be maintained.

14.3 Testing Of Earth Continuity Path

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

14.4 Testing of Polarity of Non-Linked Single Pole Switch

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Engineer-in-charge as well as the local authorities.

14.5 Pre - Commissioning Checks

Note: Pre-Commissioning checks are to be carried out by Electrical contractor in presence of Project Management Team.

S. No.	Component	Points to be checked
1.	Wires	<ul style="list-style-type: none"> ◆ Correct identification of each wire by continuity check and providing correct ferrules as per approved drawings. ◆ Correct colour coding and correct connection by proper copper lugs. ◆ Wires are dressed and bunched properly. ◆ Connections are properly tightened. ◆ Not more than two wires are connected on any one side of terminal. ◆ IR values of the circuit are measured and recorded.
2.	Switch boxes & Receptacles	<ul style="list-style-type: none"> ◆ Wires are connected properly as per wiring diagram. ◆ Correct colour coding and correct connection by proper copper lugs is done. ◆ Wires are dressed and bunched properly. ◆ Connections are properly tightened. ◆ Not more than two wires are connected on any one side of terminal. ◆ Earthing connection is made properly. ◆ Functional check is OK ◆ IR values of the circuit are measured and recorded.
3.	Panels	<ul style="list-style-type: none"> ◆ External cables are glanded properly. ◆ Wires are connected properly as per wiring diagram. ◆ Correct colour coding and correct connection by proper copper lugs is done. ◆ Wires are dressed and bunched properly. ◆ Connections are properly tightened. ◆ Not more than two wires are connected on any one side of terminal. ◆ Two Earthing connections are made properly. ◆ Functional check is OK ◆ IR values of the circuit are measured and recorded. ◆ Check proper mechanical operations of circuit breaking devices including alignment of trolley for drawout type device. ◆ Check contact alignment. And proper sequence of closing and opening of main and arcing contacts.

		<ul style="list-style-type: none">◆ Check electrical relays, meters & controls for correct wiring.◆ Check polarity and connections of all instrument transformers.
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S. No.	Component	Points to be checked
4.	Light fittings	<ul style="list-style-type: none"> ◆ Correct colour coding and correct connection by proper copper lugs is done. ◆ Connections are properly tightened. ◆ Not more than two wires are connected on any one side of terminal. ◆ Earthing connection is made properly. ◆ IR values of the circuit are measured and recorded.
5.	Lighting Poles	<ul style="list-style-type: none"> ◆ Concrete foundation is firmly set and cured. ◆ Correct colour coding and correct connection by proper copper lugs is done. ◆ Connections are properly tightened. ◆ Not more than two wires are connected on any one side of terminal. ◆ Earthing connection is made properly.
6.	Cables	<ul style="list-style-type: none"> ◆ Cable identification tags are provided at both ends. ◆ Cable entry in all equipment is through proper sized glands. ◆ Cable termination is made by proper crimping type lugs. ◆ Connections are properly tightened. ◆ Not more than two conductors are connected on any one side of terminal. ◆ IR values of the circuit are measured and recorded.
7.	Earthing	<ul style="list-style-type: none"> ◆ The resistance value of each earth electrode are measured and recorded. ◆ Total resistance of earthing system should be as per the design value and in any case, shall not be more than 1 Ohm as per IS-3043. ◆ Continuity test for earth continuity conductors with ELV tester.

S. No.	Component	Points to be checked
8.	Transformer	<ul style="list-style-type: none"> ◆ Check HV and LV cable terminations, earth connections, fittings and accessories, oil levels and oil leaks at various joints. ◆ Check breather, thermometers and buchholz relay for proper functioning and operation. ◆ Check junction boxes/ marshalling box for correct wiring. ◆ Check oil test as per IS-1886. Oil shall withstand at least 40 kV with a gap of 4mm. ◆ Insulation resistance shall be carried out on new transformer without drying out the transformer if it has not been idle or stored for a long period. Otherwise, this test shall be carried out during drying out of transformers. This test shall be carried out between primary & secondary to earth as well as between primary and secondary. Winding which is not under test shall be earthed during the test. A megger rated 1000volts or higher shall be used for this test. ◆ Check operation of automatic tap changer and it's control panel for correct functioning. ◆ Check operation of forced cooling system, wherever provided, with it's control panel for it's correct functioning. ◆ Check external connections of the transformer in accordance with the diagram of connection and phase sequence. ◆ Check for CT/ PT connections provided on transformer. Check electrical continuity of secondary circuit with ELV tester. ◆ Adjust spacing of arcing horns/ rod gaps. ◆ Any other test specifically called for by the manufacturer or the contract.

14.6 Commissioning Checks

Note: Commissioning checks are to be made in following sequence starting from Transformer/ DG to main panel to last light fitting. All results of testing and observations are to be preserved for record and reference by any statutory authority.

S. No.	Component	Points to be checked
1.	Transformer	<p>A. Ratio test</p> <ul style="list-style-type: none"> ◆ With 415V applied on high voltage side, measure the voltages between all phases on low voltage side for all tap positions. <p>B. Buchholz Relay</p> <ul style="list-style-type: none"> ◆ Test for angle, air injection etc. ◆ Check that there is no air in protector. <p>C. Alarm circuit checks for,</p> <ul style="list-style-type: none"> ◆ Buchholz relay ◆ Oil and winding temperature thermometer ◆ Cooling gear failure <p>D. Fans and pumps (for ONAF transformer)</p> <ul style="list-style-type: none"> ◆ Ensure that oil valves are open ◆ Check the rotation of pumps, automatic starting, overload device etc. <p>E. Tap changing test to check mechanism, indications etc.</p> <p>F. Check that neutral earthing switch wherever provided is in closed position.</p> <p>G. Ensure that all protective relays in HT and LT panels are set properly.</p> <p>H. All rectification points are attended and correctly rectified</p> <p>j. First switch on the transformer on NO load and keep for 15-20 minutes.</p> <p>K. Slowly one by one switch on the loads</p>
2.	Main LT panel	<ul style="list-style-type: none"> ◆ All rectification points are attended and correctly rectified. ◆ Incoming line voltage is correct as per panel incoming meter or checked by tong tester. ◆ Energize only control circuits and carry out closing and tripping operations (where AC supply is derived from main supply and used for operation, the switch gear bus may be energized). ◆ Check operation of electrical interlocks. ◆ Check tripping of breaker by manual operation of relay.

		<ul style="list-style-type: none">◆ Check operation of mechanical closing and tripping devices.◆ If incoming line voltage is correct, switch on out going feeder one by one and note that each one is kept ON for 5 – 10 minutes without any problem.
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S. No.	Component	Points to be checked
3.	Switch boxes & Receptacles	<ul style="list-style-type: none"> ◆ All rectification points are attended and correctly rectified. ◆ Check the voltage with test lamp. ◆ Switch on the circuit.
4.	Lighting Panels	<ul style="list-style-type: none"> ◆ All rectification points are attended and correctly rectified. ◆ Incoming line voltage is correct as per panel incoming meter or checked by tong tester. ◆ If incoming line voltage is correct, switch on out going feeder one by one and note that each one is kept ON for 5 – 10 minutes without any problem.
5.	Light fittings	<ul style="list-style-type: none"> ◆ All rectification points are attended and correctly rectified. ◆ Switch on the circuit.
6.	Lighting Poles	<ul style="list-style-type: none"> ◆ All rectification points are attended and correctly rectified. ◆ Check the voltage with test lamp. ◆ Switch on the circuit.
7.	Earthing	<ul style="list-style-type: none"> ◆ Check if all earth electrodes in earth pits for it's correct installation and connection to earth grid. ◆ Check if all protective conductors from the earth electrodes to grid and from grid up to all electrical equipment are made correctly. ◆ Remove the protective conductor/ grid connection with earth electrode and measure earth electrode resistance by using earth megger. ◆ Repeat above procedure for all electrodes. ◆ Ensure that total earth resistance of the installation is less than 1 mega- ohms.

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S. No.	Details of Materials/ Equipment	Manufacturer's Name
A.	<u>HIGH VOLTAGE EQUIPMENT</u>	
1	HT Termination Kit: 11 kV	Birla-3M M-Seal Raychem Ikebana
2.	HT XLPE Cable: 11 kV	Cable Corporation of India RPG Universal Polycab Fort Gloster KEI
3.	Protection Relay Numeric Type	ABB AREVA L & T Schneider Electric Siemens
4.	Potential Transformer	Jyoti Kappa Pragati Matrix
5.	Current Transformer (Cast Resin Epoxy Coated)	Jyoti Kappa Pragati Matrix
6.	Battery Charger	Caldyne Chabbi Electricals Volstat Mahamai
7.	Sealed Maintenance Free Batteries	Exide Global (Rocket) Hitachi Shinkobe
8.	Insulating Mats	DL Miller & Co. Ltd. Premier Polyfilm Ltd. RMG Polyvinyl India Ltd. Tycoon

S. No.	Details of Materials/ Equipment	<i>Manufacturer's Name</i>
B.	MEDIUM VOLTAGE EQUIPMENT	
1.	LT Panel & Capacitor Panels	SPC Electrotech Pvt. Ltd. Tricolite Adlec Control System Advance Panels & Switchgears Pvt. Ltd. Jakson
2.	Final Distribution Board	Legrand Hager (L&T) Schneider Electric (MG) ABB Siemens
3.	Air Circuit Breaker (3/ 4 Pole)	Larsen & Toubro (U-Power) ABB (E-Max) Schneider Electric (Master pact MVS) Siemens (3WL)
4.	Moulded Case Circuit Breaker (MCCB)	Larsen & Toubro (D-Sine) ABB (T – Max) Schneider Electric (Compact) Siemens (3VL)
5.	Motor Protection Circuit Breaker(MPCB)	Hager (Marketed by Larsen & Toubro) ABB Schneider Electric Siemens
6.	Miniature Circuit Breakers (MCB)	Legrand Hager (L&T) Schneider Electric (MG) ABB Siemens
7.	Residual Current Circuit Breaker (RCCB)	Legrand Hager (L&T) Schneider Electric (MG) ABB Siemens
8.	Power/ Aux. Contactor/ Capacitor Duty Contactor	Schneider Electric (MG) Hager (L&T) ABB Siemens
9.	Change Over Switch	Larsen & Toubro C & S HPL – Socomec
10.	Control Transformer/ Potential Transformers	Gilbert & Maxwell Automatic Electric Matrix Advance Precise
11.	Current Transformer (Epoxy Cast Resin)	Gilbert & Maxwell Automatic Electric Matrix Advance Precise

S. No.	Details of Materials/ Equipment	<i>Manufacturer's Name</i>
12.	Protection Relay	
	a. Numeric Type	ABB Areva Larsen & Toubro Siemens
	b. Electromagnetic Type	ABB Areva Larsen & Toubro
13.	Indicating Lamps LED type and Push Button	Vaishno Electricals GE Power Controls Larsen & Toubro (ESBEE) Schneider Electric Siemens
14.	Overload relays with built in Single Phase preventer	ABB Larsen & Toubro Schneider Electric Siemens
15.	Electronic Digital Meters (A/ V/ PF/ Hz/ KW/ KWH) with LED Display	Schneider Electric (Conzerv) Cadel Secure EI Measure
16.	Static Power Meter & Logger (SPML) with RS 485 port	Schneider Electric (Conzerv) Cadel Secure Larsen & Toubro EI Measure
17.	Power Capacitor with Detuned Filters	ABB L&T EPCOS Schneider Electric (Meher)
18.	Automatic Power Factor Correction Relay (Numeric Type)	Areva BELUK (Germany) Schneider Electric (Conzerv) L&T EPCOS
19.	PVC insulated XLPE aluminium/ copper conductor armoured MV Cables upto 1100 V grade	Cable Corporation of India Finolex Skytone Ravin Cable Universal Polycab
20.	LT Jointing Kit/ Termination	Birla-3M Raychem REPL Safe Kit

S. No.	Details of Materials/ Equipment	<i>Manufacturer's Name</i>
21.	Cable Glands Double Compression with earthing links	Baliga Lighting Comet Cosmos Gripwell
22.	Bimetallic Cable Lug	Comet Cosmos Dowell's (Biller India) Hax Brass (Copper Alloy India)
23.	PVC insulated copper conductor stranded flexible wires	Finolex Batra Henlay KEI R R Kabel Polycab
24.	PVC Conduit & Accessoires (ISI approved)	AKG BEC Precision Polypack D Plast
25.	Switch & Socket	
a)	Common Area (Residential, Office & Retail)	Clipsal (Opal Series) M K India (Wraparound/ Blenze) Legrand (Mosaic) Wipro (NorthWest) Anchor Roma L&T
b)	Residential Apartments	Anchor (AVE) Italy ABB – Concept BS Clipsal (Neo-Series) Legrand (Arteor) Wipro (North West)
26.	Industrial Socket	
	a. Splash Proof	Clipsal Gewiss Legrand Neptune Balls Schneider Electric
	b. Metal Clad	BCH Legrand
27.	Ceiling Fan	Anchor Crompton Greaves Orient Usha
28.	Selector Switch, Toggle switch	Kaycee Salzer (Larsen & Toubro)

S. No.	Details of Materials/ Equipment	<i>Manufacturer's Name</i>
29.	Lighting Fixture	
	a. Incandescent/ Halogen/ PL/ Metal Halide/ Fluorescent with Electronic ballast	GE Philips Thorn Wipro Bajaj
	b. External Lighting Fixture	Bajaj Electricals Ltd. Keslec LIGMAN Philips Wipro
	b. Aviation Obstruction Light (LED Type)	Actos Bajaj Binay
30.	Timer	ABB Larsen & Toubro Legrand Schneider Electric Siemens
31.	50 W Halogen Light Transformer (Encapsulated Transformer)	Gemini Global Opal Philips Reiz
32.	Cable Trays (Factory Fabricated)/ Raceways	Profab Engineer Ricco STEEL Needo Maheshwari Electrtricals
33.	Sealed Maintenance Free Batteries	Amar Raja Exide Global (Rocket) Hitachi Shinkobe
34.	Battery Charger	Caldyne Chhabi Electricals Volstat
35.	Advanced Lightning Protection System	Erico LPI Indelec
36.	Lightning & Surge Voltage Protection	Hager OBO Bettermann Schneider Electric
37.	Lighting Poles	Bombay Tubes & Poles Bajaj Electricals Keselec K-Lite
38.	Fire Sealant & Fire Retardant Paint	3 M India Ltd. HILTI Promat

S. No.	Details of Materials/ Equipment	<i>Manufacturer's Name</i>
39.	Earthing System	Ashlok Galaxy Indelec Forend Erico
40.	Anchor Fastener	Fischer Hilti Power Fastners Shakti
41.	Exit Signage	Legrand Philips Prolite Thorn
B.	<u>SMATV</u>	
1.	Coaxial Cable	Beldon Comm-Scope (US Imported) Triscope (USA)
2.	Tap off/ splitters complete with gasketed G. I. boxes	Catvision CE DX Powerage Vision Hire
C.	<u>TELEPHONE</u>	
1.	Tag Block	Krone TVSE
2.	Telephone Patch Cords	Delton Finolex Skytone Fusion Polymer Polycab
D.	<u>UNINTERRUPTED POWER SUPPLY</u>	
1.	UPS	APC Merlin Gerin Emerson Power Network Riello PCI India Pvt Ltd EATON

67. TECHNICAL SPECIFICATIONS FOR EXTERNAL ELECTRICAL

SCHEDULE OF TECHNICAL DATA FOR D.G SETS

1. DG SET (To be filled by the Bidder)

- a. Engine make
- b. Alternator Make
- c. Operating Duty
- d. KVA Rating
- e. KW rating
- f. BHP Rating
- g. Physical Dimensions
 - i. Length (mm)
 - ii. Width (mm)
 - iii. Height (mm)
- h. Shipping Weight (Kg)
- j. Engine Lub Capacity (Ltrs)
- k. Fuel Consumption at NTP
 - i. 100% loading (ltrs/ hr)
 - ii. 75% loading (ltrs/ hr)
 - iii. 50% loading (ltrs/ hr)
- l. No. of Cylinder/ Stroke
- m. Power Factor
- n. Efficiency (%)
- o. System back Pressure (KPA)
- p. Exhaust Flange
- q. Exhaust Gas Flow Rate (CFM)
- r. Compression Ratio
- s. Heat Rejection to Exhaust System (KW)
- t. Heat Rejection to Cooling System (KW)
- u. Total Radiated Heat (KW)
- v. Exhaust Temperature (°C)

APPENDIX

DG SETS – TEST PROCEDURE

DG Set shall be duly tested at factory as per manufacturer's standards and procedures detailed as under:-

- 1) Before testing, following details shall be recorded on test report:-
 - i) Engine S. No.
 - ii) Alternator S. No.
 - iii) Engine Model and Make
 - iv) Alternator Model and Make
 - v) Engine and Alternator Rating
 - vi) Date of Testing
 - vii) Cooling System Type
 - viii) Rated Sped, Voltage & KW Rating
- 2) Check the tightness of al bolts and necessary connections before starting the DG sets.
- 3) Start the DG set and run at idle for few minutes. If any leakage occurs, rectify them and note down the parameters on test report.
- 4) Raise the load gradually and allow the performance parameters to reach steady state conditions and note down the following parameters on test report:
 - i) Speed in RPM
 - ii) Load in KW
 - iii) Current in Amps
 - iv) Voltage
 - v) Frequency (Hz)
 - vi) Lube Oil Pressure
 - vii) Water Temperature
 - viii) Lube Oil Temperature
 - ix) Regulation of Voltage & Speed

Above parameters shall be recorded at following loads and duration:

Idle Run	-	-	05 mins
15% Load	-	-	30 mins
50% Load	-	-	60 mins
75% Load	-	-	60 mins
100% Load	-	-	120 mins

110% Load - 60 mins

The DG sets shall be tested with standard test bench facilities as per ISO – 8528 – 6.

APPENDIX
TEST REPORT

Description	Engine	Alternator	DG Set	Panel
Make				
Model				
Rating				
S. No.				

Rated Voltage:

Rated Speed:

Load built up test on resistive load bank (unity power factor)

Load %	Time Min.	Start Time	Stop Time	Volt (Line to Line)			Current (Amps)			Load (kW)	Frequency (Hz)	Lube Oil Pr. Bar	Lube Oil Temp (°C)	Water Temp (°C)	Speed RPM
0															
25															
50															
75															
100															
110															
Volt & RPM at no load Volt & RPM at full load Notes: Date: Tested By: Witnessed By:															

TECHNICAL SPECIFICATIONS FOR DG SETS

A. DIESEL OPERATED GENERATOR SET

1. GENERATORS

1.1 SCOPE

The scope of this section consists of but not necessarily limited to the following:

- a. The contractor shall supply, deliver to site, hoisting into position, install, test and commission the standby power generating set together with the necessary controls and switchboards as specified and indicated in the Drawings. Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided without any additional cost to complete the system.
- b. Provide manufacturer's factory representative's services, including coordination, start-up and testing supervision at site.
- c. Testing (factory and field) start-up supervision, training and providing necessary documentation and tools for operation.
- d. Carry out performance test run at site.

1.2 SUBMISSION

For bidding

The bidder shall submit offer with the following documents in two sets.

- Schedule of deviations from technical specifications.
- List of proposed makes, for the items listed in the tender.
- Technical datasheets indicating overall dimensions & Catalogues of major items, highlighting the offered models.
- Design drawing of residential silencer.
- Day oil tank detailed design drawing.
- Structural support drawings.
- To submit power controller (Synchronization module) drawings along with operation logic.
- Supporting structure details of chimney e.t.c.
- Other documents and comments, if any.

For approval before construction/ erection

The Sub-contractor shall submit the following documents.

- a) For all the supplies, the sub-contractor shall submit the following documents in 4 sets for approval.
 - General arrangement drawings, with all dimensions, showing: space-requirements, weights (for transport and service conditions), requirements of civil works/ foundation, fixing and mounting facilities, connection devices, etc.
 - Electrical drawings, showing: power and control single line and functional/ control multi line diagrams, terminal blocks, components' list with make, type, quantity, etc.

- Quality assurance plan and bar-chart showing manufacturing schedule.
- The sub-contractor shall incorporate all comments and submit revised drawings in stipulated time till all drawings are finally approved for manufacturing.

Final

The sub-contractor shall submit the following documents, reflecting the true final as built situation, in 6 sets, and one soft copy in CD.

- a) The drawings including wiring diagrams as revised and “as built”.
- b) Inspection and preliminary testing certificates and reports and shipping release.
- c) Test certificates of kWh meters from Government approved Lab or Electric Supply Co. of concerned area.
- d) Guarantee certificates.
- e) Instruction & maintenance manuals, Catalogues etc.
- f) Any other certificate/ report as called for by the Client/ Consultant.

1.3 **PRODUCT**

DG set shall conform to following standards:-

IS 4722
BS 5000
IS 1460
ISO 8528
BS 5514
ISO 3046

1.3.1 **Capacity**

Actual power output shall be as shown in drawings and in schedule of quantities.

Diesel Engine

The diesel engine shall be of the 4 stroke cycle, continuous rating (prime or stand by as specified in SOQ), multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply Center/ State Pollution Control Board and shall conform to BS:649/ 5514.

The engine shall be complete with radiator body jacket, lubricating oil pump, lubrication oil pressure gauge, tachometer, digital or electronic type governor, integrated hours-run recorder, over-speed trip and all other necessary auxiliaries.

The brake horse power of the engine with all attached accessories as specified shall not be less than that which is required by the full load rating of the alternator at site operating conditions taking into consideration losses, plus a reserve factor of at least 10%.

1.3.2 Starting

Starting system of the standby generator shall be of a heavy-duty electric motor complete with a 24 V D.C. heavy-duty battery of suitable capacity. The electric motor shall be capable of cranking the engine to achieve the rated speed in less than 10 seconds from the initiation of the starting process. The electric start battery shall be of adequate capacity for 3 successive starts. Time delay relays shall be incorporated to provide a rest period of 1-5 seconds (adjustable) before each successive start and a time lag period of 19-100 seconds (adjustable) before the system lock out due to failure of the 3rd start to crank up the engine.

The generator set shall be provided with a micro-processor based control system which is manufactured to provide automatic starting, monitoring, and control functions for the generator set. Interface to BMS system according to point schedule on drawings shall be provided.

The control system shall include an engine governor control, which shall function to provide steady state frequency regulation. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

1.3.3 Speed Regulation

The governor shall be capable of regulating the speed of the engine within the limits approximately 10% of the rated speed within 4 seconds due to a sudden application or removal of a full load. The steady load speed shall vary within the limits of approximately 1% of the rated speed.

1.3.4 Cooling

The engine cooling system shall be of radiator type system to cool the engine as well as the body to minimize heat radiated into the generator room.

1.3.5 Lubricator

The lubricating system shall be by a positive displacement oil pump providing a positive force feed to all lubricating points.

1.3.6 Exhaust System

Adequate sized piping and fittings shall be installed to carry the engine exhaust discharge into the atmosphere at a height as indicated in the drawings & as per the requirement of Center/ State Pollution Control Board or Pollution Control Committee as the case may be.

Galvanized M.S. structural support and vibration arrestors for D.G. set chimney to specify along with drawing for statutory clearance..

Mufflers shall be installed to reduce the engine exhaust noise to a maximum of 5 dBA above ambient noise level at nearest area accessible to the public within 3m from Generator Room and at least 2m above floor level. Flexible connection shall be provided between the engine and the fixed piping.

1.3.7 Fuel Piping And Fuel Tank Installation

The complete system shall include engineering, supply, installation, testing and commissioning of tank for storage of fuel, pumps, piping, valves and control system.

1.3.8 Instruments

An instrument panel mounted on the engine shall be provided and shall comprise the following flush-mounted instruments and gauges:

Lubricating oil inlet and outlet temperature

Lubricating oil pressure gauge

Tachometer, positive driven

Hour counter.

1.3.9 Protection Devices

Warning indication and automatic shut-down shall be provided for the following:

Low oil pressure shutdown and alarm

Low and high coolant temperature alarm

High coolant temperature shutdown

Fail to crank shutdown

Overcranking shutdown

Overspeed shutdown

Low & high DC voltage alarm

Low battery alarm

Low fuel-day tank alarm

High and Low AC voltage shutdown

Under frequency shutdown

Over current and alarm and shutdown

Short circuit shutdown

Ground fault alarm

Overload alarm

Emergency stop

Failure indication lights and alarm for all fault conditions shall be provided on control panel for restoring the operation to normal.

The starting circuit shall be disconnected in the event of any of the above shutdowns.

1.3.10 Alternator

The alternator shall be brush less synchronous drip proof, self-ventilated and screen-protected and directly coupled on to the diesel engine by flexible coupling and shall be continuously rated for site operating conditions and conform to BS 5000 (part99) or IS 4722..

The full load output voltage shall be 415 volts, 3 phase, 4 wire, 50 Hz at 0.8 power factor with neutral solidly earth with the frequency maintained at 50 Hertz at all time under any load condition including transient overload due to motor starting etc.

The rotor shall consist of the main alternator field poles the brushless exciter and its rectifier module, all bolted on a common alternator shaft. The rotor shall be mechanically and electrically balance up to

135% of the rated speed. The insulation of the alternator shall be non-hygroscopic, Class “H” on the exciter, Class “H” on the stator and Class H on the rotating pole pieces.

The rectifier module of the exciter shall be impregnated with epoxy resin and shall be capable of withstanding without damage or deterioration of the thermal, centrifugal and other stresses that is experienced during normal or short circuit conditions. Rectifiers shall be of silicon type.

The voltage build up shall be of self-excitation using the residual voltage of the alternator through a solid-state voltage regulator. The voltage regulator shall be capable of maintaining the voltage regulation to $\pm 1\%$ independent of power factor, heating and 5% of speed variation. The voltage output of the alternator shall also be capable of manual adjustable to $\pm 5\%$ of the rated voltage.

The response of the voltage regulator shall be less than 10 millisecond. The voltage dip shall not exceed 15% when a rated continuous load is supplied to the unloaded alternator and the correction time shall not exceed 200 millisecond. When the rated load is withdrawn, the voltage overshoot shall not exceed 20%.

The automatic voltage regulator and the exciter shall be manufactured to withstand 50% overload at a constant terminal voltage.

A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of motor current for not more than 10 seconds.

1.3.11 Generator Control Panel

The generator control panel shall have all necessary instruments and accessories for operation and control of the generating set. On sensing the utility mains voltage dip to below said voltage, the control panel shall send a signal to start the generator. After 3 successive start and if the diesel generator is not started up, the alarm signal shall be activated.

The generator control panel shall consist of all AMF system, Auto-transfer switch, circuit breakers, protective relays if applicable and accessories required to control the generator operation and shall include but not limited to the following:

Voltmeters

Ammeter

Frequency Meter

Power factor meter

Kilowatt meter with maximum demand indicator

Kilowatt hour meter

Hour run meter

Start-stop and automatic mains monitoring system

Emergency off push button

Manual speed adjusting control reset for overload, alarm muting.

Fully automatic trickle battery charger with voltmeter

Indicating lamps for ‘Mains Available’, ‘Mains on Load’, ‘Standby Available’, ‘Standby on Load’, ‘Alarm’, ‘Mains Fail’, etc.

Audio and visual (flasher) alarm.

The start-stop and automatic mains monitoring system shall be equipped with the following:

Duty selector switch for 'off-automatic-test-manual' operation

Manual start-stop push button switch

Manual alternator circuit breaker 'On-Off' switch

Cancel alarm switch

Reset switch

Indicating lamps

Battery Status

1.3.12 Acoustic Treatment

All DG sets up to 1000 kVA shall be provided with it's own outdoor type acoustic enclosure duly tested and approved for 75 dBs as per norms of central/ local pollution control board.

1.3.12.1 Acoustic Enclosure For Diesel Generator

Acoustic Enclosure for DG Set shall be as given below:

- | | | | |
|----|------------------------|---|--|
| a. | DG Set Capacities | : | 2 No. 625 kVA DG Set |
| b. | Structure | : | MS Press bend 3 mm |
| c. | Panels | : | Steel fabricated double wall insulated panels. |
| | Thickness of panels | : | 100 mm thick |
| | Outer sheet | : | 2 mm thick CRCA sheet steel |
| | Inner Sheet | : | 1.25 mm thick CRCA Perforated sheet steel |
| | Frame & Strainer | : | 2 mm thick CRCA sheet steel |
| d. | Insulation | : | Mineral wool as per IS 8183 - 1993 |
| | Thickness | : | 100 mm thick (50 mm x 2 slabs) |
| | Density | : | 64 Kg/ m ³ |
| | Anti Droning | : | HDPE sheet |
| | Thickness | : | 6 mm thick |
| e. | Air Circulation System | : | Axial flow fans of suitable capacity required for each 625 kVA DG Set offered suitable ducted exhaust arrangement for fresh air intake and exhaust shall be made to avoid short cycling. |
| f. | Finishing | : | Powder coating of colour shade approved by consultant/ owner. |

g.	Noise Level	:	75 dBA at a distance of 1.0 meter.
h.	Location	:	Outdoor
i.	Δ T Acoustic Enclosure	:	Should not exceed from 7°C above ambient temperature.
j.	Painting of Exhaust Piping:		High temperature aluminium paint shall be used (600 – 700°C) for painting of un clad exhaust pipe and top of the chimney
k.	Base frame for canopy	:	Powder coated as per approved colour
l.	Lighting	:	Proper lighting shall be made inside acoustic enclosure for maintenance purpose

1.3.13 **Testing and Commissioning**

All the necessary comprehensive tests shall be performed to the approval and satisfaction of the Project Manager at the completion of installation. Before the commencement of acceptance testing, the installation shall be in a state of practical completion and shall have completed all of the preliminary testing and adjusted the equipment to its proper running order.

A full ten (10) days' notice of his readiness for carrying out acceptance tests shall be given to the Project Manager.

Prior to the date of giving such notice a complete details schedule of the tests to be carried out shall be submitted to the Project Manager for his approval and alterations and additions to the schedule are required to be made.

Notwithstanding his approval of the testing schedule the Project Manager may at any time before or during the testing period direct further tests to be carried out that he considers necessary.

Any variation to the programme for the testing period shall be at the discretion of the Project Manager.

Upon completion of all above tests, four (4) sets of the test results shall be submitted for the approval of Project Manager. All test reports submitted shall be endorsed by all parties witnessing the test including the contractor's and manufacturer's Qualified Personnel.

No acceptance tests shall be carried out except in the presence of the Project Manager or their authorized representatives appointed for the purpose.

The Contractor shall provide at his own cost all materials, including electric power, instrument test set, fuel, lubricants and other consumable, Load Bank required for the tests and adjustments of the equipment and for carrying out the acceptance tests and any re-tests that may be necessitated by failure of the installation or by any other causes within his control.

The Contractor shall ensure that the fuel supplied for use in acceptance tests is part of a batch for which certified test data is available. Two copies of the test certificate shall be supplied to the Project Manager prior to the commencement of tests.

During the testing period the Contractor shall appoint a qualified personal to carry out the checking and testing the testing instrument (equipment which are to be used for the test) including accurately calibrated test equipment for checking the accuracy of gauges and instruments forming part of or supplied with the installation.

Prior to commencement of testing a detailed list of the equipment shall be submitted to the Project Manager for his approval and no item on the list shall be removed from the site without his consent until the completion of testing.

1.3.14 Battery Charger

1.3.14.1 General

The battery charger shall be Float cum Boost type IGBT controlled. The charger shall have selector switch for Auto Float – Boost/ Manual Float/ Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

1.3.14.2 Construction Feature

The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5. Four wheels shall be provided at the base.

1.3.14.3 Performance

The D.C output voltage of Float/ Boost charger shall be stabilized within $\pm 2\%$ for AC input variation of $230\text{ V} \pm 10\%$, frequency variation of $50\text{ Hz} \pm 5\%$ and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response IGBT control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float/ Manual Float/ Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float/ Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

1.3.14.4 Components

The battery charger shall essentially comprise of the following

- 1 No. double pole ON/ OFF MCB at AC input.
- 1 No. pilot lamp to indicate charger ON.
- 1 No. Main Transformer: Double wound, naturally air cooled, having copper winding.
- 1 set single phase full wave bridge rectifier consisting of 4 No. IGBTs, liberally rated, mounted on heat sinks and complete with resistor/ condenser network for surge suppression.
- 1 No. rotary switch to select auto float/ manual float/ manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.
- 1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at $\pm 2\%$ of time set value for AC input voltage variation of $230\text{ V} \pm 10\%$, frequency variation of $\pm 5\%$ from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.
- 1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa..
- 1 No. DC ammeter and toggle switch to read charger output current and battery charge/ discharge current.

- 1 No. moving coil DC voltmeter to read the DC output voltage.
- 2 set potentiometer to adjust the output voltage during manual/ auto float and boost modes.
- 2 No. double pole ON/ OFF MCB at DC output, 1 No. at charger output and the other at load.
- 2 set DC output terminals. 1 set for the load and the other set for the battery.
- Alarm Annunciation: Visual and audible alarm with manual accept reset facility shall be provided for the following for BMS Connectivity
 - a. AC mains Fail
 - b. Charger Fail
 - c. Load/ Output over volt.

1.3.14.5 Rating

AC Input	230 V + 10% AC 50 Hz single phase.
DC Output	To float/ boost charge batteries and also supply a continuous load.
Current Rating	30.0 Amps
Float Mode	27.0 V nominal (Adjustable) between 24-28.0 V.
Boost Mode	29.0 V nominal (Adjustable) between 24-32.0 V.
Voltage Regulation	+ 2% for AC input variation of 230 V + 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100%

1.3.14.6 Performance Tests

The schedule of tests to be performed in the Factory Acceptance Test shall include the following:

On each of three separate days and before any other operation of the diesel-alternator on that day three successful manual start-up operations to be accomplished.

Three separate manual start-up operations each within one minute of the diesel-alternator being shut down after running continuously for not less than one hour and attaining normal engine running temperatures.

Three separate automatic start-up operations with simulation of “mains failure”. In all or any of these tests the diesel-alternator may be out on load by the automatic closing of the emergency power supply circuit breaker.

Three separate automatic shutdown operations, each initiated by mechanical simulation of a “low pressure” condition. Three separate automatic shutdown operations, each initiated by manual instigation of an “over-speed” condition.

Three separate abortive start-up operations, each inducing “failure to start” shut-down. The load tests shall be carried out as follows:

25% of full load at 1.0 pf	For half hour
50% of full load at 1.0 pf	For one hour
75% of full load at 1.0 pf	For one hour
100% of full load at 1.0 pf	For two hours
110% of full load at 1.0 pf	For one hour

At the completion of the test, readings shall be taken of Voltage, Frequency, Current, Temperature, Vibration, Fuel ratio to Unit produced, Flue analysis and the following:

Insulation resistance – rotor, stator, exciter – to earth;

Insulation resistance – between stator windings;

Alternator rotor and exciter armature temperature

1.3.14.7 Site Test

Upon the delivery to the site and if the generator set is required to re-assemble on site, similar tests shall be carried out by the Contractor to ensure that the performance is not degraded. The tests, but not limited to are:

Diesel engine-Generator coupling and shafts alignment.

On load 'mains failure' simulation test

Safety devices test

Remote monitoring

Auxiliary contacts etc.

Load tests.

Load tests may be carried out through building load and/ or Contractor load bank. Cost to arrange for the load for purpose of testing shall be included in the Tender.

1.3.14.8 Painting of Pipe Work

All pipe work, other than buried pipes, shall be painted immediately after installation with at least one coat of red primer and two (2) finishing coats of best quality aluminum paint. The color will be determined by the Project Manager on site.

1.3.14.9 Vibration Control

The complete generator assembly shall be isolated on static deflection un housed spring-neoprene in series isolator with non-skid neoprene pads. Start-up and shut down rocking restraint snuffers shall be provided at four corners of base frame.

All fuel line pipes shall be cushioned with a layer of harness and neoprene pad at attached points.

All pipe work and engine silencers shall be suspended on static deflection spring-neoprene in-series hangers.

Detail calculation and proposal for justifying the size and provision shall be provided for Project Manager review prior to the installation.

Emission standards for Diesel Engines (Engine rating upto 800 KW) for generating sets

Parameter		Area Category	Total engine rating of the plant (includes existing as well as new generator sets)	Generator sets commissioning date On or after 1.7.2005
NO _x (as NO ₂) (at 15% O ₂), dry basis, in ppmv		A	Upto 75 MW	710
		B	Upto 150 MW	
NMHC (as C) (at 15% O ₂), mgNm ³		Both A and B		100
PM (at 15% O ₂), mgNm ³	Diesel Fuels HSD & LDO	Both A and B		75
	Furnace Oils – LSHS & FO	Both A and B		100
CO (at 15% O ₂), mgNm ³		Both A and B		150
Sulphur Content in fuel		A		<2%
		B		<4%
Fuel specification		For A only	Upto 5 MW	Only diesel fuels (HSD, LDO) shall be used.
Stack height (for generator sets commissioned after 1.7.2003)		Stack height shall be maximum of the following in meter:		
		i. 14 Q ^{0.3} , Q=Total SO ₂ emission from the plant in Kg/ hr		
		ii. Minimum 6 m above the building where generator is installed.		
		iii. 30 m.		

Acronyms Used

MW	:	Mega (10 ⁶) Watt
NO _x	:	Oxides of Nitrogen
NO ₂	:	Nitrogen Dioxide
O ₂	:	Oxygen
NMHC	:	Non-Methane Hydrocarbon
C	:	Carbon
PM	:	Particulate Matter
CO	:	Carbon Monoxide
SO ₂	:	Sulphur Dioxide
PPMV	:	Part per million (10 ⁶) by volume
FO	:	Furnace Oil
HSD	:	High speed diesel
LDO	:	Light Diesel Oil
LSHS	:	Low Sulphur Heavy Stock
kPa	:	Kilo Pascal
mm	:	Milli (10 ³) meter
kg/ hr	:	Kilo (10 ³) gram per hour
mg/ Nm ³	:	Milli (10 ³) gram per Normal metre cubic

Area Categories A & B are defined as follows:

Category A: Areas within the municipal limits of towns/ cities having population more than 10 lakhs and also upto 5 km beyond the municipal limits of such towns/ cities.

Category B: Areas not covered by Category A

The standards shall be regulated by the State Pollution Control Boards or Pollution Control Committees, as the case may be.

1.3.14.10 Limits of Noise for Power Generating Set (Upto 1000 KVA) Manufactured on or after the 1st Jan, 2005

Applicability

These rules apply to Generator sets upto 1000 KVA rated output, installed on or after 1st Jan, 2005.

Requirement of Certification

Every manufacturer or importer of Power Generating set must have valid certificates of Type Approval and also valid certificates of conformity of production for each year, for all the product models being manufactured or imported after 1st Jan, 2005 with the specified noise limit.

All Power Generators shall have a valid Type Approval certificate and conformity of production certificate. All Power Generator shall have conformance label meeting the requirements. The conformance label shall contain the following information:

- Name and address of the supplier (if the address is described in the Owner's manual, it may not be included in the label).
- Statement "This product conforms to the Environment (Protection) Rules, 1986"
- Noise limit viz. 75 dB (A) at 1 m.
- Type approval certificate number.
- Date of manufacturer of the product.

Authorized agencies for certification

The following agencies are authorized to carry out such tests as they deem necessary for giving certificates for Type Approval and Conformity of production testing of Generator and to give such certificates:

- Automotive Research Association of India, Pune.
- National Physical Laboratory, New Delhi.
- Naval Science & Technology Laboratory, Palghat
- National Aerospace Laboratory, Bangalore

2. DG SET TESTING

2.1 AT MANUFACTURER'S WORKS

The routine tests and full load test on Engine, Alternator shall be carried out at manufacturer's work in accordance with applicable Indian standards in the presence of Clinet's representative. The subcontractor shall submit testing plan of testing in loading of 25% step and full load test for 1 hour.

2.2 TESTING AT 'OEA's WORKS

Following tests shall be conducted at the assembler's work in the presence of client representatives.

- a. Full load testing for 8 hours with load bank with all parameters like L.O Pr + C.W Temp + Specific Fuel Consumption + Temperature Inside room during Running + Sound Level at 1 Mtr from encl level during running + Temperature Rise of Breaker + Set Speed in R.P.M.
- b. Overload testing at 10% overload for one hour immediately after the full load test with all parameters, as mentioned in "a", noted.
- c. Operation of protective devices and safety devices.

2.3 SITE TESTING

Following tests shall be conducted at site in the presence of the client representative before energisation. The subcontractor shall provide all testing equipment, labour and consumables required for the testing.

- a. Checking the alignment by engine manufacturer's representative and obtaining approval.
- b. Insulation resistance test on alternator, control panel and power cabling / Bus bar trunking.
- c. Checking the AMF operation both on auto and manual mode.
- d. Checking the engine safeties for satisfactory operation.
- e. Checking vibration levels.
- f. Testing of individual protective devices on engine and alternator and ensuring that the wiring is carried out properly.
- g. Full load running for 8 hours continuously. All the readings shall be logged to evaluate the fuel consumption, lube oil pressure, water & oil temperature vis-à-vis the electrical load.
- h. One hour overload testing at 110% load shall be carried out at the end of the full load trial.
- i. The guaranteed specific fuel consumption shall not exceed 150 grams / BHP. HR with a tolerance of + 2.5 %. The same shall be proved during the load trial.
- j. The noise level at 1m from the enclosure and the temperature rise inside the enclosure shall be measured.
- k. Any deviation from the guaranteed parameters shall be made good and these performance parameters should be measured once again till the required results are achieved.

The DG set shall be deemed to be commissioned after satisfactory performance of all associated equipment.

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S. No.	Details of Materials / Equipment	Manufacturer's Name
1.	Diesel Generating Engine	Cummins India Caterpillar Perkins Volvo
2.	Acoustic Enclosure	Powerica S & W TIL
3.	Alternator	Stamford Leroy Somer Caterpillar
4.	Fiberglass	Owens Corning UP Twiga
5.	Alarm Annunciator	Advani Oralikon Larsen & Toubro Minilec
6.	Flexible Pipe Connections	Flexionics Resistoflex
7.	Oil Flow Meter	Crown Kent Schlumberger
8.	Level Indicator (Oil)	Forbes Marshall
9.	Anchor Fastner	Fisher Hilti Shakti
10.	Welding Rod	ADOR Advani Cosmos Esab Super Bond (S)

LIST OF INDIAN STANDARDS (IS)

IS : 2551-1982	Danger notice plate.
IS : 3043 - 1987	Code of practice for earthing.
IS :4146 - 1983	Application guide for voltage transformers
IS : 5216 – 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS 5:1994	Colours for ready mixed paint and enamels
IS 2705 (Part-1): 1992 (Second Revision)	Current transformers – Specification General requirements
IS 2705 (Part-2) : 1992 (Second Revision)	Current transformers - Specification Measuring Current Transformers
IS 2705 (Part-3) : (Second Rev.)1992	Current transformers - Specification Protective Current Transformers
IS 2705 (Part-4): (Second Rev.) 1992	Current transformers - Specification Protective Current Transformers for Special Purpose Applications
IS 3043 :1987	Code of practice for earthing
IE Rules, with amendments upto 1995 :1956	Indian Electricity Rules
IS 4146 : 1983	Application guide for voltage transformers
IS : 2071 - 1974 - 76	Methods of high voltage testing
IS : 3427 :1997 IEC:60298,60694	AC Metal enclosed switchgear and control gear for rated voltage above 1kv and upto and including 52kv.
IS : 12729 :1998	General requirement for switchgear and control gear for voltage exceeding 1000V
IS : 13118 :1991	Specification for high voltage alternating current circuit breaker
IS: 5578 & 11353-1985	Marking and arrangement of bus bars
IS: 3156	Potential transformer
IS: 9385	HV HRC Control Fuse
IS: 1248	For measuring instruments

A P P E N D I X

ABBREVIATIONS

The following abbreviations have been used in the accompanying Specifications, drawings and Schedule of Quantities.

CU	stands for copper.
GI	stands for Galvanized Iron (Mild Steel)
V	stands for Volts
KV	stands for Kilo Volts
HV	stands for High Voltage (11 kV and above)
HT	stands for High Tension
PVC	stands for Polyvinyl Chloride
AMP	stands for Amperes
KWH	stands for Kilowatt Hours
KW	stands for Kilo Watts
BIS	stands for Bureau of Indian Standards
IEE	stands for Institution of Electrical Engineers - London

TECHNICAL SPECIFICATIONS FOR HT PANEL

1. HT PANEL

1.1 SCOPE

Manufacturing, testing and supplying of integrated cubicle type metal clad, form 3 a, floor mounted and draw out type free standing, front operated indoor type 11 kV switchgear as per specifications given below:

System

The switchgear enclosure shall conform to degree of protection IP 4 X.

The switchgear shall be made from MS sheet steel 2 mm thick (CRGO) and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrestor.

1.2 BREAKER COMPARTMENT

Vacuum Circuit Breaker shall be mounted in draw out truck with front plate which covers the cubicle when the breaker is in service position. This front plate shall be provided with view glass to facilitate observation of mechanical ON/ OFF indication of Circuit breaker, Spring charged/ discharged indication and operation counter. Necessary orifice shall be provided for manual charging of the springs. ON/ OFF push button for opening and closing of the circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated/ Test & Service.

1.3 BUS BAR COMPARTMENT

Bus bars of rectangular cross section of copper conductor supported by cast epoxy insulator to withstand full short circuit currents up to 18.4 for 1 second for 11 kV system and 26.3 for 1 second for 33 kV system shall be provided at the rear. Bus bar chamber shall be provided with inter panel barriers with epoxy cast seal off bushings.

1.4 CT AND CABLE COMPARTMENTS

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT's of double core and two numbers three core cable termination. The cable entry shall be from the top/ bottom.

1.5 SEPARATE COMPARTMENTS

Circuit breakers, instrument transformer, bus bars, cable etc shall be housed in a different compartments as required for form 3 a, compartmentalization. All relays, switches, lamps, etc. comprising the control, indication and protective devices shall be housed in a separate compartment on the front of the cubicle.

1.6 TECHNICAL PARTICULARS OF VCB CIRCUIT BREAKER

S. NO.	DESCRIPTION	11 kV
i.	Rated Current	630 A
ii.	Rated Voltage	12 kV
iii.	Rated Frequency	50 Hz
iv.	Rated Short Circuit breaking Current	18.4 kA for 1 sec.
v.	Rated short circuit making current (kAP)	50 kA
vi.	Insulation level (kVrms/ kVP)	28 kV/ 75 kV

1.7 EARTHING SWITCH

Cable earthing switch shall be provided in the cable chamber and shall be operated from the front of the panel. The ON/ OFF position of switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

Earthing switch shall also be provided on bus bar side. The ON/ OFF Switch shall be indicated by mechanical indicator. The earthing switch shall be suitably interlocked with the breaker, so that it can be operated only when the breaker is in OFF position.

1.8 ISOLATING CONTACTS

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ± 10 mm.

1.9 LOW VOLTAGE PLUG AND SOCKET CONNECTOR

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/ isolated position

1.10 INTERLOCKS AND SAFETY DEVICES

The following interlocks shall be provided:

- The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is 'ON'.
- The circuit breaker can not be switched 'ON' when the truck is in any position between test and service position.
- Front part of the truck can not be removed when the breaker in 'ON' position.
- The low voltage plug and socket can not be disconnected in any position except test/ isolated position.
- The truck cannot be moved inside the panel, when the LT plug and socket is disconnected.
- Earthing switch can not be switched 'ON' when the truck is inside the panel.
- The truck can not be inserted when the earthing switch is 'ON'.

1.11 SAFETY DEVICES

The following Safety devices shall be provided for the safety of the operating personnel:

- a. Individual explosion vents shall be provided for breaker/ bus bar/ cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.
- b. Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.
- c. Circuit breaker and sheet metal enclosure shall be fully earthed.
- d. Self locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

1.12 PROTECTIVE EARTHING

The earthing connection between the truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the isolated position when inserted and remains earthed when the truck is pushed further into the connected position or when the truck is being withdrawn until the truck has moved part the isolated position.

1.13 CURRENT TRANSFORMER

1.13.1 GENERAL REQUIREMENTS

Accommodation shall be provided in the circuit breaker panel, to mount one set of dual ratio CT. Access to the CTS for cleaning, testing or changing shall be from the front, back or top of the panel.

1.13.2 RATING

Dual ratio CTS of suitable burden (but each not less than 15 VA) shall be preferred with 5 amps secondaries.

Instrument Security Factor (ISF) of each CT shall not be more than 5.

The CTs shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways. Secondary terminals of CTS shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT'S shall have 2 No. of cores for following application:

- | | |
|--------|--|
| Core-1 | for metering |
| Core-2 | for over current & earth fault protection. |

Class of accuracy of each winding

- | | |
|------------------|------|
| Metering class | 1.0 |
| Protection class | 5P10 |

1.14 POTENTIAL TRANSFORMERS

The potential transformers shall be confirming to IS 3156/ IEC 60185. The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Potential transformer(PT'S) shall be mounted on a draw out trolley and housed in separate metal compartment and shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings. HT HRC Control fuses shall be confirming to IS – 9385/ IEC – 60282. Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

Ratio	:	11000 $\sqrt{3}$ / 110/ $\sqrt{3}$ / 110 V
V A Burdan	:	100 V A for 100/ $\sqrt{3}$ and 110 V winding
Class	:	CL –1 for both the windings.
Basic Insulation level	:	Same as mentioned for VCB in clause -6.
Over voltage factor	:	1.2 Continuous

Single phase PTs shall be used and shall be connected in Star/ Star.

1.15 PROTECTION AND TRIPPING ARRANGEMENT

Protection

All protection relay shall be numeric type of approved make.

The protection and tripping arrangement of circuit breaker shall be:

- i. Numeric type instantaneous short circuit protection Device No.50 Range 500 – 2000% shall be provided on all phases.
- ii. Numeric type back up over current protection for Phase faults Device No.51 Range 50 – 200% shall be provided on all phases.
- iii. Numeric type ground fault protection Device No.50G.CT's. Range 20 – 80% shall be provided.
- iv. Lockout and trip supervisory relays etc shall be provided with manual reset facility.
- v. Auxiliary relay for transformer fault.
- vi. Surge Arrestor

1.16 CONTROL WIRING

The control wiring shall be carried out with minimum 2.5 sq. mm. PVC insulated FRLS copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

1.17 METERING INSTRUMENT PANEL ACCESSORIES

i. Metering

Digital type Trivector meter of approved make (Smart demand controller) shall be provided on the incomer feeder. Specification of the meter shall be as follows:

Accuracy	: Class 0.5, compliant to revenue class certification
	: Real time measurement per phase & average
	: V, I, PF, kW, kVAR, kVA
	: Peak demand, sliding window. Protected.
	: V & I unbalance, Phase reversal
	: Time of Use (TOU)
Power Quality Measurement	: Total Harmonics
Logging & recording for all measurements	: Interval or event-based, 32 channel measurement & recording Event logging
	: “Bust” data recording
	: Min/ Max recording
Alarming	: Over & under measurement detection by 24 set point functions.
Multiport Communication	: One each of RS 485 and RS 232 ports.

ii. Instrument Panels

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

iii. Instrumentations

- a. Digital type Voltmeter of class 1.0 accuracy and 96 x 96 mm square in size as per IS-1248 shall be provided, with selector switch as required as per BOQ. The instrument shall be calibrated for the ranges specified.
- b. Digital type Ammeter of specified range to class 1.0 accuracy and 96 x 96 sq mm in size as per IS -1248 shall be provided along with necessary selector switches as required as per BOQ.
- iv. The following minimum indication lamps shall be provided in the front of cubicle.

Breaker open/ closed/ tripped, spring charged, trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.
- v. After meeting all necessary control and indication requirements 2 no. NO and 2 no. NC auxiliary of the breaker shall be made available for the owner, wired up to terminal block.
- vi. Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.

vii. Anti-condensation space heaters suitable for operation on 240 V single phas, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

1.18 DRAWINGS/ DOCUMENTS REQUIRED FOR REVIEW/ APPROVAL

Following drawings documents shall be submitted by the manufacturer for approval.

- a. General arrangement (GA) of equipment layout.
- b. Equipment list.
- c. Relay and metering system schematics.
- d. Supply and erection schedule.
- e. Catalogue and specification sheets.

1.19 INSPECTION AND TESTING

After manufacturing of switchgear panels tests shall be carried out on the equipment as per relevant IS and Electricity Regulations.

1.20 QUALITY ASSURANCE

Vendor shall submit in substantial detail a quality assurance plan indicating all activities step by step at various manufacturing/ fabrication stages to meet the requirement of this specification and various standards/ regulations/ practices to enable comprehensive assessment of its merits and reliability.

**2. TECHNICAL DATA FOR SWITCHGEAR CUBICLE TYPE WITH VCB BREAKER
(TENDERER MUST FILL IN THE FOLLOWING TECHNICAL DATA)**

2.1 SWITCHGEAR CUBICLE

- i. Make
- ii. Type
- iii. Reference Standard
- iv. Voltage (System/ Rated)
- v. Phase/ Frequency
- vi. Short Circuit Rating
 - a. Interrupting Symmetrical
 - b. Short time for 1/ 3 sec.

2.2 CONSTRUCTION

- i. Drawout feature for Circuit Breaker with Service Test & Disconnected
- ii. Minimum clear space required at:
 - a. Front for breaker withdrawal
 - b. Rear
- iii. Overall dimension & Operating weight

2.3 BUS BAR

- i. Material & grade
- ii. Reference standard
- iii. Cross sectional area size
- iv. Continuous current at 40 deg C
- v. Max temp rise over for 40 deg C
- vi. Short time current for 1/ 3 sec.
- vii. Min clearance of bare bus bar & connection
 - a. Phase to phase
 - b. Phase to ground

2.4 CIRCUIT BREAKER

- i. Make
- ii. Type
- iii. Rated voltage
- iv. Rated frequency
- v. No. of poles
- vi. Rated current
 - a. Continuous at 40 deg C & withincubicle
 - b. Short time current for 1 sec/ 3 sec

2.5 MAX. TEMP RISE OVER 40 DEG C AMBIENT

2.6 RATED OPERATING DUTY

2.7 INTERRUPTING CAPACITY AT RATED VOLTAGEAND OPERATING DUTY

- a. Symmetrical

2.8 TYPE OF CONTACTS

- a. Main
- b. Arcing

2.9 MIN CLEARANCE IN AIR

- a. Between poles
- b. Between live parts & ground

2.10 OPERATING MECHANISM

- a. Type
- b. No. of breaker operations stored
- c. Trip free or fixed trip?
- d. Antipumping features provided

2.11 CLOSING COIL

- a. Voltage
- b. Permissible voltage variation
- c. Power required at rated voltage

2.12 BREAKER/ BREAKER CUBICLE PROVIDED WITH THE FOLLOWING:

- a. Mech. safety interlocks
- b. Automatic safety shutter
- c. Emergency manual trip
- d. Mech. ON/ OFF indicator
- e. Operation counter
- f. Spring charge/ discharge indications
- g. Manual spring charging facility
- h. Mechanical Antipumping

2.13 NET WEIGHT OF THE BREAKER

2.14 IMPACT LOAD FOR FOUNDATION DESIGN

2.15 OVERALL DIMENSIONS IN MM

3. TESTS

Routine Tests shall be conducted on the HT Panel in accordance with the latest versions of IEC. Type Test certificates for tests conducted earlier on similar equipment shall be furnished.

3.1 TYPE TESTS

Units shall be type tested in accordance with IEC standards 60056, 60129, 60265, 60298, 60420, 60529 and 60694. The following type tests have been performed and available if required

- Short time and peak withstand current test
- Temperature rise tests
- Dielectric tests
- Test of apparatus i.e. circuit breaker and earthing switch
- Arc fault test

3.2 ROUTINE TESTS

Routine tests shall be carried out in accordance with IEC 60298 standards. These tests shall ensure the reliability of the unit.

Below listed test shall be performed as routine tests before the delivery of units;

- Withstand voltage at power frequency
- Measurement of the resistance of the main circuit
- Gas leakage test
- Withstand voltage on the auxiliary circuits
- Operation of functional locks, interlocks, signaling devices and auxiliary devices
- Suitability and correct operation of protections, control instruments and electrical connections of the circuit breaker operating mechanism
- Verification of wiring
- Visual inspection

Tests shall be performed in the presence of Purchaser's representatives. The Contractor shall give at least fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at works shall be furnished. The equipment shall be dispatched from works, only after receipt of Purchaser's written approval of the test reports.

Each completely wired Ring Main Unit shall be tested to ensure that all of its protective, control and interlock systems are satisfactorily functioning in the manner as required.

The Bidder shall indicate tests recommended to be carried out at site during installation and commissioning to ensure satisfactory performance of all the equipment supplied.

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S.No.	Details of Materials/ Equipment	Manufacturer's Name
1.	HT panel	Tricolite (ABB) Ambit (ABB) Sterling & Wilson (Siemens) Advance Panels & Switchgear (Siemens) Adelec (Schneider) Jakson (Schneider) L&T Control & Switchgear
2.	Protection Relays	
	a. Numeric Type	Tricolite (ABB) Ambit (ABB) Sterling & Wilson (Siemens) Advance Panels & Switchgear (Siemens) Adelec (Schneider) Jakson (Schneider) L&T Control & Switchgear
	b. Electromagnetic Type	Areva Easun Reyrolle
3.	Potential Transformer	ECS Jyoti Kappa Matrix Pragati
4.	Current Transformer (Cast Resin Epoxy Coated)	ECS Jyoti Kappa Matrix Pragati
5.	Static Power Meter & Logger (Trivector Meters)	Conzerv System Pvt. Ltd. (Schneider) Cadel Larsen & Toubro
6.	Electronic Digital Meter (A/ V/ PF/ HZ/ KWH) With LED Display	Conzerv System Pvt. Ltd. Cadel
7.	HRC Fuse and Fuse Fitting	Siemens GE Power Control
8.	MCBs	Schneider Siemens L & T ABB Legrand
9.	Indicating Lamps	Siemens Schneider L & T

LIST OF INDIAN STANDARDS (IS)

IS 5: 1994	Colours for ready mixed paint and enamels
IS: 335: 1993	New insulating oils
IS: 1866	Code of practice for maintenance of insulation oil
IS: 2026 - 1977 to 81 (Part I to IV)	Power Transformers
IS: 2099 & 3347	Bushing for alternative voltages above 1000 volts
IS: 2551: 1982	Danger notice plate.
IS 2705 (Part-1): (Second Rev.) 1992	Current transformers – Specification General requirements
IS 2705 (Part-2): (Second Rev.) 1992	Current transformers - Specification Measuring Current Transformers
IS 2705 (Part-3): (Second Rev.)1992	Current transformers - Specification Protective Current Transformers
IS 2705 (Part-4): (Second Rev.)1992	Current transformers - Specification Protective Current Transformers for Special Purpose Applications
IS: 3043 – 1987	Code of practice for earthing.
IS: 3637	Gas Operator Relays
IS: 3639: 1966	Fittings and accessories for power transformers
IS: 4146 – 1983	Application guide for voltage transformers
IS: 4201: 1983	Application guide for current transformers
IS: 4257 Part1: 1981	Dimensions for clamping arrangement for bushings 12KV to 36KV
IS: 5216 – 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS: 5561	Electrical power connectors
IS: 6600: 1972	Guide for loading of oil immersed transformers
IS: 8468: 1977	On-load tap changers
IS: 8478: 1978	Application guide for on-load tap changers
IS: 8603 Parts 1 to 3: 1977	Dimensions of porcelain transformer bushings for use in heavily polluted atmosphere
IS: 9434	Sampling and analysis of free and dissolved gas in oil filled equipments
IS: 10561: 1977	Power Transformers: General
IS: 10028 Part-1: 1985	Code of practice for selection, installation and maintenance of power transformers: Selection
IS: 10028 Part-2: 1981	Code of practice for selection, installation and maintenance of power transformers: Installation

IS: 10028 Part-3: 1981	Code of practice for selection, installation and maintenance of power transformers: Maintenance
IS: 12676	Dimension of OIP insulated condenser bushings
IE Rules, with amendments upto 1995: 1956	Indian Electricity Rules
IEC 44 -1: 1996	Instrument Transformer -P1: Current Transformer
CBIP	Manual on Transformers

APPENDIX-V

ABBREVIATIONS

The following abbreviations have been used in the accompanying Specifications, drawings and Schedule of Quantities.

CU	Stands for copper.
GI	Stands for Galvanized Iron (Mild Steel)
V	Stands for Volts
KV	Stands for Kilo Volts
HV	Stands for High Voltage (33 kV and above)
MV	Stands for Medium Voltage (3.3 kV TO 11 kV)
LV	Stands for Low Voltage (415/ 230/ 110 Volts)
HT	Stands for High Tension
LT	Stands for Low Tension
IEE	Stands for Institution of Electrical Engineers - London
NEC	Stands for National Electrical Code

TECHNICAL SPECIFICATIONS FOR TRANSFORMER

1. OIL FILLED TRANSFORMERS WITH ON CIRCUIT TAP CHANGING SWITCH

1.1 SCOPE

Design, manufacture, testing, supplying and commissioning of 11 kV/ 433 volts (no load voltage) step down, transformer complete with all the accessories and fittings for efficient and trouble free operation.

1.2 CODES AND STANDARD

Transformer shall Conform to Indian Standard IS: 2026-1977 (Part I to IV), IS: 6600-1972, IS: 10028-1985, IS: 8468-1977, IS: 335

1.3 RATING

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

1.4 CONNECTION AND VECTOR GROUP

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11. Connection and Vector group shall be stated in the Data Sheet and Rating plate.

1.5 SYSTEM OF SUPPLY

3 phase, 50 Cycles, 11 kV earthed system.

1.6 TAPPINGS

On circuit tap changing links on HV side. The tapplings to be provided for variation on HV side from (-) 15% to (+) 5% in steps of 1.25 % each.

1.7 TEMPERATURE RISE

Continuously rated for full load, temperature rise not exceeding 45° C by thermometer in oil or 55 Deg C by resistance.

1.8 TYPE

Outdoor type

1.9 TERMINALS

The cable box with glands on H T side shall be suitable for 3 core XLPE cable of specified capacity. Flanges with cable box/ bus duct on LT side shall be suitable for aluminum conductor armoured cables/ LT bus duct of size mentioned in BOQ. All cable glands shall be earthed.

1.10 COOLING

Natural cooling by means of pressed/round tubes around transformer tank

1.11 INSULATION

The transformer shall be oil insulated type. Oil type shall confirm to IS: 335.

1.12 EARTHING

Two earthing terminals shall be provided at the bottom on both sides.

1.13 FITTINGS AND ACCESSORIES

Indicating Platinum resistance type thermometer with alarm & trip contact, temperature sensing relay with alarm & trip contacts and temperature sensing devices (PT 100 type RTD) in each limb shall be provided.

Transparent cover shall be provided for HV tapping so that tapping position (OFF load) can be clearly visible externally.

Limit switches for electrical protection shall be provided on the door. The contact of switches shall be wired upto marshaling box & shall be suitable for 220V DC operation. Marshaling box shall be weatherproof with IP42 rating.

Neutral CT (for transformer secondary winding neutral) secondary terminal shall be brought to marshaling box by vendor. Shorting link shall be provided on marshaling box terminal for CT secondary terminal shorting. Neutral CT shall be provided after neutral trifurcation point and placed in between the trifurcation point and the earthing bus. Neutral CT details are as follows: Ratio 3200/5A, CL. PS, for 64R protection. The CT location in neutral shall be suitable for REF protection. CT details shall be similar to that of CT's supplied by the panel vendor.

Cabling for winding temperature indicator to marshaling box shall be in vendor's scope. Necessary neat cleating arrangement for taking these cables to marshaling box shall be provided on transformer tank by vendor. Inside the marshaling box the contacts of WTD shall be wired with 1.5 sq. mm PVC wires. Contacts of instruments shall be wired to marshaling box in such a way that all alarm contacts shall be placed together. All these contacts of instruments shall be suitable for using in 220V DC Circuit.

Epoxy insulator supports of neutral earthing conductor from neutral busbar to bottom of Transformer shall be provided by vendor

All control terminal blocks shall be of Nylon 66 material preferably of Wago/ Phoenix make, cage clamp type. The CT terminals shall be disconnecting type and all other terminals shall be cage clamp type.

Degree of Protection shall be IP-23. Vendor shall confirm maximum noise level as per IS. Maximum efficiency of Transformer shall occur at 60% load of rated capacity. Gasket protection covers shall be used in all gasketed joint. All gasketed joint shall be endless. LV box inspection cover shall be adequate so that all the parts inside are accessible for maintenance. Transformer design shall be suitable for seismic zone. HV & LV box orientation shall be 180°. Surge arrestor of appropriate voltage rating shall be provided by vendor. Glass fibre enclosure for housing the surge arrestor inside the transformer cubicle shall be provided by vendor. Transformers shall be provided with facilities for lifting the complete transformer as well as for lifting the core and coil assembly.

The transformer shall be capable of withstanding the short circuit stresses due to terminal fault on one winding with full voltage maintained on the other winding for minimum period of two seconds. Transformer shall be of the natural air cooled type.

The transformer shall be free from any annoying hum or vibration. The audible sound level of the transformer shall be limited to the values given in relevant codes & standards. The design shall be such as not to cause any undesirable interference with radio or communication circuits. Sound level shall not be more than 65db from 1 meter.

1.13.1 The following accessories and fittings shall be provided for Transformer

- a) Lifting Lugs: The arrangement for lifting the active part out of the transformer tank along with the cover by means of lifting lugs without disturbing the connections.

- b) Swivel Type Rollers: the transformer to be provided with 4 Nos Bi-Directional rollers fitted on cross channels to facilitate the movement of the transformer in both directions.
- c) Air release Valve: An air release valve is to be provided on the top of the tank cover facilitate the release of the entrapped air and filling of oil.
- d) Oil Conservator: The transformer to be provided with an oil conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purpose of transport. It has to be provided with magnetic oil level gauge and an oil filling hole 1 1/4" BSF size with a cap, which can be used for filtering oil. For draining purpose a plug shall be provided.. A connection pipe between the conservator and the main tank is to be provided which projects inside the conservator and the main tank
- e) Breather: The transformer to be provided with an indicating dehydrating silicagel breather of sufficient capacity.
- f) Drain-cum-oil Filter Valves: The transformer to be provided with a drain-cum-oil filter valve of 1 1/4" BSF size at the bottom of the tank.
- g.) Diagram and rating plate: Diagram and rating plate shall be provided indicating the details of transformer, connection diagram, vector group, tap changing diagram etc.
- h.) Dial type thermometer for Oil (150 mm dia) with maximum set pointer at 75 deg C and electrical contacts for electrical alarm at high temperature.
- i) Winding temperature indication and electrical contacts for trip / alarm.
- j.) Buchholz relay of double float type with high gas pressure alarm & trip suitable for 24 volts DC supply.
- k.) Filter valve of 1 1/4" BSF at top.
- l.) Explosion vent.
- m.) Disconnecting chamber shall be provided for cable termination.
- n) Outdoor type Marshalling box with interconnecting cables
- o) HT Cable box suitable for 3 C x 300 sq.mm HT XLPE (E) cable
- p) LV Cable box suitable for 3 C x 300 sq.mm 1.1 kV XLPE (E) cable or L.V bus duct flange arrangement as per BOQ

1.13.2 The following accessories and fittings shall be provided for OLTC

- a) High Torque Electric motor suitable for 415 Volts, 3 phase, 50 Hz AC supply
- b) Motor drive and energy accumulator
- c) Motor isolating device with over load protection
- d) Contactors for forward and reverse operation of motor
- e) 'Raise/Lower' control for local & remote operation
- f) 'Raise/Lower' Limit switch
- g) Interlock between manual & electrical operation

- h) Auxiliary contacts
- i) Retainer Switch
- j) Tap Position Indicator
- k) Tap operation counter
- l) Stoppers to prevent over travelling of mechanism
- m) Internal illuminating lamp with switch
- n) 'Local/Remote' control selector switch
- o) Auto/Manual selector switch
- p) Anti-condensation heater with switch and thermostat
- q) Handle for manual operation
- r) Driving Mechanism chamber locking arrangement
- s) Terminal Strips
- t) Lubricating Chart
- u) Undrilled gland plate for cable entry

1.13.3 The following accessories and fittings shall be provided for remote indicating

- a) Potentio meter for remote tap position indicator
- b) Contacts for Tap change in progress indication y
- c) Contacts for Upper and Lower limit reached indication
- d) Contacts for Tap change stuck / incomplete indication

1.14 IRON CORE

The magnetic circuit shall be built of transformer grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stamping shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework clamping arrangement and general structure of the cores shall be of robust construction and shall be capable of with sustained any shock to which they may be subject during transport, installation and service. The assembled core shall be securely clamped on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

The core shall be provided with lugs suitable for lifting the complete core and coil assembly.
The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2000 V for one minute.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

1.15 WINDING

The coils used for winding shall be circular in shape made of paper insulated continuous and smooth tinned or enameled electrolytic copper conductors of high conductivity.

Liberal ducts shall be provided to prevent any hot spot temperature in the winding that may adversely affect the life of the equipment. Adequate supports wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short-circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a through shrinking and seasoning process so that no further shrinking of windings occurs during service at site. However, adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short-circuit.

Highly sophisticated design techniques shall be applied to ensure electrical, mechanical and thermal stability. Windings can be Helical and continuous disc type windings to provide maximum strength and short circuit withstand capabilities. The winding coils shall be pressed before core-coil assembly to ensure proper trouble free service. Clamping rings shall be placed on top and bottom of the winding to ensure high axial short circuit withstand capability to the transformer

1.16 OIL SOAK PIT

Suitable capacity Oil soak pit (minimum 30 % oil content) shall be provided for power transformer . Oil from the soak pit shall be safely drained to the common burnt oil pit. Capacity of burnt oil pit shall be such that to hold 110% of the oil content of one transformer

1.17 DRAWING AND LEAFLETS

Three copies of operation and maintenance manual with complete instructions for the installation, operations, maintenance and repairs, circuit diagram, foundation and trenching details shall be provided with the transformer.

1.18 MAXIMUM ALLOWABLE POWER TRANSFORMER LOSSES

Maximum allowable losses for Dry type distribution transformers with highest voltage for equipment upto 33kV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% LOADING	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD
500	1.6	5.5

1.18.1 MEASUREMENT AND REPORTING OF TRANSFORMER LOSSES

All measurement of losses shall be carried out by using calibrated digital meters of class 0.5 or better accuracy and certified by the manufacturer. All transformers of capacity of 500 kVA and above would be equipped with additional metering class current transformers (CTs) and potential transformers (PTs) additional to requirements of utilities so that periodic loss monitoring study may be carried out.

1.19 TESTS

1.19.1 FACTORY ROUTINE TEST

Prior to transformer's dispatch out of the factory, each transformer shall be routine tested (in presence of representatives of the client or their nominated).

The routine tests to be performed shall be:

- Measurement of winding resistance.
- Measurement of voltage ratio and check of voltage vector relationship
- Measurement of impedance voltage/short circuit impedance and load-loss
- Measurement of no-load loss and current
- Measurement of insulation resistance
- Induced over-voltage withstand test
- Separate-source voltage withstand test.
- Partial Discharge test to IEC 270.
- Transformer noise measurement
- Temperature Rise
- Di – Electric Strength of oil

1.19.2 TYPE TEST

In addition to the routine tests, the following type tests may be conducted as per details in IS 2026.

- Lightning impulse-test.
- Temperature rise test.
- Short-circuit test
- Air pressure test
- Unbalanced current test: the value of unbalance current shall not be more than 2% of the full load current.

1.19.3 SITE TEST

Following tests should be witness by the Vendor at Site.

- i. The transformers shall be fully tested on site prior into putting into service to ensure that all items are in proper working condition, correctly installed and free from damage.
- ii. Transformer tap-changers, emergency stop, door interlocks, temperature relays, their controls and all other auxiliary equipment shall be operated to prove that they are functioning satisfactorily before the transformers are put into service.
- iii. Insulation Resistance Test.

Transformers shall be transported with nitrogen filling. Oil (including 10% spare oil) shall be sent in returnable drums for filling at site. Suitable oil filtration machine shall be deployed for filtration/ filling of oil.

Transformer yard shall be provided with gravel filling, small gate for man entry as well as big gate for transformer.

Transformers shall be mounted on rails provided as part of foundation/ soak pit construction. The wall of the soak pit below the transformer shall be raised by min 300mm above FGL to prevent water from nearby areas entering the soak pit. Rail top may be at the same height as the top of soak pit wall (FGL +300mm).

Cable trenches with pre cast shall be provided in transformer yard for power cables and control cables.

1.20 REMOTE TAP CHANGER CONTROL PANEL (RTCC)

Construction Features

RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall conform to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self-threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.

The following components shall be provided in the RTCC panel:

- Digital Tap Position Indicating Meter
- Raise/ Lower Push Buttons for Remote Control of OLTC
- Tap Change in Progress Signal Lamp.
- Supply on Signal Lamp
- Local/ Remote Control Indicating Lamps
- Panel illuminating lamp with door switch.
- Space Heater with Switch and Thermostat.
- Automatic Voltage Relay with Time Delay Element.
- Selectors switch for Auto/ Manual Operation.
- Undrilled Gland Plate for Cable entry.
- Earthing Terminal
- Lifting Eyes Bolts.

2. TECHNICAL DATA FOR TRANSFORMER
TENDERER MUST FILL IN THE FOLLOWING TECHNICAL DATA

<u>S. No.</u>	<u>Technical Parameters</u>	<u>Oil Type</u> 33 kV/ 11 kV11 kV/ 433 V	<u>Dry Type</u>
1.	Type and class of insulation		
2.	Output in KVA (Continuously rated)		
3.	Rated Voltage		
	a. HV (Volts)		
	b. LV (Volts)		
4.	No. of phase		
5.	Type of cooling		
6.	Frequency		
7.	Winding Connection		
8.	Tapings		
9.	Vector Group		
10.	Ref. Ambient temperature		
	Temperature rise winding		
	Class of insulation		
11.	Physical Dimensions		
	a. Length (in mm)		
	b. Width (in mm)		
	c. Height (in mm)		
12.	% Impedance		
13.	Iron losses at normal voltage ratio		
14.	Copper loses at normal voltage ratio at full load		
15.	Efficiency at unity power factor		
	a. Full load		
	b. 75% load		
	c. 50% load		
16.	Regulation at unit power factor		
17.	Regulation at 0.8 power factor		
18.	Approximate weight		
	a. Core & winding (Kgs.)		
	b. Total Weight (Kgs.)		
19.	Oil (Ltrs)		

68. TECHNICAL SPECIFICATIONS FOR SECURITY SYSTEM

A. CLOSE CIRCUIT TELEVISION SYSTEM (CCTV)

1. SYSTEM REQUIREMENT

The CCTV System shall be real time system consisting of Day Night P/T/Z Cameras, indoor varifocal cameras, recorders, matrix and monitors.

The proposed solution shall not require proprietary computer, server, and network or storage hardware.

The proposed system shall be of a manufacturer with as minimum of five (5) years of experience and offerings in the IP network video software market, the letter stating the same should be submitted by the manufacturer.

The VMS system shall be based on the latest in software programming technology Microsoft .NET frame work. No old technology shall be permitted looking at the future up gradations and service support for the system.

The IBMS contractor shall provide infrastructure for distribution of power to each camera from the control monitoring station. Incoming power cable shall be terminated at one location inside central monitoring station by electrical contractor. Receiving of power at main control panel and further distribution shall be contractor respectively.

All components as mentioned below to be provided with connectors and outputs for providing a seamless Digital CCTV & Access Control Network.

All cameras shall be UL listed models only.

Quoted price shall be inclusive of gold plated connecting leads, connectors, jumpers, nuts, screws, bolts, mounting plates/brackets, back boxes etc and as required to make the system complete and operational in all respects complete as per specifications and as required.(Detailed cut-sheets, catalogues, colours to be provided for Components being quoted alongwith the tender)

The switches may be procured through the Client's IT team, if required and vendor shall provide all technical specifications for the same before ordering and approval shall be obtained from Engineer-In-Charge. However, Quoted price shall be inclusive of the cost of Switches.

2. SYSTEM OBJECTIVE

- a. To enable the important areas of the premises to be remotely monitored.
- b. To enable sensitive areas to be scanned from pre-selected position.
- c. To enable automatic recording by Digital Multiplex Recorder on hard disk and to play back the recorded events on selected monitors & back-ups of the events on CD.

3. REAL TIME RECORDER

- a. The system shall have the capability to handle 16 video inputs at real time, 400fps, IP enabled and 2 monitor outputs with a facility to have the control from the Security Control Centre.
- b. It shall be capable to support PTZ controllers as required (Select camera view, multi-screen view)
- c. It shall be possible to monitor the whole premises from the Security Control Room
- d. Operator interface to the system shall be through keyboard / CCTV Control Panel in the Security Control.

- e. It shall be possible to programme multiple system features including functions such as monitor sequence, camera dwell, camera tour, by-pass and restore cameras and alarms.
- f. The system shall have high speed operation, automatic reboot from power loss, automatic configuration down loading.
- g. The system shall be capable of displaying the system status on high resolution monitor.
- h. The system programming shall be password protected and shall have different levels of passwords for programming.
- j. All cameras and the integrated CCTV System equipment shall be designed for continuous operation.

4. HARDWARE MPEG4 ENCODER

The Encoder should convert Analog Composite / S-Video input into good quality MPEG4 stream and able to transmit as Unicast / Multicast IP packet with low latency. The Encoder should have the following specifications or should match with the requirement.

Encoder with

Video Input - Four composites, 1Vpp into 75 ohms (NTSC/PAL)

Resolution Scalable from CIF to 4CIF 352x240 to 704x480 NTSC, 352x288 to 704x576 PAL per channel

Compression - Dual stream MPEG-4 per channel

Compression - Dual stream MPEG-4 per channel

Frame Rate 1-30 FPS Programmable NTSC (full motion) - CIF, 2CIF and 4CIF 1-25 FPS Programmable PAL (full motion) - CIF, 2CIF and 4CIF

Interface Ethernet 10/100Base-T Connector RJ-45

IGMP Multicast network protocol enabled

Protocols Transport: RTP/IP, UDP/IP, TCP/IP with full multicast support. DNS and DHCP

Security SSL-based authentication

Bandwidth Each stream is configurable between 30 Kbps and 4 Mbps for a total of 6 Mbps per cam-era (dual streaming - viewing and recording combined)

Input 12 dry contacts, Output 3 Relay Contact, 48V AC/DC at 100 mA max.

Bi-directional Audio (EA) Input: -46 to -3 dBV into 1 kOhm, Output: -46 to -3 dBV into 16 ohms minimum, Connectors: One set of 0.14 in. (3.5 mm) input and output stereo jacks

Communication Protocols Port 1: RS-232 (maximum 230 Kbps) Port 2: RS-422/485 2/4 Wires (maximum of 230 Kbps)

Configuration Remote: Via Video management software and standard web browser Local: Telnet via the serial port using any ASCII Terminal

Firmware Upgrade - Flash memory for upgrade of encoders and application firmware over the network

Power - 12VDC , 25W

19" 1U (1.75") high rack mount enclosure

Operating Temp: 32° F to 122° F (0° C to 50° C)

Humidity : 95% (Non-condensing)

5. LAYER -2 MANAGEABLE SWITCH

Number of ports	24 No. 10/100 base-TX RJ45 ports 2 Combo 1000 base T/SFP with 1 No single mode 1000 base Fiber LX duplex port module
Switch Fabric	8.8 Gbps
Packet forwarding	6.6 Mbps
Transmission Method	Store and forward
MAC Address Table	8 K entries per device
MAC Address learning	Dynamic entries : automatic update, static entries : user defined
Packet Buffer Memory	16 Mbytes per device
Power Supply	AC 230 V @ 50 Hz

6. LAYER -3 MANAGEABLE SWITCH

Number of ports	12 No single mode 1000 base . Fiber LX duplex port module (16 po (to converge Fibre cable from Encode L2 Switches and existing Lai 12 Nos 10/100/1000 base TX RJ 45 port to connect to L2 switch upl
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and NVR box

Switch Fabric	48 Gbps
Packet forwarding	35 Mbps
Transmission Method	Store and forward
MAC Address Table	16 K entries per device
Packet Buffer Memory	16 Mbytes per device
Power Supply	AC 230 V @ 50 Hz

7. NETWORK VIDEO RECORDER (NVR) /NETWORK ATTACHED STORAGE (NAS)

NVR/NAS box should be used to record the video streams which are viewed and monitored. The video streams should be recorded based on the control settings assigned by the administrator using video Surveillance control software. Control Room and Engineer-In-Charge should be able to access the recorded video streams. The NVR/ NAS should support simultaneous play back and recording at full duplex operation

It shall provide a high quality recording storage and play back of images. It should support integration with LAN to provide Centralized Management and shall operate on Windows/ Linux O/S. Support of user management for security level control and authentication required. This NVR/NAS boxes should have the following features and specifications.

NVR– (Capacity to be decided by Vendor)

Onboard CPU	Xeon 3.0 GHz Dual processor capable or greater
Onboard Memory	4 GB DDR SDRAM
Drive Capacity	2.5 TB, IDE/SATA/SCSI @ 7200rpm with RAID 5
Network Interface	Dual Gigabit Ethernet
Storage Box interface	Ultra 320 SCSI interface

Storage Array – XX TB External Interface	Dual U 320 SCSI interface on controller
Disk Interface	To support 3 Gbps SATA drives
Raid Management	0, 1,5,10 and JBOD, Hot spare drive operation, multiple raid selection, Inline Array Expansion.
Array Management	RS 232, Ethernet using integrated software.
Form Factor	Rack Mount design
Network Transport Protocols	TCP/IP, IPX (Internet work Packet Exchange)
Network File Protocols	CIFS (Common Internet File System), NFS (Network File System), HTTP/HTTPS, FTP, NTP (Network Time Protocol), SNMP (Simple Network Management Protocol), SMTP (Simple Mail Transport Protocol), DHCP (Dynamic Host Configuration Protocol) and DNS (Domain Name System/Service).
Secured Administration Access	Administrator can use Secure Sockets Layer to Connect the NVR and Configure NVR to Respond Only to SSL for Configuration.
Drive Status / Space Monitoring	Supported
Network Client Support	Microsoft Windows, Linux
Power supply	AC 230 V @ 50Hz

OR

NAS – Capacity to be decided by the vendor

The specifications for each unit are as follows:

Onboard CPU	Xeon 3.0 GHz Dual processor capable or greater
Onboard Memory	4 GB DDR SDRAM
HD Drive	IDE/SATA/SCS @7200rpm with RAID 5
Host Interface	Dual Gigabit Ethernet
Network Transport Protocols	TCP/IP, IPX (Internet work Packet Exchange)
Network File Protocols	CIFS (Common Internet File System), NFS (Network File System), HTTP/HTTPS, FTP, NTP (Network Time Protocol), SNMP (Simple Network Management Protocol), SMTP (Simple Mail Transport Protocol), DHCP (Dynamic Host Configuration Protocol) and DNS (Domain Name System/Service).
Secured Administration Access	Administrator can use Secure Sockets Layer to Connect the NVR and Configure NVR to Respond Only to SSL for Configuration.
Drive Status / Space Monitoring	Supported
Network Client Support	Microsoft Windows/ Linux
Power supply	AC 230 V @ 50Hz

8. **PCs FOR VIDEO SURVEILLANCE ADMINISTRATION / CLIENT SOFTWARE**

FEATURES	DESCRIPTION
Processor	Intel Dual Core Pentium D Procesor 3.2 Ghz with EM 64 Technology
Memory	1 GB (2 x 512 mb) dual channel DDR2 533 memory, Upto 8 GB Max.memory expandable through four DIMM slots
Cache (External)	2 x 2 MB L2 Cache
ROM	512 MB Flash ROM, Can be upgraded from a diskette
Expansion Bus	2 No PCI Express (x1), 4nos 32 bit PCI slots, 33 MHz PCI 2.2 slots, 1-graphics slot
Graphic Accelerator	N-vidia Quadro FX 4400(DVI/VGA)with 512 MB Memory with dual monitor capable graphics card
Hard Disk	160 GB 7.2K rpm SATA hard disk
Power Supply	375 W switchable/50 Hz with dual power supply provisions
Keyboard	Cordless 104 keys window 98 keyboard, PS/2 Compatible
Operating System	Supports Windows XP, OS/2 Warp, Windows NT, DOS 6.22
Software	WindowsXP Professional and Windows 2000, Microsoft Internet Explorer
Power Management	EPA compliant
Desktop Manager	Based on SNMP protocol
Antivirus Software	PC-Cilin or equivalent pre-loaded
Diagnostic Software	PAQ 95 or equivalent pre-loaded
Network	Broad cam 10/100/1000 Mbps Ethernet adapter Network Interface Card with wake on LAN support
Interfaces	1 parallel, 8 USB 2.0, 1 serial, 2 Ultra ATA/100,2 optional IEEE1394, 1 PS/2 Keyboard, 1 PS/2 Mouse, 1 video, 1 Microphone jack, 1 Line-in jack, 1 RJ-45, 1 Headphone jack & 1 line-out jack (analog/SPDIF digital
Audio Card	Integrated AC 97/16 bit Stereo full-duplex and integrated speaker
Mouse	Cordless Mouse
Monitor	Monitors shall be with a minimum 19 inch color TFT flat panel display.
CD DVD Writer	DVD/CD-RW Combo Drive with speakers

FEATURES	DESCRIPTION
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9. PC FOR VIDEO WALL DISPLAY

CPU	Pentium® 4 Dual Processor 3.2 GHz, 800FSB, 512KC
Mother Board	Intel Original Mother Board
Memory	1 GB DDR RAM
Hard Drives	80 GB IDE @ 7200RPM
CD-Rom Drive	52x
AGP slot	1
Network Adapter (NIC)	Integrated 10/100/1000 Base –T
Sound Card	In- Built
PCI slots	Min 6 nos. on mother board
USB	2 nos. at front panel
Keyboards	Cordless Keyboard
Mouse	Cordless Mouse
Operating system	Windows 2000/XP

10. LCD MONITORS for VIDEO WALL

Picture tube	21” Flat Screen Colour
Aspect ratio	16:9
Resolution	1024 x 768
System	PAL
Input	VGA port
Operating voltage	AC 180-230 V, 50 Hz \\

11. DIGITAL VIDEO SURVEILLANCE SERVER CONTROL SOFTWARE

11.1 GENERAL

- a. The Network Video Management System shall be a software based solution running on standard off-the-shelf computer server and communicating over Ethernet network using the TCP/IP network protocol.
- b. The proposed solution shall not require proprietary computer hardware.
- c. The proposed solution shall be based on Windows™ 2003 Server Operating System or higher.
- d. The NVMS shall be designed as a distributed architecture for a fully redundant operation. The following redundancies shall be basic features of NVMS.
 - i. Redundant recording shall be a basic feature of the NVMS
 - ii. Failover recording capabilities shall be a basic feature of the NVMS
 - iii. Distributed recording capabilities shall be a basic feature of the system
 - iv. Distributed main Database shall be a basic feature of the system. The system shall not be based on a single database and rather on a database failover architecture.
- e. The NVMS system shall be based on the latest in software programming technology and shall be based on Microsoft .NET frame work.
- f. The NVMS system shall support both analog and IP enabled cameras
- g. Support of analog cameras shall be done using Camera Encoder Video Servers and shall not require the installation of video capture cards
 - i. The NVMS shall support both NTSC and PAL video formats
 - ii. The NVMS shall support video both from analog and IP fixed color/B&W cameras, PTZ/Dome cameras, infrared cameras, X-Ray cameras, low light/IR cameras, and any other camera that provides a composite NTSC/PAL 1 v p-p video signal.
- h. The NVMS shall support multiple Video Servers (Encoders) and Monitor Decoders technologies to interface with analog cameras and PTZ domes.
 - i. The NVMS shall support the JPEG video format
 - ii. The NVMS shall support the M-JPEG video format
 - iii. The NVMS shall support the MPEG-4 video format
 - iv. The NVMS shall support the MPEG-2 video format
 - v. The NVMS shall support all the above video compressions simultaneously.
- j. The NVMS shall sustain full operation using CIF, 2CIF, VGA, 4CIF and Megapixel video resolutions
 - i. The NVMS shall be able to support all cameras at the maximum frame rate and the maximum resolution while maintaining less than 80% load on the Server
- k. The NVMS in addition to Video shall provide full Audio monitoring and recording functionality

- l. The NVMS shall allow for 2-way audio communication using the audio interface
 - i. The NVMS shall provide the ability to communicate back to an audio enabled Encoder, Decoder or IP camera and provide an IP based Intercom
- m. The NVMS Audio function shall be available as independent sources and/or synchronized with video
 - i. The NVMS shall allow the use of audio inputs for Audio recording of telephone lines, microphones, radio systems or any other analog audio interface.
 - ii. The NVMS shall allow for audio search by date, time and alarm event with or without association to video.
- n. The NVMS video storage shall be capable of storing forty (40) cameras on each of the video archive servers each at 30 images per second NTSC/ 25 PAL, at 704x480 NTSC and 704x576 PAL video resolution.
- o. The NVMS shall be based on the TCP/IP communication protocol between all IP cameras, camera Encoders, monitor Decoders, Network Video Management Software and Media Storage Servers
 - i. The NVMS shall also support the UDP/IP network protocol.
- p. The NVMS storage system shall be based on advanced recording methods and shall not rely on the Windows Operating System to manage the storage.
- q. The NVMS shall provide the coactivity to an external storage system
- r. The NVMS storage option as a minimum shall provide RAID-5 redundancy
- s. All storage redundancy and mirroring capabilities shall be done using hardware interface and shall not rely on the Windows Operating System to perform these functions
- t. The network based video recorder server (Media Storage Server) shall as a minimum provide multi-video compression support in addition to the base MPEG-4 and shall simultaneously record video from MPEG-2, MPEG-4 video , Jpeg and M-Jpeg image compression algorithm standards.
- u. The NVMS shall allow for specific cameras to be set at the most optimized recording technique, MPEG-2, MPEG-4, J-PEG or M-JPEG, and should be available for live monitoring and recording signals.
- v. The system shall be flexible and as a minimum the compression scheme shall be able to run in one of several bandwidth selections. Bandwidth options shall include but not be limited to:
 - i. 64 Kb;
 - ii. 128 Kb;
 - iii. 256 Kb;
 - iv. 384 Kb;
 - v. 512 Kb;
 - vi. 786 Kb;
 - vii. 1.5 Mb;
 - viii. 2MB;
 - ix. 3MB; and
 - x. 4MB.
- w. The system shall allow the recording, live monitoring, playback of archived video audio, and data simultaneously

- x. The NVMS shall allow the user to view live video at 30 fps NTSC/ 25 PAL while recording at a lower frame rate for more efficient video storage.
- y. The NVMS shall allow the user to view live video at High resolution 4CIF while recording at a lower CIF or 2CIF for more efficient video storage.
- z. The NVMS client application shall support multiple flat panel monitors to be connected to a single computer.
 - i. Each monitor shall have independent controls and shall support multi views up to 16 real time camera views.
- aa. The NVMS client application shall allow each user with the ability to view 32 cameras on a single PC all at 30fps NTSC/ 25 PAL
 - i. The system shall maintain the capability to add additional flat panel monitors for other applications.
- ab. The NVMS shall provide unlimited analog video outputs through the IP monitor Decoders.
- ac. The NVMS shall provide the user with the ability to fully control the system using PC based keyboard or mouse.
- ad. The NVMS shall offer a plug and play type hardware discovery service with the following functions:
 - i. Automatically discover devices as they are attached to the network
 - ii. Discover devices on different network segments including the Internet and across routers.
- ae. The NVMS shall provide a reporting utility for tracking but not limited to the following options. Video and images shall be stored with reports for documenting events.
 - i. Alarms
 - ii. Incidents
 - iii. Operator logs
 - iv. Service requests
- af. The IP Based NVMS shall provide file export tool for export of single frames of video in J-PEG and BMP file formats and for export of motion video files in AVI file format for transport and playback on computers utilizing a Windows environment
- ag. The NVMS shall allow for each of the system Media Storage Servers to be set for fail over recording or redundant recording independently.
- ah. The NVMS database and video storage shall be based on SQL Server 2000 or better
- aj. The NVMS database shall be design as a distributed architecture and shall not introduce a single point of failure.
 - i. All database information shall be stored in multiple locations simultaneously and shall not require manual or automated synchronization.
- ak. The IP Based NVMS shall allow for installation of Anti-Virus and network security Software
- al. The NVMS shall be based on a client – server architecture.

- am. Increase of storage size should not be restricted by software licensing from DVMS software OEM. If the offered software restricts the storage size by DVMS licensing then licenses should be provided for unlimited storage size.
- an. It should be possible to upgrade the system with more video analytics features in future if required.
- ao. The DVMS shall provide the ability for real time video calibration “stitching” tools providing panoramic video view of areas that are covered by multiple cameras as a single image. The video stitching software shall provide the ability to “stitch” up to eight (8) cameras in any direction, horizontal, vertical and overlay to provide a single view of the selected cameras.
- ap. **It should be possible to use more analytics features in future if required.**
 - i. Video Motion Detection (VMD) and Non-Motion Detection (NMD) which includes multiple trip-wire detection rules, multiple video detection zones, unattended object and illegally parked vehicle detection
 - ii. Video Analytics for people and car counting
 - iii. Video Analytics Behavior recognition including tailgating detection, loitering detection and grouping detection (group can be defined to be up to five people)
 - iv. Video Analytics for Crowd detection package (crowd is defined by percentage of area covered)
 - v. Video Analytics Object removal detection
 - vi. Video Analytics PTZ Camera Control - PTZ camera control for object tracking
 - vii. Video Analytics VMD Detection over PTZ Camera Presets

11.2 NVMS SERVER SOFTWARE

- a. The NVMS software shall consist of an MS-SQL based Main Server Database Server, Media Storage Server (audio and video storage), Digital Virtual Matrix, Internet Video Broadcasting Server, Incident Reports, Alarm Management, Network Management System and Watchdog modules
- b. The NVMS SQL based Database Server shall offer the capability to be installed on multiple servers to enable distributed architecture on the LAN or WAN
- c. The NVMS Database Servers shall not limit the number of Media Storage Servers which can be networked together to form a distributed video management and recording system
- d. The NVMS Database Server shall maintain a catalog of settings for all the clients, servers, encoders, decoders and IP cameras in the system
 - i. The Server shall enable the client to dynamically create connections between Encoders and Decoders and view live or recorded video on the digital VGA monitors (audio, video, serial ports and digital I/Os)
 - ii. The Server shall provide the client seamless operation of all Encoders and Decoders available in the system regardless of the actual connection to different archive servers.

- iii. The Server shall detect signal loss and have the capability to alert the systems administrator
- iv. The Server shall receive all incoming events (motion detection and triggered digital input and relay output) in the system and take appropriate actions based on user-defined event/action relationships.
- v. The Server shall create an audit trail of all events and user activities.
- vi. The Server shall perform dynamic bandwidth management.
- vii. The Server shall authenticate users and give access to the NVMS Monitor Client application based on predefined user access rights.
- e. The NVMS Media Storage Server shall offer the capability to be installed multiple servers software on multiple Computer Servers to enable distributed archiving architecture on the LAN or WAN
- f. The NVMS shall provide a Failover Server Database Server module for system redundancy
 - i. The Failover Server shall synchronize its configuration database with the main Server database.
 - ii. The Failover Server shall take over the NVMS main Server operations in the event there is network or main Server failure.
 - iii. The NVMS shall support multiple Server failovers.
 - iv. The NVMS shall allow for each of the system Failover Directories to operate independently.
- g. The NVMS Media Storage Server shall support all camera connections indicated in BOQ, through video Encoders or IP cameras, all recording at 30fps NTSC/ 25PAL
- h. The NVMS shall record all video from all cameras, Encoders and IP cameras, in the native video format of each (e.g. Mpeg-4, MPEG-2 or M-Jpeg video compressions)
- j. The NVMS shall record all video in real time simultaneously at bandwidth ranging from 8 Kb/sec to 4 Mb/sec, frame rates ranging from 1fps to 30fps NTSC/25PAL and resolution ranging from CIF (352X240 NTSC, 352x288PAL) to 4CIF (704X480 NTSC, 704x576PAL).
- k. The NVMS shall be able to set each camera frame rate, bit rate and resolution independently from other cameras in the system, and altering these settings shall not affect the recording and display settings of other cameras.
 - i. The NVMS shall utilize multicast network communication for video monitoring.
 - a. Unicast based equipment will not be considered as an approved equal for alternate system
- l. The NVMS shall require no proprietary hardware for video and audio recording servers.
- m. The NVMS shall not utilize any hardware or software multiplexer or time-division technology for video or audio recording and monitoring.
- n. The NVMS shall provide a Failover Media Storage Server module for system redundancy
 - i. The Failover Archive Server shall synchronize its configuration database with the Server Database Server.

- ii. The Failover Archive Server shall take over the NVMS Archive Server operations in the event there is any system Archive failure.
- iii. The NVMS shall support multiple Media Storage Server failovers.
- iv. The NVMS shall allow for each of the system Failover Archive Server to operate independently.
- o. The NVMS shall provide a Redundant recording module for system redundancy
 - i. The redundant recording shall record all video in multiple server, mirroring recording, and shall synchronize all setup and configuration databases with the mirrored server(s).
 - ii. The NVMS shall support multiple redundant recording servers.
 - iii. The NVMS shall allow for each of the system Media Storage Server to be set for redundant recording independently.
- p. The NVMS shall support a built-in Digital Video Matrix Switcher
 - i. The Virtual Matrix Switch shall provide a full matrix operation of IP video to analog output.
 - ii. The Virtual Matrix Switch shall provide a full matrix operation of IP video to digital monitors.
 - iii. The Virtual Matrix Switch shall have the capability of creating camera sequences with the following functionalities:
 - a. Each Sequence shall have capability upto 500 cameras.
 - b. Each camera in the sequence shall have its own individual dwell time, from 1 to 60 seconds.
 - c. Each entry in a sequence shall have the capacity to trigger PTZ camera presets, patterns or auxiliaries.
 - d. Multiple users shall be able to view the same camera sequence simultaneously, not necessarily synchronized one with the other
 - iv. The NVMS Virtual Matrix Switch shall have the capability to create and execute Visual Basic (VB) or .NET scripts on events or on schedules.
 - v. The NVMS Virtual Matrix Switch Macros shall give the Server Services the capacity to perform the following:
 - a. Interface with Access Control Systems
 - b. Interface with Point of Sale Systems
 - c. Interface with Alarm Systems
 - d. Interface with Process Control Systems
 - e. Interface with Building Management Systems
 - f. Automate user/client operations

- vi. The Virtual Matrix Switch shall have the capacity to interface with legacy video walls via a CCTV keyboard connected to Encoder, Decoder or the client PC
- q. The NVMS shall support an Internet Video Broadcast server (IVB)
 - i. The IVB shall act as a proxy for NVMS client, Media Storage Servers and web based clients connecting to the NVMS system via the Internet.
 - ii. The IVB shall act as a Gateway for network topologies that restrict a client from receiving the multicast UDP video and audio streams directly from the Encoder/Decoder,
 - iii. The IVB shall communicate the streams via a unicast, UDP or TCP transmission protocol.
 - iv. The NVMS shall support video motion detection module
 - v. The NVMS Media Storage Server shall perform Video Motion detection on each individual camera based on a grid of 1320 motion detection blocks.
 - vi. The NVMS Media Storage Server motion detection shall allow for multi zone masking.
 - a. It shall either be set to full screen, one zone (all 1320 block activated), or a custom motion mask can be configured with multiple zones by selecting any number of available blocks.
 - vii. The NVMS Media Storage Server motion detection sensitivity shall be adjusted by configuring the amount of motion required to trigger an alarm and the amount of time that the motion is present.
 - viii. The NVMS Media Storage Server motion detection sensitivity shall be adjusted by configuring the amount of motion after trigger is required to stop the alarm and the amount of time that the motion is present.
 - ix. The NVMS Media Storage Server motion detection shall provide a learning mode allowing the system to automatically learn the motion in the selected detection zone and subsequently use motion in the “learned” area to trigger motion alarm
- r. The NVMS shall support a built-in Watchdog module
 - i. The Watchdog shall monitor operation of all services and automatically restart them if they are malfunctioning.
 - ii. The Watchdog shall be responsible for restarting the application or in a last resort restart the server in case of malfunction of software components
- s. The NVMS shall provide a full interconnectivity between analog matrix operations and IP video to analog and digital outputs.
- t. The NVMS shall have the capacity for unlimited analog video inputs and outputs.
- u. The NVMS shall have the capability to program each IP viewing station to view and control selected cameras only.
- v. The NVMS shall provide a Windows based GUI (Graphical User Interface)
- w. The NVMS shall provide operation on multiple VGA monitors connected to a single PC using standard hardware and software.

- x. The NVMS shall be based on a true open architecture that allow for use of non-proprietary PC and storage hardware that shall not limit the storage capacity and shall allow for gradual upgrades of recording capacity
- y. The NVMS shall digitally sign recorded video using 248-bit RSA public/private key encryption.
- z. The NVMS shall allow for changing the encryption key.
- aa. The NVMS Shall support management and control over unlimited satellite sites.
- ab. The NVMS shall provide alarm dry contact interfaces to allow for any alarm input initiating any action in the NVMS system.
 - i. The NVMS shall transmit dry contact information over the IP Digital Transmission Network.
- ac. The NVMS shall provide a serial interface for alarm input to allow for any alarm input initiating any action in the NVMS system.
- ad. The NVMS shall transmit alarm serial information over the IP Digital Transmission Network.
- ae. The NVMS Shall support full duplex audio communication and transmission signals over the IP Digital Transmission Network.
- af. The NVMS shall provide alarm management module.
 - i. The alarm management shall be able to set any monitor or groups of monitors to automatically display cameras in response to alarm inputs.
 - ii. The alarm management shall be able to reset automatically or manually alarmed video.
 - iii. The alarm management shall allow for multiple modes of alarm handling capability, these modes to be programmed within the same system.

12. DIGITAL VIDEO SURVEILLANCE CLIENT CONTROL SOFTWARE

- a. The NVMS client shall consist of Administrator Tool application, a Monitoring application, an Archive Player application, a Web Monitoring access, a Web Archive Player access and a Mobile Monitor application.
- b. The NVMS client shall perform the following applications simultaneously without interfering with any of the Storage Server operations (Recording, Alarms, etc.):
 - i. Live display of cameras
 - ii. Live display of camera sequences
 - iii. Control of PTZ cameras
 - iv. Playback of archived video
 - v. Retrieval of archived video
 - vi. Instant Replay of live video
 - vii. Use of graphical controls (maps)
 - viii. Use of procedures (Macros)
 - ix. Configuration of system settings
 - x. Execution of system macros
 - xi. Events Back-ups
- c. The NVMS client applications shall support any form of IP network connectivity, including: LAN, WAN, VPN, Internet, and Wireless (WiFi and Cellular) technologies.
- d. The NVMS client applications shall support IP Multicast (UDP) and Unicast (TCP or UDP) video streaming.
- e. The NVMS client applications shall automatically adapt to the network topology and use the best available method to receive streaming video.
- f. The NVMS client applications shall provide an authentication mechanism, which verifies the validity of the user.
- g. NMRS Client MONITOR Application
 - i. The Client Monitor application shall allow for live monitoring of video and audio.
 - a. The Monitor shall enable view of 1 to 4 video tiles simultaneously on a single SVGA (1024x768) monitor at 30fps per camera.
 - b. The Monitor shall enable view of up to 8 video tiles simultaneously on a computer supporting dual SVGA (1024x768) monitor outputs at 30fps per camera.
 - c. The IP Based NVMS Shall provide on each of the VGA monitors independently the following tile views:
 - 1. Full screen
 - 2. Quad
 - 3. 3x3 (9-view)
 - 4. 4x4 (16-view)
 - 5. 1 + 9 (One large and 9 small view)
 - 6. 1+11 (One large and 11 small view)
 - 7. 1+12 (One large center tile and 12 small view)
 - 8. 1+15 (One large and 15 small view)

- ii. The NVMS Monitor application shall allow operators to view an instant replay of any camera.
 - a. The operator shall be able to define the amount of time he wishes to go back from a predefined list or through a custom setup period.
 - b. The operator shall be able to control the playback with play, pause, forward, and speed buttons.
- iii. The NVMS Monitor application shall allow operators to add bookmarks or to switch their instant replay view into the Archive Player application, for advanced operations, by clicking on a single button in the Instant Replay tab.
- iv. The operator shall be able to choose and trigger an action from a list of available actions included but are not limited to:
 - a. View camera in a video tile
 - b. View camera on a Decoder (analog monitor)
 - c. View Map or procedure in a video tile
 - d. Starting/stopping PTZ pattern
 - e. Go to PTZ Preset
 - f. Sending alert messages
 - g. Sending e-mails
 - h. Send/receive messages through a serial data stream
 - j. Executing a macro
- v. The NVMS Monitor application shall provide management and control over the system using a standard PC mouse, keyboard.
- vi. The NVMS Monitor application shall display all cameras attached to the system regardless of their physical location on the network.
- vii. The NVMS Monitor application shall display all camera sequences created in the system.
- viii. The NVMS Monitor application shall allow for unlimited cameras sequences, which can be run independently of each other on either digital VGA monitor tiles or analog CCTV monitors.
- ix. The NVMS Monitor application shall allow operators to control (Pause/Play, skip forwards, skip backwards) Camera Sequences, without affecting other operators' ability to view and control the same sequence.
- ix. The NVMS Monitor application shall display all cameras, sequences and analog monitors in a logical tree.
- x. The NVMS Monitor application operator shall be able to drag and drop a camera from a tree of available cameras into any video tile or an analog monitor icon for live viewing.
- xi. The NVMS Monitor application operator shall be able to drag and drop a camera sequence from a tree of cameras into any video tile or an analog monitor icon for live viewing.
- xiii. The NVMS Monitor application shall support Graphical Site Representation (Maps) functionality, where digital maps are used to represent the physical location of cameras and other devices throughout facility.
 - a. The NVMS Maps shall have the ability to contain hyperlinks to create a hierarchy of interlinked maps.
 - b. The NVMS Maps shall be able to import maps from any graphical software supporting BMP, JPEG and/or GIF image formats.

- xiv. The NVMS Monitor application operator shall be able to drag and drop a camera from a map into a video tile for live viewing.
 - a. The operator shall be able to click on an icon in a map to initiate PTZ camera preset, run PTZ pattern, view camera in an analog monitor or send an I/O stream.
- xv. The NVMS Monitor application shall support the procedure functionality, where procedures can be triggered to appear during a certain event and can be used to provide detail written or verbal instructions to the operator as to the actions to be taken.
- xvi. The NVMS Monitor application shall support touch screen technology
- xvii. The operator shall be able to optimize the monitor for touch screen technology
- xviii. The NVMS Monitor application shall support digital zoom on a fixed camera's live video streams
- xix. The NVMS Monitor application shall support digital zoom on a PTZ camera's live video streams
- h. Each workstation running the IP Based NVMS client application shall be able to use a CCTV keyboard that can control the entire set of cameras throughout the system, even if the system consists of motorized cameras produced by different manufacturers.
 - i. The NVMS client shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including cameras of various manufacturers' brands, including their PTZ functionalities (i.e.: one keyboard manufacturer controls other manufacturer's dome or vice-versa).
 - ii. The NVMS client shall allow for a CCTV keyboard to be attachable directly to a encoder/decoder via its serial port.
 - iii. The NVMS client shall allow for a CCTV keyboard to be attachable directly to the PC running the NVMS client application via its serial port.
 - iv. The NVMS client CCTV Keyboard Interface shall provide full PTZ control.
 - a. The operator shall be able to control pan-tilt-zoom, iris, focus, dome relays and dome patterns
 - b. The NVMS client software shall allow the operator to access the PTZ configuration menus with no need of additional hardware.
 - c. The NVMS client software shall allow for operator PTZ priority ranging from 1 to 255
 - 1. This shall prioritize which operator has control over a camera vs. another operator trying to control the same camera at the same time.
 - v. The NVMS client CCTV Keyboard Interface shall provide full video matrix operations
- j. The NVMS shall support full control for PTZ (Pan Tilt and Zoom) cameras.
- k. Access Control Alarm Receiver Module

The DVMS shall provide a integration interface to access control using well defined SDK. The SDK for third party (Other system manufacturers involved in this project) should be provided along the system without any additional cost which will enable them to develop the

software interface with CCTV system. Access control system should be seamlessly integrated with CCTV system since the beginning of the system implementations.

13. UNINTERRUPTED POWER SUPPLY:

A. Features On Line

- Built in protection against over voltage, overload, spikes transients and battery discharge.
- Alarm for battery operation.
- Rating of 15 KVA
- 15 Minutes SMF battery backup at full load operations.

INPUT

- Input 230 V AC single phase.
- Frequency: 50 Hz \pm 5 %

OUTPUT

- KVA : 15 KVA
- Voltage : 230 V AC
- Voltage Regulation : 0.5 %
- Freq. Regulation : 50 Hz \pm 5 %
- Overload : 150 % for 10 seconds

14. ACCESSORIES

14.1 WEATHER PROOF HOUSING FOR OUTDOOR APPLICATION

The Housing should be made of extruded aluminum and should be weather proof. The minimum internal dimensions of the housing should be capable of housing the camera and the Verifocal lens.

The camera housing should be:

- Compatible to camera
- Suitable for the make and model no of cameras offered and as specified by the manufacturer
- Should be compact and indoor / outdoor type as required.
- Suitable for operation in upright and inverted position
- Should be weather proof in case of outdoor mounting.
- Should be Vandal proof

14.2 CAMERA MOUNT

The camera mount should be:

- Of the same make as that of camera and suitable for the model number offered as specified by the manufacturer.
- Should be compact and indoor / outdoor type as required.
- Should support the weight of camera. Camera accessories such as housing pan & tilt head in any vertical or horizontal position.
- Should be weatherproof in case of outdoor mounting.

14.3 SPEED DOME CONTROLLER/PTZ CONTROLLER

Speed Dome Controller should have variable speed joystick, LCD for programming and it should be able to control the Encoders as well as speed dome for PAN / TILT / Zoom functions.

14.4 VIDEO WALL RACK

The video wall mountings should be of powder coated MS frames/supports and should be strong enough to take care weight of all Monitors. It should be suitably fabricated in such a way that only screens of monitors should be visible outside. Power supply wiring with suitable capacity sockets /earthing should be neatly installed on the rack. Video wall computers should also be enclosed in the rack. The supporting frames of monitors should not sag due to its weight.

14.5 CABLES

No.	Connectivity	Cable Type	Connector
1	Camera to Video Encoder	Coaxial RG11	BNC
2	Video Encoder to L2 Switch	UTP CAT 6	RJ45
3	L2 Switch to L3 Switch in control room	Single Mode Fiber	SC
4	L3 Switch to Video Wall Switches	UTP CAT 6	RJ45
5	From L3 switches to NVR/NAS Box	UTP CAT 6	RJ45

14.6 INSTALLATION OF UTP CABLE

- a) Cables should be dressed and terminated in accordance with the manufacturer's recommendations and / or best industry practices.
- b) Pair untwist at the termination should not exceed one-half an inch.
- c) Bend radius of the cable in the termination area should not be less than 4 times the outside diameter of the cable.
- d) The cable jacket should be maintained as close as possible to the termination point.
- e) Cables should be neatly bundled and dressed to their respective panels or blocks. Each panel or block should be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- f) The distance between UTP data cable and any power cable should be more than 4 inches.
- g) Each cable should be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view should not be acceptable.
- h) Cables should be installed in continuous lengths from origin to destination (no splices).
- i) Horizontal distribution cables should be bundled into groups of not greater than 40 cables. Cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle.
- j) Cables should not be attached to ceiling grid or lighting support wires.
- k) Any cable damaged or exceeding recommended installation parameters during installation should be replaced by the contractor prior to final acceptance at no cost.
- l) A self-adhesive label or PVC marker ferrules should identify the Cables. A cable label should be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate. Similar label or marker ferrules should also be placed on a section of the cable near to the patch panel termination.

- m) Pulling tension on 4-pair UTP cables should not exceed 25-pounds for a single cable or cable bundle. The pathway should be adequately sized so as not to exceed the 80% cross-section fill of cables. The pathway should be securely installed in the facility.
- n) Care should be taken when pulling cables into trucking to avoid damage due to snagging. Trucking partitions should be used to separate the data cables from power, and bridges should be used where data cables have to cross the mains.

Instruction of OFC cable

- Proper cable preparation is essential for splicing and installation. The following points outline some special precautions which are specific to fiber optic cable installation and therefore need to be noted.
- Fiber Stress: The fibers in the cable should not be subject to any undue stress. This means that if the cable is to be pulled into a long duct route then the specialized equipment and procedures should be used. As well, if the cable runs vertically for a significant length (more than 10m) then loop should be provided every 10m.
- Bend Radius: The cable manufacturer's minimum bend radius should be observed. i.e. there should be no bends tighter than specified either during installation or once cable has been seen fixed.
- Cable Ties: If cable ties are used, then it is very important that they are not over tightened, thereby causing localized bending and fiber stress.
- Spare Cable: At least 5m of cable should be left at each end to allow testing, positioning of enclosures, spare fiber for repairs etc. Where appropriate, spare loop of cable should be included along the cable run to assist repair in case of accidental damage.
- Labeling: All cables and cable end should be labeled clearly.
- Cable End Protection: Where cable ends are to be left exposed then they should be sealed with heat shrink caps to prevent ingress of dirt or moisture.
- Earthing: In many circumstances completely non-metallic fiber optic cables can be used to eliminate all earthing problems. If metallic elements are present then they should be earthed in accordance with the installation.

LIGHT GUIDE INTERCONNECT UNIT (LIU)

It should be installed for terminating the OFC cables. It shall provide minimum bending radius and the splice trays shall function as a splice cover for pigtail splicing. It shall be of complete aluminum fully powder coated. Cable glands shall be provided for secure anchoring the incoming cables. Rubber grommets shall be provided at the cable entry point for tight sealing. The splice tray shall also be of aluminum powder coated with splice holder. Cable spools shall be of flame retardant.

OFC CONNECTORS

It shall be single mode SC type with push-pull mechanism. Fully in compliance with latest industry standard. It shall be possible for selection of wide range of ferrule hole diameter selection.

OFC ADAPTORS

It shall be suitable for single mode SC type fiber cable connectors. Fully in compliance with latest industry standard. It shall be with snap / latch mechanism.

OFC PATCH CORDS

It shall be suitable for single mode SC type fiber cable connectors with plastic moulded plug type connectors. Standard 2.5 mm ceramic ferrules shall be used. It shall be compact and easy to connect.

POWER WIRING SYSTEM

Rigid PVC (heavy duty) Conduit Wiring System as per IS: 9537.

MATERIALS

Conduits

- (i) All rigid conduit pipes shall be of PVC and be ISI marked. The wall thickness shall be not less than 1.6 mm for conduit upto 32 mm dia and less than 2 mm for conduits above 32 mm dia.
- (ii) The maximum number of PVC insulated cables conforming to ISI: 694-1990 that can be drawn in one conduit as per standard norms. Conduit sizes shall be selected accordingly in each room.
- (iii) No conduit less than 20 mm in diameter shall be used.
Flexible conduits will only be permitted for interconnections between switchgear, DB's and conduit terminations in wall.
All flexible conduits used in the system should be Halogen free, flame retardant and self extinguishing polyamide conduits.

Conduit Accessories

- The conduit wiring system shall be complete in all respects, including their accessories.
- All conduit accessories shall be of solvent cement plastering type and under no circumstances pin grip type of clamp grip type accessories shall be used.
- Bends, couplers, etc. shall be solid type in recessed type of works and may be solid or inspection type as required.
- Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauge) for conduit up to 25 mm dia. and not less than 0.9 mm (20 gauge) for larger diameter.
- The minimum width and the thickness of clips used for fixing conduit to steel joints, and clamps shall be per standard norms.

Outlets

- The switch box or regulator box shall be made of metal on all sides, except on the front. In case of cast boxes. The wall thickness shall be at least 2 mm and in case of welded mild steel sheet boxes, the wall thickness shall not less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be duly painted with anticorrosive paint before erection.
- An earth terminal with stud and 2 metal washers shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.
- Clear depth of the box shall not be less than 60 mm, and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.
- The fan regulators can also be mounted on the switch box covers, if so stipulated in the tender specifications, or if so directed by the Engineer-in-charge.
- Except where otherwise stated, 3 mm thick phenolic laminated sheets as per clause shall be fixed on the front with brass or cadmium plated iron screws as approved by the Engineer-in-charge.

Wires

Wires shall comply the following features:

- PVC insulated with a rating of 105 deg. C bright annealed electrotype grade (99.9% pure) copper standard conductors multi drawn simultaneously (Unilay, twisted conductors) for uniformity of resistance, dimension and flexibility.
- Color coded as below:

Phase – R	-	Red
Phase – Y	-	Yellow
Phase – B	-	Blue
Neutral	-	Black
Earth	-	Green

Installation

- Common aspects for recessed and surface conduit works

Conduit joints

- The conduit work of each circuit or section shall be completed before the cables are drawn in.
- Conduit pipes shall be joined by means of couplers and accessories only.
- Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of conductors while pulling through such pipes.

Bends in conduit

- All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing cast iron inspection boxes, whichever is most suitable.
- No length of conduit shall have more than four bends from outlet to outlet.

Additional requirements for recessed conduit work.

i) Making

- a. The chase in the wall shall be neatly made, and of ample dimensions to permit the conduit to be fixed in the manner desired.
- b. In the case of buildings under construction, the conduit shall be buried in the wall before plastering, and shall be finished neatly after erection of conduit.
- c. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

ii) Fixing conduits in chase

- a. The conduit pipe shall be fixed by means of staples hooks or by means of saddles, not more than 60 cm part, or any other approved means of fixing.
- b. All joints of conduits pipes shall be treated with some approved preservative compound to secure protection.

iii) **Fixing conduits in RCC work**

- a. The conduit pipe shall be laid in position and fixed to the steel reinforcement bar by steel binding wires before the concreting is done. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
- b. Fixing of standard bends or elbow shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius which will permit easy drawing in of conductors.
- c. Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

iv) **Fixing inspection boxes**

- a. Suitable inspection boxes of the minimum requirement shall be provided to permit inspection, and to facilitate replacement of wires, if necessary.
- b. These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS:2667 – 1977.

v) **Fixing switch boxes and accessories**

Switch boxes shall be mounted flush with the wall. All outlets such as switches socket outlets, etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

vi) **Bunching of cables**

- a. Cables shall be always be bunched so that the outgoing and return cables are drawn into the same conduit.
- b. In case of three phase loads, separate conduits shall be run for each phase from the distribution boards to the load points, or outlets as the case may be.

15. SPECIFICATION FOR IP BASED CAMERA

15.1 PTZ CAMERA SPECIFICATIONS : 36 X OPTICAL ZOOM

15.1.1. GENERAL

The network (IP) PTZ Dome camera shall consist of a dome drive with a variable speed for pan and tilt with continuous 360° rotation, 1/4-inch high resolution color camera, motorized zoom lens with optical and digital zoom and auto focus and high resolution digital video of 4CIF (704x480 NTSC / 704x576 PAL) using the MPEG-4 compression algorithm and TCP/IP transmission.

15.1.2 CAMERA SPECIFICATIONS

- a. The camera shall be a network (IP) based camera.
- b. The camera shall be available in NTSC and PAL formats.
- c. The camera shall operate from 24VAC
- d. The camera as a minimum shall maintain 30fps NTSC/ 25fps PAL video at 4CIF digital video resolution (704x480 NTSC/ 704x576 PAL)
- e. The camera shall digitize and compress the video using the latest in video compression technology and shall utilize MPEG-4 video compression
- f. The digital video shall provide dual encoded video streams to allow simultaneous and independent viewing and recording of live video at different frame rates and/or quality.

- i. The camera shall provide the option to set each stream at a frame rate between 1-30 NTSC /1-25 PAL
 - ii. The camera shall provide the option to set each stream at three (3) video resolutions:
CIF (352x240 NTSC/ 352x288 PAL)
2CIF (704x240 NTSC/ 704x288 PAL)
4CIF (704x480 NTSC/ 704x576 PAL)
 - iii. The camera shall provide the option to set each stream at variable bandwidth from 64kbs to 4Mbs
- g. The camera shall provide six (6) auxiliary dry contact in and one (3) relay out
- i. Auxiliaries shall be accessible over the Ethernet IP network
- h. The camera shall have an Ethernet (IP) interface using an RJ-45 CAT5, CAT5e or CAT6 UTP cable
- a) The camera shall as minimum provide the following communication protocols:
 - i TCP/IP, UDP/IP, RTP/IP, HTTP, IGMP, ARP
- j. The camera IP protocol shall communicate over the Ethernet network using Multicasting technology and shall utilize IGMP-Snooping version 2.0 or better
- k. The camera shall provide a Bidirectional audio in and out
- a) Audio input -46 – 3dBV into one ohm
 - b) Audio output -45 – 3dBV into 16 Ohms minimum
- l. The camera shall be comprise of a camera block “driver” which consist of a 1/4” CCD
- m. The camera block “driver” shall as minimum support the following mechanical and technical specifications
- i) The camera shall deliver a 360° continuous pan travel
 - i The camera motor shall be of a brushless micro stepping motor
 - ii The camera pan travel speed as minimum shall support a variable speed between 0.1° per second continuous pan to 280° per second
 - iii) The camera tilt travel as minimum shall be between 0° to -90°
 - iv) The camera shall provide 118 preset positions
 - i. Camera shall provide Preset Accuracy of +/- 0.1°
 - v) The camera shall provide a freeze image option for preset call up
 - vi) The camera shall provide three (3) user defined patterns including pan, tilt, zoom, functions; pattern programming shall be available through the digital IP management system
 - vii) The camera shall provide “home” settings for the camera to return after pre-programmed time frame
 - viii) The camera shall provide eight privacy windows blanking in variable color options from white to black colors.
 - i. All video covered by privacy window shall be obscured at any user defined pan, tilt and zoom angles
 - ix) Camera shall support the auto flip feature to rotates the dome 180° at bottom of tilt travel
- n. The camera shall provide high resolution 36x color, Day/Night camera optical zoom with a minimum of 12x digital zoom and shall have the following specifications:
- a) The 36x high resolution color, Day/Night camera shall:
 - i. The camera shall be a high-resolution 470 TV lines color and 550 TV lines in monochrome mode
 - ii. The camera shall be a 1/4-inch color CCD type with 470/550 lines of resolution 2:1 interlacing
 - iii. The camera shall provide a pixel array of 758 (H) x 504 (V)
 - iv. The camera shall have light sensitivity of 0.1 lux at 35 IRE color/day and 0.01 monochrome/night

- v. The camera shall provide a varifocal zoom length of 3.5mm - 91.0mm
- vi. The camera shall provide angle of view of 55° wide and 2.2° tele
- vii. The camera shall provide 26x using optical zoom and 12x by using digital zoom
- viii. The camera shall have white balance controls, manual or automatic
- ix. The camera shall have Digital Slow Shutter (DSS)
- x. The camera shall have automatic backlight compensation (BLC)
- xi. The camera shall have automatic gain control (AGC).
- xii. Camera shall provide Day/Night option – on/off
- o. The camera shall maintain operation at temperature of 32° - 122° F (0°-50° C) in normal operation
- p. The camera shall provide for outdoor operation a fan and heater and shall maintain operation at temperature of -40° - 142° F (-40°- 60° C) in normal operation
- q. The camera shall support SSL security protocol.
- r. The housing shall be mountable in:
 - b) Outdoor bracket mount
 - i. The camera housing shall be constructed of aluminum
 - ii. The camera dome shall be of acrylic materials
 - iii. The camera shall provide the option to install vandal resistant bubble constructed of polycarbonate.
 - iv. Bracket mounts thread shall be of 1½ inch NTP
 - v. Outdoor bracket mount shall provide fan and heater for wide climate operations
 - c) The housing shall meet or exceed NEMA-4X and IP66 requirements for weather resistance.
 - d) Regulatory
 - i. FCC /UL
 - e) Warranty
 - i. Minimum two (2) years

15.2 FIXED CAMERA SPECIFICATIONS:

15.2.1 GENERAL

The camera shall be with 1/3-inch high resolution color camera, high resolution digital video of 4CIF (704x480 NTSC / 704x576 PAL) using the MPEG-4 compression algorithm and TCP/IP transmission.

15.2.2 CAMERA SPECIFICATIONS

- a) The camera shall be a network (IP) based camera.
- b) The camera shall be available in NTSC and PAL formats.
- c) The camera as a minimum shall maintain 30fps NTSC/ 25fps PAL video at 4CIF digital video resolution (704x480 NTSC/ 704x576 PAL)
- d) The camera shall digitize and compress the video using the latest in video compression technology and shall utilize MPEG-4 video compression
- e) The camera should support IEEE 802.3af protocol for power over Ethernet.
- f) The digital video shall provide dual encoded video streams to allow simultaneous and independent viewing and recording of live video at different frame rates and/or quality.
- g) The camera shall provide the option to set each stream at a frame rate between 1-30 NTSC /1-25 PAL

The camera shall provide the option to set each stream at three (3) video resolutions:

- a. CIF (352x240 NTSC/ 352x288 PAL)
- b. 2CIF (704x240 NTSC/ 704x288 PAL)
- c. 4CIF (704x480 NTSC/ 704x576 PAL)
- h) The camera shall provide the option to set each stream at variable bandwidth from 64kbs to 4Mbps
- j) The camera shall provide two (2) auxiliary dry contact in and one (1) relay out
- k) Auxiliaries shall be accessible over the Ethernet IP network
- l) The camera shall have an Ethernet (IP) interface using an RJ-45 CAT5, CAT5e or CAT6 UTP cable
- m) The camera shall as minimum provide the following communication protocols:
 - a. TCP/IP, UDP/IP, RTP/IP, HTTP, IGMP, ARP
- n) The camera IP protocol shall communicate over the Ethernet network using Multicasting technology and shall utilize IGMP-Snooping version 2.0 or better
- o) The camera should be able to take lenses using the standard C / CS mounts.
- p) The camera should support Day / Night Operation. The minimum illumination at 40 IRE, F1.2 should be 0.5 for day and 0.05 for night.
- q) The camera scanning system should be at least 625 TVL.
- r) The camera should be fitted with Verifocal, manual iris, CS mount, 1/3" 5 – 50 mm lens.
- t) The camera shall be comprise of a camera block "driver" which consist of a 1/3" CMOS
- u) The camera shall maintain operation at temperature of 32° - 122° F (0°-50° C) in normal operation
- w) The camera shall support SSL security protocol.
- x) The camera should be fitted in a housing capable of withstanding conditions prevailing on an Indian port.
- y) Regulatory
- z) FCC / UL
- aa) Warranty
- ab) Minimum two (2) years

15.3 FIXED DOME CAMERA SPECIFICATIONS:

- a. The camera shall employ complete solid-state circuitry, ensuring high operational reliability. The cameras being considered for this project shall be both monochrome & coloured with one-third imager size.
- b. The camera shall deliver well defined, clear, high resolution, B&W/ Colour picture without lag or geometric distortion.
- c. The camera shall also possess the following features:
 - Excellent sensitivity for usable picture suited to the ambient light level conditions and its variations. A high sensitive automatic light compensation circuit ensuring constant video signal independent of wide variations in light levels.
 - High resolution
 - Low power consumption
 - Phase adjustable line lock facility or with internal crystal oscillator

- d. The camera unit shall be complete with all electronic circuitry, devices, components, standard mount for lenses, mounting assemblies etc. The mounting assemblies of the cameras shall be individually selected depending upon the special requirements as per actual site conditions. Focal length of lens for cameras to be atleast 4 mm.

- e. Equipment specification for indoor dome camera (Monochrome)

Imager	:	1/3" Interline transfer CCD
Signal System	:	PAL
Resolution	:	More than 400 TVL
Pixel	:	510 (H) x 582(V)
Scanning system	:	2:1 interlaced
Scanning Frequency Vertical 50.00Hz	:	Horizontal 15.63KHz
Minimum scene	:	0.5 Lux
Lens	:	Wide Angle lens, f=3.8mm at F2.0 (H70° & V52°)
Video output	:	1.0 V (P-P)75 Ohms
S/N ratio	:	47dB(AGC=Off)
Ambient Temperature	:	-10°C to +50°C (Without condensation)
Power Requirement	:	12VDC (10 - 15VDC)
Mounting Position	:	Indoor (Ceiling & Wall)
Appearance	:	Body = ABS resin(white), cover = acrylic resin

f. Equipment specification for wall mount fixed camera (Monochrome)

Imager	:	1/3" Interline transfer CCD
Signal System	:	PAL
Resolution (Horizontal)	:	570 lines
Pixel	:	500 (H) x 582(V)
Scanning system	:	2:1 interlaced scanning
Scanning frequency	:	Horizontal - 15.63KHz Vertical - 50.00 Hz
Minimum scene	:	0.01 Lux at F1.4 illumination
Video output	:	1.0 Vpp, 75 ohms
S/N ratio	:	50dB or more(AGC=Off)
Lens	:	Wide Angle Lens f= 3.5mm at F1.4,H(72°)&V (55°)
Ambient Temperature	:	-10°C to+50°C(Without Condensation)
Mounting Position	:	Outdoor/Indoor (Ceiling, Wall & pole)
Appearance	:	Body = AES/PC resin (White)

g. Technical Specifications for varifocal Dome Colour Camera

Image Sensor	:	1/4 -inch color interline – transfer CCD
Active Pixels	:	752 (H) x 582 (V)
Scanning Frequency	:	(H) 15.625kHz. (V) 50Hz.
Minimum Illumination	:	0.6 Lux
Synchronization	:	Internal
Video Output	:	VBS 1.0 Vp-p/75 Ohms, BNC
Lens Focal Length	:	3.5-8 mm
Mechanical-iris	:	Automatic (Maximum, F5.6, F11)
S/N Ratio	:	48 dB
Focus	:	Automatic
White Balance	:	Automatic
Electronic Shutter	:	Automatic (1/50 ~ 1/10000) Fixed (1/100)
Pan Rotation	:	+/- 180 deg.
Pan Speed	:	9 deg., 18 deg., 90 deg. / sec
Tilt Rotation	:	0 ~ 90 deg.

Tilt SpeedP	:	9 deg., 18 deg., 90 deg. / sec
Power source	:	DC 12V, External
Power consumption	:	Max 20 VA
Operating Temperature	:	0 ~ 40 deg. C 32 ~ 104 deg. F
Relative Humidity	:	10 ~ 75% (there should be no condensation)
Storage Temperature	:	-5 ~ 55 deg. C 23 ~ 131 deg. F
Storage Humidity	:	10 ~ 95%

The camera shall be housed in a vandal resistant housing

- a. The camera housing shall be of a low profile, “No Grip” housing which is made from polycarbonate and composite materials with a polycarbonate viewing bubble.
- b. The housing shall include tamper resistant fasteners to prevent entry without a special tool. Tamper resistant fasteners shall be pin-in Torx Type.
- c. The housing shall be mountable in three (3) configurations:
Surface mount
Recessed (ceiling) mount
Corner mount
- d. The housing shall meet or exceed NEMA-4X and IP67 requirements for weather resistance for all models which includes surface, recessed/ceiling and corner options.
- e. Warranty
 - i. Minimum two (2) years

16. **EARTHING REQUIREMENT**

Protective (loop earthing) conductor (s) shall be laid along the runs the conduit between the metallic switch boxes and the distribution boards/ switch boards, terminated thereto. These conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

Jointing of wires is not permissible, however looping may be done from point (same circuit) or using a terminal strip in junction box where site condition warrants, prior permission from Engineer-in-Charge shall be obtained.

2. ACCESS CONTROL SYSTEM

2.1 GENERAL

2.1.1 SYSTEM DESCRIPTION

The Security Management System (SMS) specified shall be fully integrated and installed as a complete package by the Access/Security Control Contractor. The SMS / ACS shall be able to provide for and integrate (as required) the following subsystems:

- Integrated Access Control
- Alarm Monitoring
- Integrated Digital Video Management
- Interactive Alarm/Facility Graphics Display
- Wireless Alarm and Video Transmission
- Associated Access Control and Alarm Equipment Control
- Multiple Language Operation
- Multiple Tenant Operation
- Access Initiated and Event Initiated Control
- Elevator Control
- Workstation and associated equipment, as required.

The SMS shall be based upon a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on a true peer-to-peer, token passing Local Area Network (LAN). The SMS shall be capable of monitoring, recording, and displaying card access activity and supervised alarm inputs/outputs on a continuous, real time basis. Each installation shall comply with local, state, and federal code requirements as applicable. The system shall be user friendly, providing a user interface that allows for training of non- technical personnel to effectively operate and administer the system.

The ACS shall be designed to provide a centralized location with the ability to monitor, control, view, and communicate from a secure location within a facility or within the facilities or systems network.

System expansion capability: Minimum 100% over specified requirements with no additional software or required software upgrades.

2.1.2 SYSTEM CAPACITIES

Total minimum number of Hosts: 1

Total number of concurrent hosts: 48

Total number of optional Backup Workstations: = total number of connected workstations

Support for up to 633,000 readers using either magnetic-strip, Wiegand, proximity, Biometrics, Pinpad technologies or user definable custom card formats.

Support for up to 6,120,000 unique ID records.

Support alarm monitoring of up to 1,638,400 supervised digital input points.

Support for 1,638,400 output control points

Support for 5,000,000 on-line transaction history records

Archive history limited only to hard disk space (Bidders to specify the hard disc capacity requiremet)

Support for up to 1100 system passwords

Support for up to 10,000 unique graphics pages

Support for Ethernet Lan: TP (10 Base-T) Twisted pair, AUI (10 Bases) Thicknet, BNC (10 Base-2-default) Thinnnet.

2.1.3 SYSTEM CAPABILITIES

The following functional capabilities are considered essential for the Security Management System (SMS) described in this specification:

Integrated Access Control
Intrusion Detection
Door Control
First Key Auto Unlock
Anti-Passback control
Alarm Assessment (Instructions)
Database Security And Encryption
Dynamic Maps Displaying Alarm Points
If/Then/and/or/not functions
Time Scheduled Events
Access Control initiated events
Windows Based, Mouse oriented operations
Dial – Up Alarm processing from remote locations
Dial – Up processing of Access Control functions for remote locations
Ability to Import and Export cardholder data
Comprehensive User Definable Reports
Comprehensive User Definable Archiving
Integrated Digital Video Management
Integrated Video Badging
Visitor Management Module
Two Man Rule
Escort Privileges
Support for OPC, DDE and ODBC technologies
Ability to be WEB enabled

2.2 RELATED WORK

2.2.1 DOOR HARDWARE

Not specifically covered under this specification. It will be the responsibility of the individual bidder/contractor to provide and install all electric locking equipment including but not limited to electro-magnetic door locks, egress equipment, door status/alarm switches, and related power supplies. All electronic door hardware provided shall meet the local authority having jurisdiction for its intended use. Any code deficiencies associated with the system once installed will be left to the installing contractor to be replaced with the appropriate equipment.

2.2.2 WIRING / CABLE SPECIFICATIONS

All wiring for Distributed Control Unit communications and all wiring for related sub-LAN controller communications shall be Belden 9184 or equivalent. Belden 9841 or equivalent may be used for LAN lengths not exceeding 5000 ft. (1220m).

All other cable is to meet the following requirements as outlined below:

- All cabling shall be shielded unless specified otherwise by a card access manufacturer.
- As a minimum, standard 18 AWG cable shall be installed unless in direct conflict with manufacturers specifications
- All cabling used in the implementation of systems integration shall be in accordance with the recommendations of the manufacturer.

Provide specialist personnel for the complete wiring installation. Provide cables, conduits, cable tray and ancillary equipment necessary to complete the installation.

2.2.3 GROUNDING

Take particular attention to the grounding of equipment cases and shielded cables to eliminate noise interference and avoid electrical loops. Provide shielded cable for all communications cabling. Correctly terminate shields at ground bars and connect to the main building ground or as specified by the manufacturer.

- Insulate all incoming or outgoing shielded cables from control cabinet casings.
- Provide suitable terminals, where grounding of cable shields is required.
- Make provision of a through connection of cable shields for through connected communications cables.

2.2.4 SYSTEM SUPPORT

Provide a guarantee, in writing, of system support for a minimum period of six years after final completion, including provision for technical support, hardware, and spare parts. Demonstrate that the manufacturer's previous systems have not been made obsolete and that the manufacturer is committed to total and complete backward compatibility. System support shall include all aspects of the originally installed system as well as system training.

2.3 SUBMITTALS

Provide a submittal for approval prior to commencement of installation and training to include:

- English language description of system operation
- Single line diagrams
- Building floor plans indicating all related equipment and their termination point
- Input/output point schedules
- A copy of the database put into logical groups that represent how information will be displayed to the user
- Sample graphics pages
- Floor plans showing location of all controllers and sensors
- Co-ordination drawings showing interface terminal numbers and cross-referenced wire numbers for all connections between the SMS and other equipment

- Details of all related equipment
- Full details of each control station including equipment and wiring diagrams and terminal layouts
- Fully detailed wiring diagrams for the entire security control, monitoring and electrical cabling installation

2.3.1 MATERIALS

Furnish and install at locations shown, the specified the following equipment to provide a completely operational Security Management System.

- Door hardware and accessories
- Card Readers
- Monitors
- PC Workstations
- Network Interface Boards
- Distributed Control Units
- Security Control Units
- Printers
- Alarm relays
- Miscellaneous cable, wire, associated connectors, and hardware
- Power supplies

All materials and equipment shall be standard, regularly manufactured equipment.

All systems and components shall be thoroughly tested and proven in actual field use.

All system main control components shall be from one manufacturer.

2.4 EXTRA MATERIALS

Based upon the contractor's and the manufacturer's experience with the equipment's performance history, the contractor shall submit a final spares list for all functions for this system. This list shall be based upon a philosophy of maintaining a central system operation with a simple remove/replace capability. The final spares list shall be developed as a result of a joint customer/contractor review of the recommended list during the installation phase. Submit this final recommended spares list for approval prior to system completion, so that spares are available upon activation.

2.5 DEFINITIONS

LAN	:	Local Area Network.
UPS	:	Uninterruptible Power Supply.
SMS	:	Security Management System.
SCU	:	Security Control Unit
DIO	:	Discrete Input/Output Unit
READER:		Selected card reader technology.

3. SECURITY MANAGEMENT SYSTEMS

GENERAL REQUIREMENTS

System administration shall be available from any workstation in the system. The system specifically must have the capability to support not less than 48 concurrent workstations connected on the network at the same time manipulating and modifying the same database. The Security Management System shall support distributed processing such that all connected workstations function in a true multi-user, multi-tasking environment. The system shall not be dependent on a Server therefore fully Client / Server based systems are unacceptable.

The system architecture shall be capable of supporting single sites and/or campuses as well as multiple sites located in different geographical locations. Any additional software options needed to support a multi-site or multi-campus system shall be included in the base bid. Connection to remote facilities shall be handled through a TCP/IP connection.

The Operating System shall be based upon a Microsoft Windows 2000, XP Professional, or Windows Server 2003 platform. Unacceptable operating systems include Windows 95, Windows 98, Windows ME, Windows NT4, Windows NT5, OS/2 and UNIX operating systems.

The system shall co-exist with the Microsoft Office Suite of applications.

The system shall support web based viewing and control.

The system shall employ a non-proprietary, open, highly scalable database based on Microsoft SQL.

The system shall have the capability, as originally bid, to transmit alarm and video information to remote and wireless operator terminals. From these terminals, operators of the system shall be able to:

- Individually call up cameras from multiple locations at the same time.
- Individually call up pre-recorded video footage.
- Take control of the facilities electric locking equipment in order to perform an emergency lock down.

It is the intend of the customer to utilize as much of the existing hardware and communications infrastructure as possible to minimize the installation costs. Any associated integration with the existing system or systems should be considered.

3.1 SOFTWARE

GENERAL

The Contractor shall provide all software required for efficient operation of all the automatic system functions required by this specification. Software shall be modular in design for flexibility in expansion or revision of the system. It is the intent of this specification to require provisions of a system that can be fully utilized by individuals with no, or limited, previous exposure to PC's and programming techniques and languages. The software shall include a general-purpose operating system, as well as access control system application software. All available vendor workstation application software shall be provided with the system, and shall reside in each and every PC. Unbundled software packages where the vendor can charge the user extra fees, require dedicated workstations, require annual software renewal licenses or require systems rebooting for access are unacceptable.

The software in the system shall consist of both "firmware" resident in the controllers / card reader cum controllers and "software" resident in the operator workstations. The architecture of the system, and the application software/firmware shall be distributed with no single-system component responsible for a control function for the entire sub controller LAN. Each controller resident on the system shall contain

the necessary firmware and I/O capability to function independently in case of a network failure. No active control sequences shall be resident in the PC workstations. All PC workstations shall be removable from the system without loss of control function -- only alarm monitoring, long-term history collection, database additions/deletions, and operator monitor/command/edit functions would be lost.

The primary operator interface to the system shall be through a graphical, "object oriented", interactive presentation using a mouse and cursor for object selection and commands. The SMS contractor shall work with the customer to complete fully integrated graphics pages allowing operators of the system to manipulate controlled points using only a mouse. The system shall not be limited to only one type of operator interface at a time.

The system software shall support an operator definable "default" system page. The default system page shall be displayed upon system start-up, operator activity time-outs, and when the system is not in use. This default system page may be any one of the standard dynamic graphic pages or a custom display developed for this purpose. The operator shall be able to display their corporate logo, emergency information, etc. as the default system page.

The system software shall support "pop-up" windows for point commands. On selecting an object with the cursor, a window shall open up to present the operator with choices corresponding to the operator's password authorizations. These point commands shall include state changes, manual override of application software, test mode activation and test value entry. This window shall include, for reference, the point's descriptor (name), the point's hardware address, and alarm status.

The system software shall support "pop-up" windows for point editing. On selecting an object with the cursor, a window shall open up to present the operator with a list of active point database editors, if permitted by the operator's password level. Selecting one of these editors shall allow the operator to modify the basic parameters associated with a point, as well as access any programs assigned to the point (such as time schedules, calculations, events, etc.).

The system software shall be based upon interactive prompts and choices using "dialog boxes," as opposed to memorization of commands, "syntax", exact spellings, etc. This interactive prompt and choices approach shall be used in monitoring, issuing commands, and editing. Command choices shall be as simple as "clicking" the cursor over the correct word choice prompts (i.e., SECURE, RELEASE, UNLOCK), without typing in the letters.

The system software shall support a "zoom" function. It shall be possible for an operator to locate any system point to monitor status, issue commands, or edit associated database without knowledge of the point's name, address, or associated controller, and without having to refer to a "tree" directory. The operator shall be able to zoom in on a building in a campus graphic, zoom in on a floor in a building graphic, zoom in on a door in a floor plan graphic, etc.

The system software shall be compiled for faster execution speeds and shall offer all of the following features and capabilities:

- Input / Output Capabilities: From any local PC workstation or any remotely connected PC workstation, the system operator shall have the capabilities through the keyboard/mouse to request dynamic displays of current values or status using a tabular or graphic format. A global database sort utility shall allow an expanded tabular display of only the points on the current graphic display. This expanded tabular display shall list point name, hardware address, dynamic state or value, alarm status, override status, and test mode status.
- Obtain a summary of all access control doors with status (under access control, access control disabled, or access control ignored) and allow issuing commands to the access control doors to manually force the door to one of the above states, or provide a momentary release (act as a valid key/card access), or return to automatic control (remove manual state).
- Add, delete, or change points within each Controller or application routine while on-line.
- Change point I/O descriptors, status, and alarm descriptors and engineering unit descriptors while the system is on-line.
- Add new Controllers and sub-controllers to the system while the system is on-line.

- Develop, modify, delete or display full range of color graphic displays providing dynamic, animated displays. All development, editing and display work shall be capable of being performed with the system fully on-line and in full communications with the Controllers and sub-controllers.
- To enhance system response the database shall be distributed with up to 96,000 ID records residing in each door-processing unit. Each DCU (distributed control unit) shall support a combination of up to 64 sub LAN controllers consisting of DPU's (Door processing unit), DIU's (digital input units), DIO's (digital input/output units). Each DPU and DCU shall be capable of providing full access control decision capabilities and monitoring of assigned input/output alarm points whether on or off-line with host computer.

3.2 DATABASE CREATION AND SUPPORT

GENERAL

The intent of this specification is to provide an SMS system that will allow the Department to independently perform his or her own modifications to the system from any operator workstation. All changes shall be done utilizing standard procedures, and must be capable of being done while the system is fully on-line and operational.

The DCU on the Controller LAN shall automatically check a PC workstation's database files upon connection to verify a current database match. A utility shall inform the operator if the DCU's database files do not match the backup files stored on the PC workstation, along with the date of the last DCU modification and date of the last backup. The Department must have, as a minimum, the on-line capability to:

- Add, Delete and Modify and points and parameters.
- Determine which PC workstation(s) will receive alarms, messages & transactions on a point by point / door-by-door basis.
- Change, add, or delete English language descriptors (i.e., name). System I/O points may be identified either by name or by it's logical address. Up to 16 characters shall be available for the English language descriptor, which shall be used in all control sequences. Use of a second abbreviated point "name" for control sequences is unacceptable complexity.
- Add, modify, or delete alarm limits.
- Add, modify, or delete individual records.
- Add, modify, or delete points in start/stop programs, trend logs, etc.
- Create and/or modify override parameters.
- Add, modify, and delete any applications program.
- Create custom relationship between points. A general-purpose user utility shall be provided, such that the user can implement software interlocks, calculations, etc.
- Assign application programs to points (as opposed to assigning points to programs).
- Obtain an "audit trail" of which application programs are controlling an individual point, on a point-by-point basis.

3.3 DOOR PARAMETERS

Provide a door parameters editor, which shall include the following options:

- Reader technology selected.
- User definable Wiegand reader formats between 26 and 64 bit.
- If the reader is for the cab of an elevator (lift).
- If the reader is used for “exit” (pushbutton exit being the default), and if so, whether the exit reader is used for continuous egress or is linked to the Mode Schedule of an “entry” reader.
- The minimum time (in seconds) allowed between successive “reads”. Used to adjust traffic flow rates through portals such as turnstiles.
- The polarity of the reader’s LED used to indicate a good read, etc.
- Whether anti-passback (APB) is implemented or not.
- What the entry zone number is (APB).
- What the exit zone number is (APB).
- Escort required criteria.
- Anti-passback criteria
- Customizable reader buzzer control per event type.
- Whether the door sense switch is used, and if so whether it is a normally open (NO) or normally closed (NC) contact.
- Whether the Request to Exit (RTE) is used, and if so whether it is a normally open (NO) or normally closed (NC) contact.
- Whether a shunt function is used.
- Whether the door-locking device (e.g., an electric strike) is used, and if so, whether it is activated for entry requests, exit requests, or both.
- How long the locking device will be unlocked after an authorized read or RTE pushbutton operation. The unlock interval shall be adjustable from 1 to 255 seconds.
- “First Key Auto-Unlock” shall be available to provide additional security for doors that implement access control after hours and automatically unlock the doors on a time schedule during the day. This feature does not unlock the door until an authorized key is read after the scheduled unlock time. If this feature is not used, the door is unlocked per the Door Mode Schedule, regardless of key activity.
- “Door Prop” alarm timer setting. This setting shall ignore the door monitor switch input for alarming during the timer interval. The timer shall be adjustable (operator selectable) from 1 to 7200 seconds.
- Individual door configuration for 2-man rule.
- The polarity control of the reader audible device to be configured for individual sounds based upon the door event (forded door, valid card read, denied card read, door open to long).

3.4 SYSTEM PASSWORDS

To limit control by the system operators, the SMS shall support system passwords at both the host level and controller level.

- The host passwords shall limit user access and privileges to provide system level security. A password shall be required to “log on” to the system. The SMS host shall support up to 1,100 passwords. It shall be possible to enable or disable each and every individual function of the SMS on a password-by-password basis using a simple point and click operation. Each password shall allow a 30-character operator name, a 10-character alphanumeric password, and 4 characters for the operator initials.
- System passwords time out after a user-defined period of time.
- The SMS System shall also be capable in utilizing the customers’ pre-issued network ID and password to automatically log them into the SMS system.
- Logon passwords shall allow for any number of limited views

- Automatic expiration of passwords as set by system administrator.
- Non re-use of system passwords
- Screen settings and system configurations are remembered based on password log in.
- User configurable ID card log on in lieu of keyboard log on.
- Separate from the SMS logon an additional layer of passwords shall limit operators from gaining access to certain control panel functions. The controller passwords shall restrict user access and privileges to system controllers. The controller passwords shall support 4 levels:
 - Level 1 – Display only access
 - Level 2 – Display controller data, issue commands, acknowledge alarms.
 - Level 3 – Display data, issue commands, acknowledge alarms and edit all functions except the DCU password function.
 - Level 4 - Display data, issue commands, acknowledge alarms and edit all functions, including the DCU password function.

3.5 SYSTEM RESPONSE TIMES

Any state change or alarm condition shall be communicated to the SMS system immediately and without delays. The times listed below shall serve as the SMS systems maximum times for doing automatic refreshes and point polling.

- Change of State: Time for a change of state or value of a field point to register an alarm or update at the workstation: 3 seconds.
- Manual Command: Time for a manual command from the workstation to override a field device: 1 seconds.
- Graphics Display: Time to display a full graphic with current parameter values: 8 seconds.
- System Logs: Time to display a system log or report: 1 seconds.
- Global Data Transfer: Time for data to travel between standalone controllers: 3 seconds.
- Local Control Event: Time for standalone controller to initiate an output action after a change of input: 2 seconds.

3.6 ALARM /MESSAGES/EVENT SIGNALING AND ARCHIVING

3.6.1 ALARMS

The SMS shall provide for user definable alarm summary screens. As a minimum the SMS shall support critical alarms, priority alarms and routine alarms. The user definable alarms summary screens shall support four states as follows:

- Point in alarm (Un-Acknowledged)
- Point in alarm (Acknowledged)
- Point returned to normal (Un-Acknowledged)
- Point returned to normal (Acknowledged)

The system shall support functions such that either of the two acknowledgement functions can be disabled so that they are not required.

For a low priority informational alarm - acknowledgements would be configured as not required and the sequence in the alarm window would be such that the alarm would appear when it enters it's alarm state and automatically clear from the alarm window when it returns to normal. The operator is still given the ability to acknowledge the alarm and append text etc but this is not enforced.

For a medium priority alarm - "point in alarm acknowledgement" is required and regardless of whether the alarm returns too normal or not, the alarm will remain in the alarm window until it is

acknowledged. If the acknowledgement is prior to the return to normal then the alarm stays in the alarm window until the return to normal is received at which point it automatically clears down.

If the acknowledgement is after the return to normal then the alarm clears down once the acknowledgement process is completed.

For the highest category of alarms the return to normal message also requires to be acknowledged. This alarm cannot clear down until both acknowledgements have been given.

The system shall support user selectable colors by alarm category. The status colors shall indicate the following:

- Alarm – The point is currently in alarm, and the alarm has not yet been acknowledged.
- Alarm Acknowledged – The point is currently in alarm, and has already been acknowledged.
- Return to normal – The point went into alarm, but has since returned to normal without being acknowledged.

The configurable summary screens will display the date/time that each alarm occurred, the number of times the point has gone into alarm, the point address, the name assigned to the point, the current status of the point, and the system graphic page the point can be found on. The Access Control System shall provide a means for storing all alarms, messages, and events for an indefinite period and allow for quick retrieval at any time. The Alarms database shall be an open format. The Access Control System shall maintain as a minimum, the latest 10,000 alarms for quick review or display. In the event of an alarm condition occurring, the Access Control System shall display a message on the operator workstation, print on the printer, sound an audible alarm, optionally display the graphic page the alarm point has been assigned, and optionally set off a visual annunciation (i.e. flashing lights).

The Access Control System shall have the following alarm processing features, all of which shall be user definable:

- Allow the user to add “wav” files to alarms based on alarm category
- Incorporate an icon on the banner which shows the number of unacknowledged alarms
- Print of the alarm screen currently being viewed
- Define multiple filters on any alarm window
- Sort the alarms contained in any window
- Alter the display preferences for any window
- Remember preferences and filters by user login
- Send alarms to pagers, beepers, mobile phones, PDA’s, and e-mail
- Escalate alarms to other destinations based on user definable parameters
- Provide for user selectable Image Verification based on card access control alarms.
- Each off normal condition shall cause an alarm and an appropriate message, including the time of the alarm, system and point descriptor, and alarm condition. The operator shall have the capability to select, at any time, which state/value shall be considered alarms and which alarms shall cause automatic dial-out to occur.

- Each critical alarm or change-of-state message shall be displayed. All Controller LAN network alarm messages shall be stored on disk and may be reviewed on the CRT and/or printed on operator selected printers at any time. It shall be possible to sort this alarm/change-of-state database by date, time and/or item fields.
- Provide an automatic page selection option for alarms. This feature (operator activated and selectable) automatically selects and displays the designated “best” graphic page for each alarm, even when the operator is signed off. In the event of multiple alarms, the page associated with the most recent highest priority alarm is displayed.
- Automatic user defined time delay of alarms during equipment start-up or shutdown shall be provided to prevent nuisance and false alarms.
- Unique alarm delays on analog and discrete input points to prevent "flutter" alarms.
- The operator shall have the capability to route specific alarms to specific workstations, and/or to specific pagers.
- Each operator workstation (user configurable) will have the ability to notify an operator of an alarm condition anywhere in the system. Alarm notification shall consist of:
 - Automatic print of the alarm condition.
 - Display of an icon indicating an alarm condition, including while in a third party program.
 - Operator selectable audible alarm indication. The audible alarm will be user configurable.
 - Relay operation at the PC workstation, used to activate notification devices where the operator will be too far from the PC to see visual indication, or the environment is too noisy to hear the PC's audible alarm.
 - Automatic alarm/message redirection of unattended workstations connected on a WAN.

3.6.2 EVENTS

The SMS software shall have the ability to automatically initiate commands, user-defined messages, take specific control actions, or change control strategy and application programs as a result of an event condition.

An event condition may be an operator defined limit, a change-of-state, a specified state, or alarm occurrence, a return to normal or logical combinations of the above. Events shall not be limited to alarm occurrences only but shall also include time, dates, as specified system results. All event assignments or modifications shall be Department defined through the input keyboard.

3.6.3 MESSAGES

The system shall be capable of automatically displaying or printing a user-defined message subsequent to the occurrence of selected events. Events shall not be limited to alarm occurrences. It shall be possible for the Department to construct independent messages for each DCU, each with as many as 64 characters. The operator shall be able to:

- **Compose, change, or delete any message**
- **Display or log any message at any time**
- **Assign any message to any event**

The Messages database shall be an open format or provide a means to export the messages information for use in other third party programs.

3.6.4 ARCHIVING

The system shall be capable of automatically archiving. Based on user configurable options the system shall be capable of:

- **Automatic or manual archiving.**
- **The overall size must be fully configurable up to 5 million records. 3 millions records shall be stored online with no archiving.**
- **Start archiving based on Time, Size, Operator or any combination.**
- **Decide where the archive will go.**
- **Archived items will be accessible directly from the access control systems alarm-handling screen.**

3.7 TRANSACTIONS

Transactions Summary: Provide password-protected access to historical files containing Access Control related transactions. The Transactions Summaries shall be based upon user defined “filters” to the Access Control database. The filters shall operate over user defined time ranges for time and date, using a two entry (earliest, latest) selection for both time and date to support multiple days, each with a time slice, versus a continuous duration between two days. The operator shall be able to establish an unlimited quantity of custom “filters”, on-line. In addition to providing an “all transactions” filter, provide an operator definable custom filter template with the following entries:

- Filter Name
- Point Address - Doors shall be points in the system. Provide two Door Points which define the low and high end of a range of Doors
- Tenant - Provide two Tenant numbers which define the low and high end of a range of Tenants (1-255)
- Key/Card - Provide two ID numbers which define the low and high end of a range of ID numbers
- Zone - Provide anti-passback zones which define the low and high end of a range of anti-passback zones (0-64)
- Records Display type: Permanent/Temporary/Both as defined in the Individuals Editor.
- Device Name: 16-character Door or Elevator cab name. May be used as an alternative to the Point address range above, for operator convenience.
- Group Name
- Last Name
- First Name
- Field Names: Provide a separate entry for each of the 1 to 16 user-defined fields. These fields may have from 1 to 16 ASCII text characters, as well as the wild card? And * symbols for matching and sorting on subsets of a field.
- Transaction Selection: Operator shall be able to select from any or all of the following: Reader entry, Reader entry-elevator, Reader exit, Denied - schedule, Denied - APB, Denied - tenant, and denied -Issue, Denied - selection.

Provide a print utility for the transactions summary, which includes the following statistics:

- Reader entries for selected readers (excludes elevators)
- Elevator entries for selected readers

- Elevator floor selection
- Reader exits for selected readers
- Reader denials (based upon Tenant, issue, selection, schedule, or APB)

3.8 ACCESS CONTROL PERSONNEL DATABASE

3.8.1 GENERAL

Provide a personnel database that shall reside in the PC workstation in a SQL format, and have access control functions downloaded to the Controller and DPU for remote, standalone operation. Where the system consists of multiple PCs on a Commercial LAN, changes to the Personnel Database in one PC workstation shall be equalized among all SMS workstations, automatically. All changes shall be done utilizing standard procedures and must be capable of being done while the system is on-line and operational. The SMS system shall employ a user-friendly “re-cycle bin” feature which is intended to protect the Department from accidental or incidental deletions of the cardholder or personnel database.

The Department must have as a minimum, the on-line capability to:

- i) Add, delete, modify and copy new ID devices (keys, cards, templates) and link these to the Personnel Database.
- ii) Assign information to the Personnel Database including the ID #, Last Name, First name, Group Name, and other user defined fields. The user shall be able to define the Field Name for the user-defined fields and field database entries of 16 alphanumeric characters. In a multi-tenant system, individual authorized tenants shall be able to assign different field names to their respective Personnel Databases.
- iii) Video badging images
- iv) Assign status to a card, which may be permanent (not a visitor), temporary (a visitor), or disabled (entered into the database, but not enabled). For cards designated as temporary, allow the operator to pre-determine the activation schedule based upon the following entries:
 - a) Begin date (MM/DD/YY)
 - b) Begin time (HH:MM)
 - c) End date (MM/DD/YY)
 - d) End time (HH:MM)
- v) Provide a means for the user to define the content and order of data presented in the Personnel Database editor specifically, provide the ability to set the sort order on any field and filter and sort the data within any field. The following options shall be available to the operator:
 - a) Permanent records - include/exclude
 - b) Temporary records - include/exclude
 - c) Disabled records - include/exclude
 - d) Display Order - allows the operator to select from key/card #, Last name, First name, Group, or any of the user defined 16 fields as the basis for the primary ordering of the presentation display. For instance if the custom field “Social Security #” were selected, the individuals would be presented in order of the alphanumeric sort of the Social Security #.
 - e) Key/card range - Displays only ID #'s between the low and high values entered.
 - f) ASCII text parameters - For each of the custom fields, allows the entry of up to 16 characters for matching and sorting, including the wild card characters of ? and *. * shall be the default and support all entries (a wide open filter)
 - g) Anti-passback options whether hard, soft, or graded.
- vi) Provide a means to assign doors to designated tenants, groups, and individuals. Assign individuals to doors associated with the tenant that the individual is a part of

and the group that individual is apart of. Provide a means to assign Mode Schedules to doors, that determine when the door is under access control, when the door is unlocked, and when the door is locked (even against authorized access control devices). Also, an Anti-Passback reset trigger may be assigned to the door mode schedule to cancel and purge anti-passback "flags" set previously (i.e., the previous day).

- vii) Provide a means to assign Personnel Schedules to doors, that determine when (date and time) authorized personnel are permitted access to designated doors. Each personnel schedule shall support seven access intervals, each with a start and stop time (time slice). Provide a seven-day week plus seven "special" days and two temporary days for each personnel schedule. Provide the ability to assign up to 31 personnel schedules per door.
- viii) Provide a means to assign personnel to "Groups" which consist of a combination of doors and associated personnel schedules. The system shall also be capable of issuing multiple groups to an individual cardholder. The user shall be able to assign individuals to groups to save keystrokes and manages organizational changes. Different tenants shall be able to assign different groups to their respective access control databases.

3.9 REPORTS

A comprehensive report writer capability based on Crystal Reports from Seagate shall be provided in each workstation. The report writer shall have design capability built in as well as provide report templates and report wizards. The report writer shall have the capability to sort and extract data from the on line open database as well as from archived files and be able to generate finished custom reports. Reports shall be capable of manual initiation and/or printout as well as automatic printout. The system will have the capability to print reports on a daily, weekly, monthly, yearly, or automatically generate reports based upon a set scheduled. The system will have the capability to print reports as a result of an "event". This report writer shall provide the capability for statistical data manipulation and extraction. As a minimum, the custom report writer must provide the capability to generate four types of reports: statistical detail reports, summary reports, trend graphic plots for up to four variables, and x-y graphic plots. Prepared Historical Report: Provide an on-line, historical, database sort report utility, with the following features:

- a) Prompts to select database sort by time, by date, by point (or range of points) with system supplied default values of 24 hours, today, all Controller LAN points, respectively.
- b) Prompts for activating conditional sorts, including: changes-of-state, alarms, returns to normal, operator sign on/off, operator acknowledgments, command errors, program control of a point, test on/off, manual on/off, program control (AIC, Event) override, power restore, LAN reconfiguration, controller off-line, time/date modifications, and archive disk memory 90% full, 95% full, and full.
- c) Provide audit trail messages of operator edits of access control, specifically editing the databases for individuals, groups, tenants, transactions, doors, personnel schedules, access-initiated control, and elevator control. Also, include door prop alarms, forced door alarms, and failure of the database to download to field controllers.
- d) Single keystroke retrieval resulting in a report listing the most recent condition first, along with the time, date, address, name, condition type, and value.

The System shall provide the operator with a set of "canned" reports. The "canned" reports shall include but not be limited to the following:

- Alarms Door-Individual Field Roster
- AMT Archive Performance Report
- Analog Sample Report
- Archives Analog Sample Report
- Archive Consumption Sample Report
- Archive Demand Sample Report

- Archive Discrete Sample Report
- Archive Override Billing Sample Report
- Archive Runtime Sample Report
- Audit Trail Report
- Door-Group Roster Report
- Door-Individual Roster Report
- Door-Tenant Roster
- Group-Door Roster Report
- Group-Individual Field Roster
- Group-Individual Roster
- Messages Report
- Network Configuration
- Tenant-Door Roster
- Tenant-Group Roster
- Tenant-Individual Field Roster
- Tenant-Individual Roster
- Transactions - Doors Report
- Transactions - Individuals Report
- Zone Census Report

Free Form Historical Reports: An operator shall be able to manually request reports from a console keyboard. All reports shall have time and date and shall not be limited to "canned" or "standard" format. Data shall be gathered from the field LAN's automatically, and archived on Department-selected workstations. The systems shall include a report writer function that supports as a minimum, the following functions:

- Long term data archiving to hard disk
- Automatic directives to download to transportable media such as floppy diskettes or tapes for storage
- Data selection methods to include database searches, sorts, and manipulation
- Data extraction shall support mathematical manipulation
- Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
- Generating reports either normally at operator direction, or automatically under PC directions. Both Events driven and scheduled automatic reports shall be supported.

Archiving to disk shall automatically occur as long as the PC workstation is ON and physically capable of communicating with the Controller LAN(s), regardless of what programs are currently being executed at the time data is needed to be stored to disk (i.e., an operator can be developing a financial spread sheet in Microsoft Excel when the SMS stores field trending information to disk -- the current Excel program shall not be interrupted or halted) for archiving.

Proprietary reporting packages will not be acceptable.

Provide facility to extract data from archived files and generate custom reports.
Automatically generate reports through user or fixed time schedules, or on demand.

Provide facility to generate reports in a user-defined format.

Provide facility to export (as a whole or individually) the following data to be used in some other common database software package:

- Tenants
- Floors
- Doors
- Transactions
- Messages
- Passwords
- Individuals
- Groups
- Field Names
- Alarms (sorted by priority)

Support two printer operations. The alarm printer will print all alarm annunciations and return to normal, operator acknowledgments, action messages, system alarms, operator sign-on and sign-off. All operator control activities shall include the operator's initials in the printed and disk record.

The data printer will be reserved for printing reports, graphical page prints, and database prints. Both printer functions shall be available from any PC workstation.

3.10 HELP SCREENS

Context Sensitive Help Screens: Provide context sensitive help screen associated with the current keyboard/mouse input.

Application Sensitive Help Screens: Provide the capability to develop help screens tailored to job specific applications. These screens shall be displayed by selecting an icon from an associated graphic display. These help screens will be intuitive in nature and provide the operator the ability to perform the task at hand without any help from outside individuals. The help screens will automatically prompt the operator to enter relevant information in to specific areas of the system.

In addition to the help screens, the SMS system will provide the operators of the system with administrative Wizards designed to aid in the training of operational personnel. These Wizards will also set operators through the process of modifying the cardholder database. As operators are editing the cardholder database through the Wizards, the information shall also automatically be added to the system with no additional editors being opened.

3.11 OPERATOR WORKSTATIONS

General

If required, provide an on-site operator workstation to provide user friendly, operator interface with the complete system.

If required, provide an off-site operator workstation to provide user friendly, operator interface with the complete system. Provide all operator interface software and commissioning.

Hardware specifications

Provide workstation equipment, conforming to the specified requirements. (Refer to the project requirements schedule).

Pentium III – 1.2GHZ or the latest configuration
512 MB Ram - File Master
256 MB Ram - workstation (equalization station)
40 gig. Hard Drive
DVD - RW Drive for data archiving
17" Video Monitor w/display 800 X 600 – TFT screen
Windows based operating System
Sound card/speakers for audible alarms

3.11.1 SOFTWARE GENERALLY

The Access Control System shall allow all connected workstations to function in a true multi-user, multi-tasking environment such that:

- All terminals can access the same network and database at the same time.
- All terminals can access and/or control the same control unit at the same time
- All terminals can access and/or modify the same control unit database at the same time
- All terminals shall be able to archive data, alarms, access transactions, and network actions to hard disk regardless of what application programs are being currently executed (i.e., LAN operating system, spreadsheets, word processing, etc.). All archiving disk traffic shall be accomplished on-line without affecting the operation of the current programs.
- An operating system to control all support functions including memory allocation, disk access and external devices.
- An application package specific to the manufacturer's SMS, operating in a Microsoft Windows 2000, Server 2003, or XP Professional environment.
- Any other required proprietary programs for functions such as graphics, reports etc.
- Latest revisions of all programs at time of practical completion.
- Licensing of software at time of practical completion.
- The software shall include all available software licenses for a fully integrated Security/Access Control and Lighting Control system.
- Operator Workstation: Any operator workstation shall:
 - Accept data from the Controller LAN on an as needed basis without having to scan the entire network of DCU's for updated point data.
 - Interrogate the Controller LAN for updated point data when requested by the system operator.
 - Allow operator command of equipment connected to DCU's .
 - Allow operator to place specific DCU's in or out of service.
 - Allow parameter editing of DCU's, and "gateway" nodes (limited only by an individual operator's password assignments).
- Store duplicate database on file for every DCU and allow this database to be downloaded to the remote panel while the system is on-line.
- Control or modify specific programs on a DCU basis.
- Develop, store and modify dynamic color graphics utilizing system supplied mouse and mouse- supported software. It shall be possible for both mouse-supported workstations and non-mouse supported workstations to coexist on the same Controller LAN.
- Provide data archiving of assigned points throughout the system and to support overlaid graphing of this data utilizing up to four variables.
- To maintain system integrity, the operator shall have available an automatic DCU save utility. The database of the DCU's shall be automatically uploaded to a workstation at 02:00 AM, for backup purposes. This utility will function for both direct connect and dial-up workstations.
- The operator will have the option of selecting daily, weekly or monthly as a scheduled frequency to synchronize time and date in DCU's from the PC workstation. This function will

be performed for dial-up as well as direct connected locations. This program shall accommodate automatic daylight savings time adjustments.

- The SMS shall support not less than 48 operator workstations, each with simultaneous access to the Local Area Network. Regardless of how the operator workstations are connected to the Controller LAN (i.e., hardwired or via modem), the network shall support all specified functions.
- The operator may print a selected DCU database whenever desired. The operator shall be able to select any or all control parameters as needed. A "bind able" printout of the database of each DCU, with a floppy disk backup shall be submitted with "as-builts" as part of the final acceptance procedure.
- The CRT shall have a feature to indicate audibly and visually, Off-Normal conditions and messages pending, whether in SMS operating mode or third party software mode.

3.11.2 GRAPHICS

The system shall support an operator definable "default" system page. The default system page shall be displayed upon system start-up, operator activity time-outs, and when the system is not in use. This default system page may be any one of the standard dynamic graphic pages, or may be a custom display developed for this purpose. Tiered graphics pages will be usable through the system allowing the operator the ability to penetrate further into the system to gain more detail on any given graphical point. The operator shall be able to display their corporate logo, emergency information, an index of all graphic pages, etc. as the default system page.

The graphics system employed by the SMS system will allow for the addition of "single button control" points to be located on any/all system graphics pages. These "single button control" points will perform a customer defined sequence of events such as:

- Automatically run and print reports.
- Secure all pre-defined doors.
- Unlock all pre-defined doors.
- Control 3rd party devices such as DVR's.
- Launch 3rd party applications
- Turn point's on/off.
- Launch 3rd party applications such as:
 - a. Windows Media Player.
 - b. AutoCAD.
 - c. Microsoft Word/Excel.
 - d. Any Windows compatible application

3.11.3 DYNAMIC GRAPHIC PROGRAMMING

Shall be part of the ACS system and not considered as an add on feature.

The operator shall have the ability to create, construct, and modify existing "dynamic" graphics pages for monitoring and system control without the need of outside assistance. This graphics utility shall be usable both for on-line control such as override and alarm acknowledgment, and for display of system status and alarm activity.

The graphics program shall have the following features:

- a) Microsoft Windows-based "Integrated" graphic package. A separate or optional graphics generation program or package is unacceptable.
- b) Minimum of one second updating of real time data.
- c) Page summary feature for all graphic pages.
- d) Operator modification of set points and adjustable parameters.
- e) User-friendly operator development of graphics.
- f) Comprehensive library of symbols.
- g) Ability to create user defined symbols.
- h) Provide an automatic page selection option for alarms. This feature (operator activated) automatically selects and displays designated "best" graphic page for each alarm, even when the operator is signed off. In the event of multiple alarms, the page associated with the most recent highest priority alarm is displayed.
- i) On-line graphic development shall be supported on all workstations connected to the LAN either as "hard-wired" direct connect or via remote dial-in.
- j) Provide for import of .BMP file format graphics developed in third party programs such as Paintbrush. Such imported graphics shall be used as a "backdrop", so that all other dynamic and animated system features may be superimposed on this graphic. Similarly, it shall be possible to import CAD type drawings, by first converting the CAD drawing from .DXF format to .BMP format.
- k) Add, delete, develop and/or modify custom dynamic color graphic displays utilizing either custom symbols or system-supported library of symbols. Graphics shall support at least 16 colors and not less than 60 outputs of real time, live dynamic data per graphic. The system shall allow this dynamic graphic data to be displayed as an animated symbol (i.e., when a door opens the door on a floor plan moves to the open position), an ASCII set (i.e., on-off), or as an analog bar graph. Each operator workstation shall support not less than 10,000 separate graphic pages.
- l) The contractor shall include 15 developed graphics as approved by the Engineer-In-Charge for this project. The following graphic pages shall be provided As a minimum:
 - m) Index page of all graphics, with direct selection.
 - n) Floor plan of each floor with door status with point control.

System graphics: Provide the following graphic displays:

- a) Master graphic from which other graphics may be selected.
- b) Building elevations and plans: A number of graphics indicating position of security operations centers, plant rooms and major items of equipment and providing access to other graphics.
- c) A series of floor plans showing all secured portals and sensor locations.
- d) System configuration: Indicating relationship of workstation, controllers, printers etc.
- e) Building single line electrical diagram: Graphic showing status and values of all monitored electrical equipment.

- f) Include graphics for the required spare points.
- g) Tenancy fit out: Allow for graphics associated with tenancy fit out.

During and/or after completing construction of the dynamic graphic flow chart, the cursor may be placed on the icon, and by "clicking" the mouse; the icon may be expanded into the associated database editor for adding, deleting, or modifying the point, module, or application program. Similarly, the point may have its "pop-up" window called up to issue point commands, or overrides. Systems requiring graphic programming languages which are off-line, or require time delays for compiling, or which are not integrated into the primary operator workstation are not acceptable.

Select a graphic screen refresh rate between one-second refresh and 60 second refresh rate.

Graphic Display: On-line graphic development shall be supported on all workstations connected to the LAN either as "hard-wired" direct connect or via remote dial-in. The system shall support any mix of mouse-supported workstations or non-mouse workstations.

The systems graphic software shall provide the following minimum features:

- a) "Page Linking" such that it is possible to "zoom" into a specific door or any other page through a sequence of graphics without using anything but the system mouse.
- b) Generate, store, and retrieve library symbols for use in generating graphic pages.
- c) Single or double height characters.
- d) 60+ dynamic points of data per graphic page.
- e) "Hot Buttons" that are customer programmed to perform any number of sequences.
- f) Pixel level resolution. Graphics will be displayed on VGA monitors with a 640 X 480 resolution, minimum.
- g) Animated objects for discrete points (i.e., doors open and close on authorized access or when a parking gate opens it goes up on the screen).
- h) CCTV icons providing direct links to the device for full control.

3.12 SYSTEM CONTROLLERS

3.12.1 GENERAL

All points in the system shall be monitored and/or controlled through "intelligent" Distributed Control Units / card reader cum controllers. Each control unit in the system shall contain its own microprocessor and memory with a minimum 300 hours battery backup. Each control unit shall be a completely independent stand-alone "master" with its own hardware clock calendar and all firmware and software to maintain complete control on an independent basis. Control Units generally shall:

Release all access doors in case of fire /fire related conditions.

- a) Acquire, process, and transfer information to the PC operator workstations or other control units on the network.
- b) Accept, process, and execute commands from the other control units or other input devices, or multiple PC workstations.
- c) Allow access to both database and control functions by multiple workstations at the same time.
- d) Record, evaluate, and report the changes of state and/or value that occur among points associated with the control unit. If any operator workstation or transmission network fails, but the power to the control unit does not, the control unit shall continue to perform all control functions associated with the points connected to that control unit.
- e) Control Unit Upload/Download Capability: Each control unit shall be able to download from or upload to any PC operator's workstation. All point data shall be modifiable from any authorized PC operator's workstation and downloaded to the control unit over the Control Unit LAN. This

upload/download shall be readily performed on a regular basis without interrupting the control functions in the control unit. All upload/downloads shall be performed without the operator workstation being taken "off-line. Additionally, all Control Unit upgrading shall be performed via a download from any workstation on the system; i.e. it shall not be necessary to replace e-proms to perform a system revision upgrade.

- f) The system controllers must provide an integral time clock and have the capability to synchronize time with operator workstation.
- g) The system controllers must provide a dedicated port for communication link between panels as well as a redundant communications port for backup communications and have the ability to auto-detect breaks in the network.
- h) The system controllers must provide a separate RS232 communications port for connection of portable operator's terminal (laptop PC and/or a hand held controlling device).
- i) Provide sufficient input/output modules to achieve the required control functions, including the required spare points.
- j) Modules: Removable without having to disconnect field cabling.
- k) Control Unit Point Scanning: It shall be possible to independently set the scan or execution speed for each point in the control unit to an operator selected time from 1 to 254 seconds.
- l) Field door controllers will have the ability to store within their own memory the last card transaction.

3.12.2 CONTROLLER SOFTWARE/FIRMWARE

Provide the following features:

- a) Real time, day of the week and calendar.
- b) Automatic clock synchronization from operator workstation.
- c) Time schedules.
- d) Holiday schedules.
- e) Temporary schedule overrides
- f) Automatic Daylight Savings Time Switcher
- g) Software timers with one-second resolution.
- h) User-defined alphanumeric software and hardware point descriptors.
- i) Resident diagnostics, which continuously monitor the operation of the unit, enunciate faults (including continuous looping of control loops, unreliable data) and provide continuous operation using the last reliable data.
- j) Test mode to drive a selected point (not the physical service) to a selected value and observe the consequential effect.
- k) Password protection.
- l) Alarm processing program including the ability to redirect alarms according to alarm priority and time schedules.
- m) Flash downloadable.
- n) Individually addressed
- o) Spare points: Allow for all software associated with the required spare points.

Program loading: On-line, either from a personal computer directly into the Control panel or through the operator workstation network.

3.12.3 CONTROLLER APPLICATION ROUTINES

Automatic Time Scheduling (ATS): Each Control Unit shall provide self-contained ATS programs for automatic start/stop/scheduling of devices. Each ATS program shall support up to seven normal day schedules, seven "special day" schedules and two temporary day schedules. The special days schedule shall support up to 30 unique date/duration combinations. Each load shall support an individual time program, as a minimum.

Each load shall be able to be assigned at least 17 control actions per day with one-minute resolution. Operator selectable time schedule operation choices shall include the following: Start, Optimized Start, Stop, Optimized Stop, Cycle, and Optimized Cycle.

A minimum of 30 holiday periods up to 99 days in length may be specified for the year.

It shall be possible to create "temporary" schedules up to a week in advance that will be in operation only on the day or days specified.

Support a temporary "special day" date and duration to be broadcast to selected or all sites to account for unusual situations Such as temporary operating hours or "snow days".

Support control actions to be performed at any operator selectable time of day as well as at "sunrise" and "sunset". Sunrise and sunset parameters shall be selectable based upon time zone, latitude, and longitude.

In addition to individual load scheduling, provide for group scheduling by designating equipment to be linked to a "master" time schedule, for quick schedule changes of large groups of equipment which follow a common schedule. The master schedule shall provide a choice of fixed start and stop times by day, or a plus and minus adjustments to the existing schedule, in minutes. Master schedules shall provide a choice of immediate activation or activation at a later date and time.

Event Initiated Programming (EIP): Each Control Unit shall provide event-initiated programs. An event may be initiated by any data point. Triggering an EIP shall cause a series of control actions in a sequence, i.e., if point A reaches an alarm condition, start points 1 through 12. Up to 64 sequences can be defined per Control Unit. Each sequence may cause up to 16 control actions. Sequences may be chained together.

Access Initiated Control (AIC) : An AIC is an automatically generated control action initiated in response to an access transaction for a selected tenant, group, or individual.

As a minimum, each Control Unit shall supply support for up to 64 AIC's regardless of the number of tenants assigned. If an AIC is directed to a single output the capability to initiate additional actions through Event Sequences and Event Action editors must exist. The capability must exist to cause control actions on a system wide basis from a single AIC (i.e. turn on Air Conditioning, lights etc.). The capability must exist to assign a minimum of 24,000 users to a single AIC. As a minimum, the following access transactions shall be capable of generating an AIC:

- a) Reader entry
- b) Reader entry - elevator
- c) Reader exit
- d) Denied entry - schedule
- e) Denied exit - schedule
- f) Denied exit - schedule
- g) Denied entry - PIN
- h) Denied exit - PIN
- i) Denied entry - anti-passback
- j) Denied entry - issue #
- k) Denied exit - issue #
- l) Denied entry - selection
- m) Denied exit - selection

3.12.4 HARDWARE SPECIFICATIONS - DOOR CONTROLLERS

The quantities and types of door controllers shall be determined by the contractor based upon the requirement to provide a fully operational system, as per the intent of the specification, as shown on the drawings and recommended by the manufacturer. As a minimum, the following features shall be supported in each Door Processing Unit:

- a) Resident card holders. (Minimum 10,000 or depends on population)
- b) Support for maximum 4 doors per SCU
- c) Standalone Access Control Logic
- d) Real Time Clock/Calendar
- e) Resident Day & Date Based Logic
- f) Central Control and Monitoring
- g) First Entry Auto Unlock
- h) Zoned Anti-Passback (Local DPU level & Global across LAN)
- i) Elevators: one or two cabs, each with one reader.
- j) 2-Man Rule
- k) Multi-drop RS485 communications
- l) Fiber optic compatible
- m) On-board battery charger
- n) Optical tamper switches
- o) switch addressable (0-31)
- p) Supervised inputs
- q) Flash downloadable
- r) Supported readers technologies:
 - I/DISC Touch Memory
 - Magnetic Key & Card
 - ABA (Track 2)
 - Wiegand (26 & 32 bit)
 - Proximity
 - Watermark Magnetics Biometrics

3.12.5 CONTROLLER OPERATION

Distributed Access Control downloads all “local” access control parameters from the Host PC to the Door Processing Interface (DPI) and then to the Door Processing Unit, so that it may operate in a standalone basis. This ensures rapid access processing and minimal dependence on a single point of failure. As a standalone controller, the DPU provides access to one or two doors. Support for a door monitor input, locking mechanism output, secondary alarm bypass output, and a request to exit input are provided for each door. Optionally, the second reader may be used for door exiting. When the door is controlled by two readers, anti-passback operation is available. As a distributed network controller the DPU allows centralized alarm monitoring, historical data collection, zoned anti-passback,

First Entry Auto Unlock allows the door to automatically unlock during the day based upon a time and day schedule (Modes) in the DPU. However, this feature ensures that the door is not unlocked until at least one “authorized” person has arrived, following occupancy time.

3.12.6 DATA COMMUNICATIONS

NETWORK: RS-485

DATA RATE: 9600 BPS

CABLE SUPPORTED: 22 AWG twisted pair, shielded (low capacitance, e.g. Belden 9184 or 9855)

CABLE LENGTH: 5000 ft (1500 m) maximum

LED's are provided to indicate data transmission, receiving data,
Normal power mode, standby power operation, RAM error,

3.12.7 ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE: 32° to 122°F (0°C to 50°C) without battery backup;
50° to 100°F (10° to 38°C) with lead-acid battery backup

OPERATING HUMIDITY: 10% to 80% RH, non condensing

3.12.8 HARDWARE SPECIFICATIONS - DIGITAL INPUT CONTROLLER

The quantities and types of controllers shall be determined by the contractor based upon the requirement to provide a fully operational system, as per the intent of the specification, as shown on the drawings and recommended by the manufacturer. As a minimum, the following features shall be supported in each Digital Input Unit:

RS-485 Communications – Multi-Drop
Remote Operation Over Dial-Up Phone Lines
“Point” based

Central Control and Monitoring
16 Supervised Alarm Inputs – Standard
4 States of Fault Supervision

- a) Cut
- b) Short
- c) Open
- d) Closed

Alarm Input Shunting Support

- a) Via DPI or MCI
- b) Centralized – Manual Overrides

Fiber Optic Compatible
On-Board Battery Charger
Tamper Input

3.12.9 DATA COMMUNICATIONS

NETWORK: RS-485

DATA RATE: 9600 BPS

NETWORK WIRING REQUIREMENTS:

CABLE SUPPORTED: 18 – 22 AWG twisted pair, shielded (low capacitance, eg: Belden 8760) CABLE LENGTH: 5000 ft (1200 m) maximum

LED's are provided to indicate data transmission, receiving data, normal power mode.

TERMINAL BLOCKS: Removable screw terminal connectors

3.12.10 ELECTRICAL SPECIFICATIONS (As per manufacture's standards)

CONTROLLER: 24V ($\pm 10\%$) DC or AC (50/60Hz),

BATTERY CHARGE CURRENT: 2 Amps maximum (short circuit), 0.6 Amps typical

POWER SUPPLY: 115Vac or 250Vac transformer (50/60 Hz $\pm 15\%$), 40VA, maximum

POWER FAILURE NOTIFICATION: Standard, using internal detection logic

3.12.11 ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE: 32° to 122°F (0° to 50°C) without battery backup;
50° to 100°F (10° to 38°C) with lead-acid battery backup

OPERATING HUMIDITY: 0% to 80% RH, non condensing

3.13 HARDWARE SPECIFICATIONS - DIGITAL INPUT/OUTPUT CONTROLLER

The quantities and types of controllers shall be determined by the contractor based upon the requirement to provide a fully operational system, as per the intent of the specification, as shown on the drawings and recommended by the manufacturer. As a minimum, the following features shall be supported in each Digital Input/Output Unit:

RS-485 Communications – Multi-Drop
Remote Operation Over Dial-Up Phone Lines
“Point” Based
Central Control and Monitoring
12 Supervised Alarm Inputs – Standard

4 States of Fault Supervision

- a) Cut
- b) Short
- c) Open
- d) Closed

8 Multi-Mode Form “C” Outputs

- a) Pulsed
- b) Tracking
- c) Latched
- d) Alarm Input Shunting Support – VIA DPI or MCI
- e) Centralized – Manual Overrides
- f) Fiber Optic Compatible
- g) On-Board battery charger
- h) Tamper input

3.13.1 DATA COMMUNICATIONS

NETWORK: RS-485

DATA RATE: 9600 BPS

NETWORK WIRING REQUIREMENTS:

CABLE SUPPORTED: 18 – 22 AWG twisted pair, shielded (low capacitance, eg: Belden 8760) CABLE LENGTH: 5000 ft (1200 m) maximum

LED's are provided to indicate data transmission, receiving data, normal power mode.

TERMINAL BLOCKS: Removable screw terminal connectors

3.13.2 ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE: 32° to 122°F (0° to 50°C) without battery backup;
50° to 100°F (10° to 38°C) with lead-acid battery backup

OPERATING HUMIDITY: 0% to 80% RH, non condensing

3.14 PROXIMITY READERS

The reader shall be proximity type with Smart Card chips. It shall read the ID number of the card or tag when presented to the surface of the reader without physical contact. Read range shall be nominally 4 inches from the rear surface when used with a card and 6 feet when used with a vehicle tag. Maximum dimensions shall be 4.6 inches (11.7 cm) high x 5.5 inches (14 cm) wide x 1.4 inches (3.5 cm) thick. The reader may be mounted directly on any material including metal without the use of standoffs, or concealed behind any building material except metal.

An LED on the front surface of the reader shall indicate to the user that the card or tag presented to the reader has been read. An audio beep tone to indicate that the card or tag has been read shall be available as an option.

Electrical connections from the reader assembly to the system interface or CPU shall be via color-coded, five conductor, #18 AWG shielded cable (six conductor optional audio tone).

Wiring from the reader assembly to the system interface or CPU may be run inside metal conduit or EMT, as may be required by electrical codes.

Any of the readers shall be capable of being powered by a 1.2 amp-hour battery for at least five hours.

Accidental or intentional transmission of radio frequency signals into the reader shall not compromise the system.

The reader shall function in the access control system's normal or anti-passback mode without changes to the reader.

The reader shall contain no internal code matching or memory devices to operate with a group of ID numbers.

The access control system readers shall have the capability to accept codes from any of the following proximity devices:

- a) The presence of small metal objects such as keys or coins near the card or tag shall not alter the code read by the reader or prevent the code from being read by the reader.
- b) The individual card or tag shall be derived from a population of at least 134 million unique codes.
- c) Cards or tags shall be sequentially numbered. The user may specify codes or numbers. Exact replacements for cards or tags, which may be lost, damaged, or stolen shall be available upon request. Cards and tags having the same number shall also be available upon request.

- d) Cards, key ring tags, or badge tags may be used interchangeably and shall be compatible with all readers in the system, regardless of the reader's physical size or style, and without any code matching or memory devices in the reader.

3.15 FIELD HARDWARE

3.15.1 DOOR CONTACT / STATUS SWITCH

UL Listed

¾" diameter recessed magnetic contacts with factory installed wire leads, minimum 1 ft. long – 22AWG.

Installation shall include the application of mounting compound for added adhesive strength.

Where field conditions prohibit the use of a recessed magnetic contact, surface mounted switch shall be used.

Type: Interior/Exterior,

3.15.2 REQUEST TO EXIT SWITCH

1 3/4" diameter opaque colored mushroom cap push button

Operation: Momentary N.O. and N.C. DPDB Circuits

3.15.3 PROXIMITY CARDS

Dimensions: 3.38" x 2.12" x 0.03"

Material: PVC

Slot Punch: Vertical/Horizontal

Permanent Marking: Includes P/N code, date code and ID number matching internal ID

3.15.4 GLASS BREAKAGE DETECTOR

UL Listed

FCC Certified

Detection range 25' minimum

Mounting locations at the wall or ceiling.

Recessed or Flush Mount, Tamper available

Operation: 25', 360° opposed.

3.15.5 PASSIVE INFRARED SENSOR

UL Listed

FCC Certified

Available in various designs to provide coverage of 30 ft. to 200 ft. depending upon the area of protection

Combination heat and motion sensitive detection technologies, both needed to verify alarm condition (dual- technology).

Ability to disable LED for Stealth mode

Sequential Logic Input

Automatic PIR temperature compensation

Catch sensitivity: 1ft. per second

Trouble output supervisory feature

Phase sensitive PIR processing

Ceiling, wall, corner, flush, and swivel mountable brackets to be available.

3.15.6 LOCKING DEVICES

All locking devices providing access are to be of the electromagnetic type to meet the following requirements as outlined below:

- Approved by the authority having jurisdiction, including local fire authorities to provide free egress at all times.
- Type: Electrified handsets, electric strikes
- UL listed
- Each door to be provide with an integral door status switch and magnetic bond sensor
- It will be up to the individual security contractor to provide the proper door locking equipment for each individual controlled door.
- All locking devices utilized on passages providing a main means of egress out of a protected space are to meet fire code and approved by the authority having jurisdiction, including local fire authorities
- Shall meet NFPA 101 Life Safety Code requirements
- UL listed
- Shall receive power from the lock power supply

3.15.7 POWER SUPPLY

Provide:

- Power supply rated for the total load of the control station for all input and output modules energized, without diversity.
- Protection against power surges and over voltages.
- Battery backup to support panel memory for a minimum of 72 hours.
- Battery backup to support electric locks for a minimum of 4 hours.
- Individually fused outputs.
- 24-volt AC/DC control circuits throughout.
- The same type and manufactured power supplies shall be used for ACS.

4. **BOOM BARRIER**

The boom barrier shall be either 3m or 4.5 m or 6 m as per site, with opening time of not more than 2 seconds, with loop controllers, boom controller, weatherproof exteriors armed with 20" long range readers and manual override switch for VIP movement. The boom shall be seamlessly connected to the nearest access controller and reports of IN/OUT movement to be recorded on the access management software.

5. **FLAP BARRIER**

The flap barrier shall be with 520mm or 900 mm passage clearance or as per site, larger passage versions are obtainable for the standard disabled law, extendable machine bodies for the functioning with open shutters and variable height, with opening time of not more than 0.5 seconds, with loop controllers, flap controller, weatherproof exteriors armed with 20" long range readers and manual override switch for VIP movement. The flap shall be seamlessly connected to the nearest access controller and reports of IN/OUT movement to be recorded on the access management software. The

barriers to have Led indicators for semaphoric signs, Antiqueue control through infrared sensors, Optical beams for safety movements & Bi-directional control.

6. INSTALLATION

Install all devices in locations as shown on the drawings in accordance with standard industry practice.

Install and adequately support fixed wiring throughout the installation. For cabling routes not specified in detail, submit a proposed route layout.

Handling cables: Handle cables to avoid damage to insulation and sheathing. Report any damage and replace or repair-damaged cable as directed.

Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables for their entire route length without intermediate straight-through joints. Where straight-through joints are used contain within a junction box arranged so that they are accessible after installation.

Tagging: Identify all cables at each end and at crowded intermediate points by means of stamped, non-ferrous tags, clipped around each cable.

Fire Caulking: Provide the appropriate penetration caulking.

Cables in false ceilings: Secure from building structure, not from other services.

Cables in conduits: Feed cables into conduits in such a way as to prevent twisting and crossing. Do not use inspection fittings for drawing in cables.

Cables on trays and ladders: Fix cables neatly to trays and ladders in single layers and parallel to the tray edge to avoid unnecessary crossovers. Fix cables at intervals not exceeding 48" by means of non-corrosive fastening materials.

Segregation: Physically segregate data cabling from power and SMS input/out cabling and mains cabling from all other cabling.

PANELS

Install panels and controllers within a dedicated metal enclosure.

Documentation: Provide plastic fade-free points list in a pocket. Include terminal numbers, point addresses and short and long descriptions.

Small point controllers: Install adjacent to the controlled device, accessible for maintenance. Provide suitable enclosure.

7. TRANSMISSION SYSTEMS

The ACS shall utilize the above LAN architecture to allow all of the Control Units to share data as well as to globalize alarms. The Controller LAN shall be based upon a peer-to-peer, token passing technique with a data speed of not less than 19.2 KB.

Each individual ACS control panel shall have the ability to maintain 100% of the information needed for it to operate in the event it is disconnected from the rest of the system. Systems that require a "master" communications controller or network manager for the database storage and alarmed and activity buffering or operate in a degraded site-code mode are not acceptable.

8. COMMUNICATIONS

Utilize an established LAN or other communication standard to link all SMS equipment.

Technique: Token Passing network for Controller LAN, Polled for Small Point & Application Specific Controllers.

Configuration: A break in the communication path of the Controller LAN shall be announced as an alarm and shall automatically initiate a Controller LAN reconfiguration such that the resulting sections of the Controller LAN continue to function as separate LANs. No loss of control shall result from such a break in the Controller LAN.

Commercial LAN: Workstations on the Controller LAN may also reside on a higher tier "commercial" LAN. This "commercial" LAN shall be based upon Ethernet, and comply with IEEE 802.3 standards. Where a "commercial" LAN is implemented, it shall be possible to connect multiple Controller LANs together, with global data sharing across this commercial LAN.

Alarms and special event notices shall be routed to different workstations on the "commercial" LAN-based upon time of day, and day of the week. Operator password assignment shall be available on both a system-wide basis and a workstation-by-workstation basis.

9. TESTING AND COMMISSIONING

9.1 GENERAL

The contractor shall perform all tests submitted in the "Test Procedure" section as outlined in the specification.

Provide a program for the testing and commissioning procedure. Use a qualified representative of the ACS supplier to co-ordinate testing and present at all tests and training courses and remain on-site until the ACS is fully operational.

9.2 FACTORY TESTING

Procedure: Submit procedure for factory test at least two weeks prior to the test.

After test: Submit summary of results and necessary modifications.

9.3 SITE TESTING AND COMMISSIONING

Carry out the following:

- Attendance at the testing of all equipment that interfaces to the ACS and confirmation of the operation of such equipment from the ACS interface terminals.
- Testing of all field wiring from terminals to field interface terminal strips.
- Testing and commissioning of all power supplies and batteries.
- Verification of communication to remote systems.
- Testing of the operation of each control point from the operator's workstation (if supplied) and verification of the status of all points on graphic displays.

Demonstrate the following:

- Operation of each control loop.
- Communications with PC workstations.
- Time schedules and after-hours operation.
- Mapping of system points to operator's workstation(s).
- Operator's workstation software.
- Power fail re-starts.
- Essential power mode operation.

Final acceptance Test:

After the testing report and as built drawings have been approved by the customer's representative, the completed system shall be tested in the presence of the customer's representative.

Acceptance of the system shall require a demonstration of the stability of the system. Should major equipment failure occur, the contractor shall replace or repair component (s).

9.4 NOTICE OF COMPLETION

When the final acceptance test described above has been satisfactorily completed, the contractor shall issue a letter of completion to the customer indicating the date of such completion. The notice of completion shall be recorded by the contractor upon receipt of the customer completion letter. This date of record shall be the start of the one-year guarantee period.

10. SPECIFICATION FOR CABLES

10.1 8 Conductor, 18-24 AWG, Overall Shielded, PVC/PVC for Card Readers

Description	:	Shielded multi conductor control cable
Conductors	:	18/22 AWG 7/32 Strand Tinned Copper, 6 conductors
Insulation	:	Colour coded PVC 0.010"
Colour Code	:	Black, white, red, green, blue, brown
Shielding	:	100% aluminium mylar foil shield overall with a 24 AWG 7/32 strand tinned copper drain wire.
Jacket	:	Gray flame retardant PVC 0.032"
Nominal OD	:	0.205"
Capacitance	:	33 pF/Ft between conductors
Ratings	:	Manufactured in accordance with UL subject 13, type CM
Passed UL VW-1 Flame Test UL CM approved		

10.2 2 Pair, 18 AWG, Individually Shielded, Polypropylene Insulated Signal Cable for Intelligent Controller Communication.

Description	:	2 pair individually shielded cable
Conductors	:	18 AWG 7/30 Strand tinned copper, twisted into 2 pairs
Insulation	:	Colour coded polypropylene, 0.008"
Colour Code	:	Black with red, Green with white
Shielding	:	Each pair individually shielded with 100% aluminium mylar foiled shield plus 22 AWG 7/30 strand tinned copper drain wire.
Jacket	:	Gray flame retardant PVC
Nominal OD	:	0.170"

Capacitance	:	35 pF/Ft
Voltage	:	UL rated 300 Volts
Ratings	:	Manufactured in accordance with UL subject 13, type CM

Passed UL VW-1 Flame Test
UL CM approved

10.3 2 Pair, 20 AWG, Shielded, Multi-pair, Signal Cable for Electrical Bolt Release.

Description	:	3 pair over-all shielded cable
Conductors	:	20 AWG 7/28 Strand tinned copper, twisted into 3 pairs
Insulation	:	Colour coded polypropylene, 0.010"
Colour Code	:	Black with red, Black with white, Black with Green
Shielding	:	100% aluminium mylar foiled shield overall with 22 AWG 7/30 strand tinned copper drain wire.
Jacket	:	Gray flame retardant PVC 0.020"
Nominal OD	:	0.251"
Capacitance	:	45 pF/Ft between conductors
Voltage	:	UL rated 300 Volts
Ratings	:	Manufactured in accordance with UL subject 13, type CM

Passed UL VW-1 Flame Test
UL CM approved

11. TESTING

11.1 GENERAL

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Engineer-in-Charge.

Wiring continuity test.
Insulation resistance test.
Earth continuity test.

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

11.2 TESTING OF WIRING

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

11.3 INSULATION RESISTANCE TEST

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation shall have an insulation resistance greater than one megohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified

in the relevant standard specification or where there is no such specification, shall not be less than one megaohms. All equipments, cables shall be inspected at works by the Architect as per relevant IS and testing commissioning of installation as per Appendix 'E' of IS:732-1989 shall be done and all record to be maintained.

11.4 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

11.5 TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCH

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Engineer-In-Charge as well as the local authorities.

11.6 FIELD QUALITY CONTROL

Tests

- a. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
- b. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
- c. Preliminary Testing: Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.
- d. Request for Formal Inspection and Tests: When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contracting Officer.
- e. Final Testing: Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. A final acceptance test will not be scheduled until the operation and maintenance (O&M) manuals are furnished to the Contracting Officer and the following are provided at the job site:
 - i. The systems manufacturer's technical representative
 - ii. Marked-up red line drawings of the system as actually installed
 - iii. Megger test results
 - iv. Loop resistance test results

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S. No.	Details of Materials / Equipment	Manufacturer's Name
A.	<u>IP CCTV SYSTEM</u>	
1.	Encoders & Accessories	Axis Pelco Divitel Bosch GE
2.	CCTV Cameras & Accessories	American Dynamics Bosch GE Pelco
3.	Monitor	American Dynamics Bosch GE Pelco
4.	L2 & L3 Switches	D-Link Cisco Lanbit
5.	Communication Cable/ Signal Cables / Control / power Cables- Indegenous	Fusion Polymers Lapp kabel RR kabel Skytone
6.	Communication Cable/ Signal Cables / Control / power Cables- Imported	Belden Comscope-USA Volex
7	Metallic Conduits (MS/GI)	AKG BEC NIC
8.	Personal Computer	Dell Hewlet Packard IBM
9.	Color Monitor	LG Philips Samsung
10.	Printer	Epson NEC TVSE Hewlet Packard
11.	Mouse	Dell Logitech Microtek

S. No.	Details of Materials / Equipment	Manufacturer's Name
B.	<u>IP ACCESS CONTROL SYSTEM</u>	
1.	Door Controller Software	American Dynamics CardKey GE – Casirusco Kaba Honeywell – Prowatch Series
2.	Electric Door Strikes	Lock netics Miwa Lock Rutherford
3.	Cards and Card Readers (MiFare only)	HID GE Kaba
4.	L2 & L3 Switches	D-Link Cisco Lanbit
5.	Communication Cable/ Signal Cables / Control / power Cables- Indegenous	Fusion Polymers Lapp kabel RR kabel Skytone
6.	Communication Cable/ Signal Cables / Control / power Cables- Imported	Belden Comscope-USA Volex
7.	Metallic Conduits (MS/GI)	AKG BEC NIC
8.	Personal Computer	Dell Hewlet Packard IBM
9.	Color Monitor	LG Philips Samsung
10.	Printer	Epson NEC TVSE Hewlet Packard
11.	Mouse	Dell Logitech Microtek
12.	Turnstiles	FAAC(ITALY) Gunnebo- (UK/ GERMANY) Kaba Magnetic- USA/ Germany

69. TECHNICAL SPECIFICATIONS FIRE DETECTION AND FIRE ALARM SYSTEM

A. FIRE DETECTION AND ALARM SYSTEM

1. BASIS OF DESIGN

An Intelligent Fire Alarm System (IFAS) shall be provided to effect total control over the life safety services required in the building. The IFAS shall be of the digital, distributed processing, real time, multi-tasking, multi-user and multi-location type.

The IFAS provided shall be able to tie-up the following Mechanical, Electrical & Low Voltage Services into an integrated system.

- a. Air Handling Units
- b. Staircase pressurization fans, Lift shafts and lift lobbies pressurization fans.
- c. Public address system.
- d. Lifts
- e. Toilet Exhaust Fan
- f. Smoke evacuation system
- g. Fire fighting system

The system shall be provided with Addressable and Analog fire alarm initiating, annunciating and control devices.

The addressable and intelligent system shall be such that smoke sensors detectors, thermal sensors, manual call points, etc., can be identified with point address. The system shall be capable of:

- a. Setting smoke sensor sensitivity remotely (from the Fire Work Station) to either high sensitivity manually or on a pre-programmed sequence e.g. occupied/unoccupied period. The FAS shall be able to recognize normal and alarm conditions, below normal sensor values that reveal trouble condition, and above normal values that indicate either a prealarm condition or the need of maintenance.
- b. Read-out or address an actual space temperature at thermal detector points. The operator shall also be able to adjust alarm and prealarm thresholds and other parameters for the smoke sensors.
- c. Provide a maintenance/pre-alert alarm capability at smoke sensors to prevent the detectors from indicating a false alarm due to dust, dirt etc.
- d. Provide alarm verification of individual smoke sensors. Systems that performs alarm verification on a zone basis shall not be acceptable. Alarm verification shall be printed on the printer at the Control Station's printer to enhance system maintenance and identify possible problem areas.
- e. Provide local numeric point address and LED display of device and current condition of the point. Local annunciation shall not interfere with annunciation from the Fire Control System.
- f. Provide outputs that are addressable, i.e. outputs shall have point address. The operator shall be able to command such points manually or assign the points to Logical Point Groups (Software Zones) for pre-programmed operation.

In the event of a fire alarm, but not in a fault condition, the following action shall be performed automatically.

- a. The System Alarm LED on the main fire alarm control panel shall flash.
- b. A local piezo-electric sounder in the control panel shall be sounded.
- c. The LCD display on the main fire alarm control panel shall indicate all information associated with Fire Alarm condition including the type of alarm point and its location within the premises.
- d. Printing and history storage equipment shall log the information associated with the Fire Alarm Control Panel condition, along with the time and date of occurrence.
- e. All system output programs assigned via control-by-event programs that are to be activated by a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
- f. The audio portion of the system shall direct the proper signal (tone or voice) to the appropriate speaker circuit.
- g. All lifts initiated through the systems will automatically be returned to Ground Floor.
- h. Air handling units on affected floors shall automatically be switched OFF and simultaneously respective fire dampers shall also be closed.
- j. Staircase pressurization fans shall be put on.
- k. Toilet exhaust fans on affected floors shall be put off.
- l. Pre-recorded alarm messages shall be played through interface with Public Address system.
- m. Start smoke evacuation system.

2. FIRE ALARM CONTROL PANEL (FACP)

- 2.1 The distributed Intelligent Fire Alarm Control Panel (FACP) shall function as fully stand-alone panel as well as providing a communication interface to the central station. FACP shall have its own microprocessor, software and memory and should be listed under UL864 or EN54. In the event of failure of the central or communication breakdown between the central station and the FACP, the FACP shall automatically operate on stand-alone mode without sacrificing any functions.
- 2.2 The memory data for panel configuration and operation shall reside in non-volatile memory (EEPROM). Removal of the board shall not cause loss of memory. If such removal can cause loss of memory, then the card containing the memory shall have battery back-up for upto 100 hours on the board itself.
- 2.3 FACPs shall supervise detection circuits and shall generate an alarm in case of abnormal condition.
- 2.4 FACPs shall provide general purpose inputs for monitoring such functions as low battery or AC power failure. FACPs shall provide tamper protection and commandable outputs, which can operate relays or logic level devices. Output commands shall take any of, but not limited to, maintained command, Momentary Command, Alarm Follow, or Alarm latch as required. Any relay in the FACP which is intended to be removable shall be supervised against removal.
- 2.5 Smoke detectors shall be powered using the FACP-based smoke detection circuits. FACPs shall provide for resetting smoke detectors, fault-isolation and sensor loop operation. It shall be possible to mix different fire devices within the same FACP to optimize field wiring.
- 2.6 FACPs shall provide indication for communication with the central console and alarm/trouble conditions in each sensor loops.
- 2.7 FACPs shall provide monitoring and control of one floor or area or for multiple floors or areas. FACPs shall meet the following requirements to assure the integrity and reliability of the system:
- a. The FACP shall be UL or EN54 listed independently as a fire alarm control panel.
 - b. FACP electronics shall be contained in an enclosure made of minimum 16 gauge steel. Access to FACP switches and electronics shall be by key-lock. Usage of no other tools should be required. Visual indicators of FSP status for each zone shall be visible without opening the key-locked cover.
- 2.8 All hardware and software to allow the FACP configuration and operation to be changed shall be provided. Memory data shall be contained in non-volatile memory (EPROM).
- 2.9 Alarm verification with field-adjustable time from 0 to 60 seconds for individual smoke detector shall be provided. During the alarm verification, the panel shall retard the alarm until the end of the period. If the alarm is only a transient smoke alarm, the panel shall automatically reset the alarm. Only a verified alarm shall initiate the alarm sequence for the software zone (Logical Point Group) or point. Final time setting shall be as per approval of the fire authorities. When alarm verification is being performed on a smoke detector, the action shall be printed on the listed printer(s).
- 2.10 Digital numeric display at the FACP shall be provided to indicate point in alarm or trouble. In such systems, means for manually scanning the points in trouble shall be provided and a trouble and alarm LED shall be used to indicate that there are points in alarm/trouble. The alarm/trouble LED shall only extinguish when all alarm/troubles are cleared from the loop.
- 2.11 It shall be possible to command test, reset and alarm silence from both the FACP and the central console.

- 2.12 FACP switches shall allow authorized personnel to accomplish the following, independent of the central console:
- a. Initiate a general alarm condition.
 - b. Silence the local audible alarm.
 - c. It shall be possible to acknowledge (Silence the local FACP audible without silencing the alarm indicating devices (hooters).
 - d. Reset all zones (Logical Point Group) / points, after all initiating devices have returned to normal.
 - e. Perform a complete operational test of the microprocessor and memory with a visual indication with each board.
 - f. Test all panel LEDs for proper operation without causing a change in the condition of any zone (Logical Point Group)
 - g. Walk Test
- 2.13 Software zones/loops shall be circuited and protected by Fault Isolation Modules such that in the event of a zone/loop short-circuit, not more than twenty (20) devices shall be left non-functional.
- 2.14 Intelligent Smoke and thermal sensors shall be located as shown and shall report sensed levels in analog form.
- 2.15 Monitor modules shall be provided to monitor and address contact-type input devices. The monitor module shall be supervised by FACP.
- 2.16 The FACP shall process the true continuous analog signal from the sensors. System using step setting to represent analog signal will not be accepted. The FACP shall be able to set dual alarms threshold for occupied and unoccupied periods. During unoccupied period, the alarm threshold shall automatically be lowered to facilitate quicker response. In addition, the FACP shall further process all analog values for pre-alarm limits to prompt the operator for early maintenance. If a sensor value increases to an above normal level or a pre-alarm limit for an extended duration, the FACP shall communicate maintenance pre-alarm.
- a. Any time sensor value transitions beyond the secondary and higher limit value, an alarm initiation and report shall be issued.
 - b. Limits and sensor values shall be displayed, modifiable, and reported in decimal values.
 - c. The FACP shall have Drift Compensation facility to compensate for environment. The FACP shall have the ability to recalibrate Pre-alarm and Alarm limits if required, after comparing each sensor's operating characteristics with the set sensitivity. This should be carried out at least once in every 24 hours. FACP should annunciate trouble conditions when sensor(s) is beyond compensation range (excessively dirty sensor).
 - d. The FACP should be UL listed or EN 54 approved to provide the sensitivity measurement and documentation required by NFPA72E.
- 2.17 FACP shall be backed up with its built in UPS power and shall also be connected to central DG Power available in the building.

2.18 FACP shall be provided with following features :

Charger Rate Control

Control-by-Time	Non-Alarm Module Reporting
Day/Night Sensitivity	Periodic Detector Test
Device Blink Control	Remote Page
Drift Compensation	Trouble Reminder
NFPA 72 Sensitivity Test Verification Counters	
System Status Reports	Walk Test
Security Monitor Points	Maintenance Alert
Alarm Verification	System Configuration Report
Printer Interface	System Point Report
Event Historical log	Programmable Automatic Timed and Manual Signal Silence
Programmable Manual Signal	Control-By-Event with Boolean Logic
Silence Inhibit Timer	and Timer Control

2.19 FACP shall have real-time clock to prevent loss of time and date in case of failure of power supplies.

2.20 The display on FACP shall provide indication for AC Power, System Alarm, System Trouble/Security Alarm, Display Trouble and Signal Silence.

2.21 Minimum two different password levels will be provided to prevent unauthorized System control or programming.

2.22 Operator control switches for Signal Silence, lamp Test, Reset, System Test and Acknowledge shall be provided.

2.23 The FACP should truly field programmable. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate these by use of the alpha-numeric keys on the FACP panel to reconfigure the above parameters. Panels, which require external programming devices to perform the above function will not be acceptable.

2.24 The FACP should have a degraded mode of operation. In the event of the CPU failure the field devices (detectors & modules) should report the condition on a simple digital communication mode to ensure reliability even during failure.

2.25 Power supply unit of FACP shall have following characters :

- The main power supply shall be 230 VAC \pm 10%, 50 Hz \pm 1% and shall in turn provide all necessary power of the FACP.
- It shall provide a battery charger for 24 hours for standby power using dual-rate charging technique for fast battery recharge.
- It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.
- It shall be power-limiting using Positive Temperature Coefficient (PTC) resistor.
- It shall provide indication for battery voltage and charging current.

2.26 For ease of service, all wiring terminal blocks shall be plug-in type and shall have sufficient capacity for 18 to 12 AWG wire termination. Fixed terminal blocks shall not be acceptable.

3. DETECTORS & ADDRESSABLE DEVICES

3.1 GENERAL FEATURES COMMON TO ALL DETECTORS

- a. Compatibility: All automatic fire detectors shall be inter changeable without requiring different mounting bases or alterations in the signal panel.
- b. Response Spectrum: Combustion gas detectors shall respond to both visible and invisible aerosols; size and colour of the aerosols shall not have a decisive influence on the response of the detector.
- c. Sensitivity: On average 30 mgs of burned material per cu.m. (as measured in a 1 cu.m. chamber) shall release an alarm sensitivity which shall be adjustable according to the use of the space.
- d. Power Consumption: Each detector shall use the minimum of power, for economic circuits, so that it shall have capacity to connect atleast 99 detectors, 50 modules and 20 fault isolator modules in one loop.
- e. Built-in-response indicator: Each detector shall incorporate indicator “LED” at the detector which shall blink during normal condition and light up on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp.
- f. Maintenance: All detectors shall be fitted either with plug-in system or bayonet type connections only, from the maintenance and compatibility point of view.
- g. Construction: The detector shall be vibration and shock proof. When disassembling for cleaning purposes, its components must not be damaged by static over voltage.
- h. Atmospheric and Thermal Disturbance : The detector shall so designed as to be practically immune to environmental criteria such as air currents, humidity, temperature fluctuations, pressure and shall not trigger false alarm, due to the above conditions.
- j. Continuous Operation: An alarm release shall not effect a detector’s functioning. After resetting the alarm, the detector shall resume operation without any readjustment.
- k. Adaptability to ambient conditions: Detectors shall be designed for adaptability to humid locations. No performance deterioration shall be acceptable.

3.2 ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS

Smoke detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum to 99 intelligent detectors should connect to one loop. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog value for smoke density. The detectors shall be ceiling mounted type and shall include a twist-lock base.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may activated remotely on command from the control panel.

The detectors shall provide address-setting means on the detector head using rotary decimal switches. Systems which use binary jumpers or DIP switches to set the detector address shall not be acceptable. The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector. Detectors providing address setting through hand held programmers shall also be accepted.

The detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

The detector sensitivity shall be set through the Fire Alarm Control Panel, and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.

Using software in the FACP, the detectors shall compensate for dust accumulation and other slow environmental changes which may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.

The area covered by each smoke detector shall be as per IS-2189.

3.3 MULTI-SENSOR PHOTO THERMAL DETECTOR:

The mutisensor or multitech smoke detector which will have both photoelectric as well as thermal detection elements shall have inbuilt microprocessor, and shall be capable of taking an independent alarm decision. The scattering of smoke particles shall activate the photo sensor. Each intelligent addressable smoke detector's sensitivity shall be capable of being programmed electronically from Control Panel without any extra tools as: most sensitive, more sensitive, normal, less sensitive or least sensitive.

In addition to the five sensitivity levels the detector shall provide a prealarm sensitivity setting, which shall be settable in 5% increments of the detector's alarm sensitivity value. The detector should continue to give TRUE alarms even if the loop controller on the main panel fails. Alarm condition shall be based upon the combined input from the photoelectric and thermal detection elements.

Each detector shall be capable of transmitting prealarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings.

Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient "environmental thresholds approximately six times an hour.. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value.

3.4 ADDRESSABLE THERMAL DETECTORS

Thermal detectors shall be intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops. Minimum 99 intelligent thermal detectors may connect to one loop.

The detectors shall use an electronic detector to measure thermal conditions caused by a fire and shall, on command from the control panel, send data to the panel representing the analog level of such thermal measurements. The detectors shall be ceiling-mounted type and shall include a twist-lock base.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated remotely on command from the control panel.

The detectors shall provide address-setting means on the detector head using rotary decimal switches. Systems which use binary jumpers or DIP switches to set the address shall not be acceptable. Detectors providing address setting through hand held programmers shall also be accepted.

The detectors shall provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions. In certain applications, LEDs may be selected to be polled without flashing through system programming. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected.

An output connection shall be provided in the base to connect an external remote alarm LED.

3.5 INTELLENT DUCT SMOKE DETECTOR

The Smoke Detector housing shall accommodate intelligent photoelectric detector. The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.

When sufficient smoke is sensed, an alarm signal to be initiated and appropriate action taken to change over air handling system to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

3.6 ADDRESSABLE MANUAL STATIONS

Addressable manual stations shall be provided to connect to the Fire Alarm Control Panel loops. Minimum 99 addressable manual stations may be connected to one loop.

The manual stations shall on command from the Control Panel send data to the panel representing the state of the manual station.

Press/break stations with resettable capability are also acceptable.

Manual stations shall be constructed of high impact LEXAN sheet with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters.

Stations shall be suitable for surface mounting as shown on the plans, or semi-flush mounting, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor unless otherwise specified by applicable building codes.

3.7 ADDRESSABLE MONITOR MODULE

The monitor module shall provide address-setting and shall also store an internal identifying code which the Fire Alarm Control Panel shall use to identify the type of device. Modules using binary jumpers are not acceptable. An LED shall be provided which shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

3.8 CONTROL MODULE

The control module shall provide address-setting and shall also store an internal identifying code which the control panel shall use to identify the type of device. Modules which use binary jumpers are not acceptable. An LED shall be provided which shall flash under normal conditions, indicating that the control module is operational and is in regular communication with the control panel.

3.9 ADDRESSABLE HOOTERS

All field hooters should preferably be addressable and software configurable. All hooters should be able to provide at least a minimum of 3 different tones, which should be user configurable. The minimum decibel level of each hooter should be 90db. All hooters should be UL/FM listed.

3.10 TELEPHONE HANDSETS

The contractor shall Provide firefighter's telephone handsets for use with the firefighter's telephone jack stations. The telephone handsets shall be red in color and have a 5 ft (1.3m) coiled cord.

3.10.1 Telephone Jacks

The contractor shall provide stainless steel firefighter's telephone jack stations at the locations shown on the drawings. The jack station shall be clearly identified with the words "FIRE FIGHTER'S TELEPHONE" for use with portable fire fighter telephone handsets.

4. CABLES

All PVC insulated FRLS copper conductor stranded cables shall be 650 volts grade and shall generally conform to IS and meets the signal cabling requirement of the system manufacturer.

Strands of cables shall not be cut to accommodate & connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturers. All cables shall be laid with minimum one diameter gap and shall be clamped at every metre and shall be tagged for identification with aluminium tag and clamped properly. Tags shall be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable shall be identified by embossing on the tag the size of the cable, place of origin and termination.

These shall be measured on linear basis including the fittings required like, end termination junction boxes.

Aluminium conductor armoured Fire Survival cable with (EPR) Ethylene Propylene rubber insulation as per BS 7846: 2009 & IEC-60502: 2004 Part-1 (Armoured), Retain circuit integrity as per BS 6387 C.W.Z (armoured), BS-8491: 2008, BS 8434-2: 2009 (armoured), (Resistance to fire at 950° C for 3 hours)

1.3 Metal Conduits & Accessories

1.3.1 Conduits

Conduits and Accessories shall conform to latest edition of Indian Standards IS: 9537 part 1 & 2. 16/ 14 (16 gauge upto 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed MS conduits as specified on schedule of quantities shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS: 2667, IS: 3837 and IS: 5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Note: Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan.

1.3.2 Joints

All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberised bushes

shall be used in the conduit entry and exit from DBs, switch boxes etc., so that wires are protected from damage to insulation of the incoming and outgoing wires

1.3.3 Recessed or Exposed Conduits

All conduits shall be as per Schedule of Quantities.

1.3.4 Flexible Conduits

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip shall have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature upto 150 deg. C and intermittent temperature upto 200 deg. C. The flexible conduit shall be corrosion resistant as per IS: 3480 & BS: 731.

1.5 Bends in Conduit

Where necessary, bends or diversions may be achieved by means of bends and/ or circular cast iron boxes with inspection cover and with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non-uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enamelling/ Galvanising of the Conduit are not damaged.

1.6 Fixing of Conduits

All conduits shall be installed so as to avoid exposure to steam, hot water or any other process pipes. After the conduits, junction boxes, outlet boxes and switch boxes are installed in position, their outlets shall be properly plugged or covered so that water, mortar, rodents and insects, insects or any other foreign matter does not enter into the conduit system. Surface conduits shall be fixed by means of heavy gauge GI saddles secured at intervals not more than 1000 mm and on either side of couplers or bends or similar fitting saddles shall be fixed at a distance of 300 mm from centre of each fitting. For conduit fixing suitable PVC/ Nylon fasteners shall be used.

Recessed conduiting shall be done by making chase in the masonry by chase cutter, the conduit shall be fixed in the chase by means of GI hooks not more than 600 mm apart. After fixing of conduit the chase shall be filled with cement mortar after fixing of chicken mesh and brought to the original finish level of the surface to the entire satisfaction of Owner

1.8 Inspection Boxes

50 mm dia inspection boxes and pull boxes shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

1.9 Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided along with the laying of recessed conduit.

1.13 Joints

All joints shall be made at main switches, distribution boards socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

5. EMERGENCY VOICE EVACUATION (EVAC)

The FACP shall contain all equipment required for audio, communication, signaling and supervisory functions. This shall include speaker zone indication, digital voice units, and microphone.

- a. Function: The EVAC system equipment shall perform following functions:
 - i. Operate as a supervised dual channel emergency voice communication system.
 - ii. Operate as a two-way emergency communication system control center.
 - iii. Supervise condition of every connection circuit.
 - iv. Audibly and visually annunciate any trouble condition of tone generators and digital voice units required for normal operation of the system.
 - v. Provide all-call activities through activation of a single control switch. Provide selectable zone calling.
 - vi. Provide automatic, digitally-recorded voice messages or field-programmed through the microphone.
- b. The system shall be modular in construction and shall be capable of being field programmable without requiring the return of any components to the manufacturer.
- c. The system and associated equipment shall be protected against unusually high voltage surges or line transients.

6. FUNCTIONAL REQUIREMENTS

6.1 INTELLIGENT SYSTEM DEVICES

- a. Each device shall be assigned a unique address via easily understood decade (01 to 99) switch. Address selection via binary switches is not acceptable. Devices which take their address from their position on the circuit are unacceptable.
- b. Devices shall receive power and communication from the same pair of conductors.

6.2 SENSORS

- a. All fire sensors shall mount on a common base to facilitate the changing of sensor type if building conditions change. The base shall be incompatible with conventional detectors to preclude the mounting of a non-intelligent device.
- b. Each sensor shall contain an LED which shall blink each time the sensor is scanned by the FACP. If the FACP determines that the sensor is in alarm, the FACP shall command the sensor LED to get latched on.
- c. Each sensor shall be capable of being tested for alarm via command from the FACP.
- d. Each sensor shall respond to FACP scan for information with its type identification to preclude inadvertent substitution of another sensor type. The FACP shall continue operation with the detector installed but shall initiate a mismatch (trouble) condition until the proper detector is installed.
- e. Each sensor shall respond to FACP scan for information with an analog representation of measured fire-related phenomenon (smoke density, particles of combustion, temperature). Systems which only monitor the presence of conventional detector in an addressable base shall not be acceptable.

- f. Photoelectric smoke sensors shall contain an optical sensing chamber with nominal sensitivity of 2.3% foot obstruction.
- g. Ionization smoke sensors shall contain a unipolar dual chamber with nominal sensitivity of 2.3% foot obscuration.

6.3 INPUT DEVICES

- a. The input device shall provide an addressable input for N.O. or N.C. contact devices such as manual stations etc.
- b. The input device shall provide a supervised initiating circuit. An open-circuit fault shall annunciate at the FACP (subsequent alarms shall be reported).
- c. The device shall contain an LED which will blink upon being scanned by the FACP. Upon determination of an alarm condition, the LED shall be latched on.

6.4 AUTOMATIC FUNCTIONS AT FACP

The alarms shall be displayed at the FACP on an LCD display. The display shall indicate the device in alarm by ID number, the appropriate alarm state, and the current time and date. It shall also display a point description of minimum 32 characters and, the respective analog value. The display shall also contain a minimum 40 characters alarm message. It shall be possible to see the number of acknowledged alarms, number of current fire alarms, number of trouble conditions and number of other miscellaneous alarms in the system. The FACP printer shall print out same information displayed on the LCD display. The LCD display and printer shall be powered directly from the panel.

6.5 MANUAL FUNCTIONS AT FACP

- i. At any given time, operator shall have the following manual capabilities at FACP by means of switches located behind a key-locked cover:
 - a. Initiate an alarm summary display on the FACP LCD display. This display shall step through all currently active alarms in the system.
 - b. Initiate a summary printout of all currently active alarms on the FACP printer.
 - c. Initiate an "all-point summary" printout on the FACP printer recording the status of each system point (initiating circuits, indicating circuits etc.)
- ii. At any time, the operator shall have following manual capabilities at the FACP under password control; Operator privileges and ID numbers of upto four digits shall assignable by the main operator or designated alternate. Actions taken by operators shall automatically be printed on the FACP printer with operator initials, time and date.
 - a. Commands output points to different mode. Such commands shall be printed with selected descriptors ON/OFF/AUTO, OPEN/CLOSE, DAY/NIGHT etc. In addition, command shall be used to ISOLATE or DISCONNECT points. When isolated, alarms and troubles shall be received but not acted upon.
 - b. Modify system parameters. Alphanumeric key pad shall be provided for operators to modify the following parameters:

- * Change sensor alarm and pre-alarm threshold
 - * Update date and time
 - * Change point descriptors
 - * Change action message
 - * Disable a point
 - * Change sensor verification time
 - * Change password

- * Activate/deactivate indicating output control point
 - * Control-by-event programs on line
- c. Select a system status report for printing on the printer from the control station. The following real time reports shall be provided:
- * All point log.
 - * Alarm summary
 - * Trouble summary
 - * Status summary
 - * Sensitivity log
 - * Disabled points log.
 - * Isolated points log
 - * Disconnected points log
 - * Logical group points log

The sensitivity log shall print the analog value of each addressable analog sensor.

- d. Select printing of a trend sensitivity log which when enabled, shall print minimum last 24 analog values for every addressable analog sensor taken at predetermined intervals. Systems which limit the number of addressable analog sensors which can be trended are not acceptable.
- e. Select a sequence of programmed commands which can be automatically executed, in sequence, via a single command.
- f. Perform a walk-test function such that a operation can be periodically checked out for all initiating devices on a zone. In walk test mode, all initiators on the selected zone shall automatically be isolated. As each device is placed into an alarm or trouble condition, the FACP shall print the condition and automatically reset the device. No audible signals shall be initiated from the zone to prevent disruption of building occupants. If a zone is inadvertently left in the walk-test mode, it shall automatically reset to normal after a five-minute idle time is exceeded.

6.6 SYSTEM SUPERVISION

- a. In the normal supervisory condition, only the “POWER” ON, and “RUN” conditions, shall be illuminated. The LCD display shall display “System Normal” and the current time and date.
- b. The LCD display shall indicate the loss of power condition and the printer shall record the same. Following restoration of normal AC power, the trouble indicators shall be automatically reset and the printer shall record the ‘return to normal condition’.
- c. The LCD display shall indicate the loop in trouble and the printer shall record same.
- d. The LCD display shall indicate trouble and the printer shall record same. Operation of a momentary “Silence” switch shall silence the audible trouble signal but the visual “Trouble” LEDs shall remain ON until the malfunction has been corrected and the system has reset. The FACP printer shall record this action.

6.7 PROGRAMMING OF FACP

The LCD display and printer programming shall be accomplished on site by means of lap-top personal computer which shall plug into the FACP. Modules requiring off-site programming are not acceptable. LCD shall initiate test of all addressable sensors in the system.

Programming functions shall include alarm/trouble type assignment, point descriptor assignment, alarm message assignment etc. Data file for the LCD display and a printer shall be stored in EEPROM.

6.8 OTHER DEVICES

Fault-isolation of fire zones (Logical Point Group) / circuit modules shall be provided to enable part of a fault-tolerant loop to continue operating when a short occurs in the loop.

6.9 FIRE ALARM GRAPHICS SOFTWARE (FAS)

The status of each detector shall be monitored by the FAS.

Using the FAS, the operator shall be able to adjust the sensitivity of any detector.

Using the FAS, the operator shall be able to define the entire database for the file system. Fire system which are not field programmable shall not be accepted.

The FAS operator shall be able to acknowledge alarms or trouble messages at the FAS.

It shall be necessary for all alarm or trouble conditions to be acknowledge at the fire system central panel.

FAS software shall be upload/download type as well as with graphic facilities.

The contractor shall list out the graphic facilities being provided by him.

All devices & detectors shall be visible on building plans superimposed in FAS software.

6.10 FIRE CONTROL SEQUENCES

Upon activation of fire alarm devices:

FACP will display the exact address & alarm in the panel.

The Central Control Station shall switch OFF the AHUs of the affected floor fire damper and toilet exhaust fans while the AHUs on the other floors shall remain operational so as to keep the area under positive pressure.

Staircase pressurization fans shall be operated through the fire alarm system.

Appropriate fire messages shall start to broadcast automatically (synthesized voice) after time delay.

Activate the fire alarm signaling devices.

Capture the lifts and return them to the ground floor.

The lifts and escalators alarms (provided by lift and escalator contractor) shall be tied to the Fire Alarm System. The Fire Alarm System shall function as follows:

In the event of a fire, a signal will be provided by the Fire Alarm System to return all lifts to ground floor.

Should an emergency alarm originate from an individual lift, an audible alarm shall sound at both Fire Control Stations, and print out at the printers.

When an alarm is detected

- * All include annunciating devices on the floor one above and one below shall sound.
- * Stairwell pressurization fans shall be started.
- * The air handling unit for the floor shall be stopped.
- * The air handling unit on the floor above and the floor below shall be started unless those floors are also in alarm.

* Smoke extraction from Exhibition Hall.

If the alarm has not been acknowledge at the central panel within one minute, all audible annunciating devices on the floor above and the floor below shall sound. If the alarm has not been acknowledged at the central panel within three minutes, all audible annunciating devices on the building shall sound.

It shall be possible to accomplish the following, independent of the central console:

- a. Initiate a general alarm condition.
- b. Silence the local audible.
- c. Silence the alarm signals. It shall be possible to acknowledge (silence) the local FACP audible without silencing the alarm indicating devices (hooters).
- d. Reset all zones, after all initiating devices have returned to normal.
- e. Perform a complete operational test of the microprocessor and memory with a visual indication of satisfactory communication with each board.
- f. Test all panel LED's for proper operation without causing a change in the condition of any zone.
- g. Print reports of all points based on Historical data.
- h. Read the status of each point based on LCD display and print the status information.
- j. Change passwords.
- k. Disable points/zones.
- l. Change sensitivity of sensors.
- m. Perform a walk test and generate walk test report.

6.11 FIRE FIGHTERS TELEPHONE SYSTEM

Fire Fighter telephone system shall be as follows:

- 6.11.1 Firefighter telephone communication system shall have with complete, common talk, closed circuits. The system shall include, but not be limited to, a master control station mounted in the fire alarm control panel, a power supply and standby battery system, and remote telephone stations.
- 6.11.2 Master control station which shall provide power, supervision, and control for wiring, components, and circuits. The act of lifting any remote telephone hand set from its cradle shall cause both a visual and audible signal to annunciate at the master control station. Removing the hand set at the master control station and depressing a button at the remote telephone hand set shall cause the automatic silencing of the audible signal. Communication between the master control station hand set and any/or all remote hand sets shall require the depressing of a push-to-talk switch located on any/all remote hand sets. During the time that the master control hand set is removed from its cradle it shall be possible to communicate between five remote hand sets and the master control station. Hand sets shall be able to monitor any conversation in progress and join the conversation by pressing the push-to-talk button. It shall not be possible to communicate between two or more remote hand sets with the master control station hand set in its cradle. The master control station hand set shall be red in color and equipped with a 5-foot long strain- relieved coiled cord. Wiring connections shall be made to terminal strips. The master control station shall monitor wire and connections for any opens, shorts, or grounds which would render the system inoperable or unintelligible. The master control station shall be equipped with a silencing switch and ring-back feature such that any audible trouble signal can be silenced and shall be so indicated by the lighting of an amber LED. Once any trouble condition has been corrected, the

amber LED shall be extinguished and the silencing switch shall sound again until the switch is restored to its original position. The master control station shall be equipped with a separate, LED annunciated switch for each telephone circuit. In addition, LEDs shall provide for the annunciation of operating and supervisory power. The loss of operating or supervisory power shall cause an audible and visual indication at the master control station and shall also cause the fire alarm trouble signal to sound on the FACP. Switches, LEDs, and controls shall be fully labeled.

Each station shall be equipped with a hinged door that is magnetically locked. Each hand set shall be permanently wired in place with a coiled cord. Each hand set shall be red high-impact cyclac and shall be equipped with a push-to-talk switch which, when operated, shall signal the master control station and a switch-equipped, storage cradle.

Provide operating and supervising power from the same supply circuit(s) utilized for the fire alarm control panel. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

6.12 SPEAKERS

All speakers shall operate on 70 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.

Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).

Frequency response shall be a minimum of 400 HZ to 4000 HZ.

The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

System paging from emergency telephone circuits shall be supported.

The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:

LED Indicators:

Lamp Test

Trouble

Off-Line Trouble

Microphone Trouble

Phone Trouble

Busy/Wait

Page Inhibited

Pre/Post Announcement Tone

Controls with associated LED Indicators:

Speaker Switches/Indicators

The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.

The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

7. THE RATE OF EACH ITEM OF WORK FOR FIRE DETECTION AND ALARM SYSTEM SHALL ALSO INCLUDE THE FOLLOWING

- a. All materials, fixing materials, accessories, appliances, tools and equipment.
- b. Approved cover plates for inspection, junction and outlet boxes.
- c. 1.6 mm thick outlet boxes and junction boxes.
- d. All fixing accessories such as clips, nails, screws etc.
- e. Providing and fixing approved saddles, hooks and grouting the same as required, in the case of all exposed conduit work.
- f. Embedding conduits and accessories in wall, floors etc. during construction and / or cutting chases and making good as necessary in the case of all concealed conduit work.
- g. Testing and commissioning of each device, circuit as per the requirements of NFPA 72, TAC, local authorities and to be witnessed by the Engineer-In-Charge/ Department and or fire protection consultant.

8. NOTICE OF COMPLETION

When the final acceptance test described above has been satisfactorily completed, the contractor shall issue a letter of completion to the customer indicating the date of such completion. The notice of completion shall be recorded by the contractor upon receipt of the customer completion letter. This date of record shall be the start of the one-year guarantee period.

9. TESTING

9.1 GENERAL

At the completion of the work, the entire installation shall be subject to the following tests in the presence of the Engineer-In-Charge.

Wiring continuity test.
Insulation resistance test.
Earth continuity test.

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the Contractor at his own cost.

9.2 TESTING OF WIRING

All wiring systems shall be tested for continuity of circuits, and earthing after wiring is completed and before installation is energized.

9.3 INSULATION RESISTANCE TEST

The insulation resistance shall be measured between earth and the whole system of conductors, or any section thereof, with all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 660 volts for medium voltage circuits.

Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 divided by the number of points provided on the circuit, the whole installation shall have an insulation resistance greater than one megaohms. The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant standard specification or where there is no such specification, shall not be less than one megaohms. All equipments, cables shall be inspected at works by the Engineer-In-Charge as per relevant IS and testing commissioning of installation as per Appendix 'E' of IS:732-1989 shall be done and all record to be maintained.

9.4 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

9.5 TESTING OF POLARITY OF NON-LINKED SINGLE POLE SWITCH

In a two wire installation a test shall be made to verify that all non-lined single pole switches have been connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Engineer-In-Charge as well as the local authorities.

9.6 INSTALLATION OF FIRE ALARM INITIATING AND INDICATING DEVICES

- a. Fire Alarm Control Panel (FACP) : The FACP shall be fixed as indicated on the drawings the enclosure with the top of the cabinet 1830 mm 6 feet above the finished floor or center the cabinet at 1525mm or 5 feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FACP.
- b. Manual Stations: The Manual stations shall be fixed as required by NFPA 101 and NFPA 72 or as shown on the drawings or in accordance with Engineer-In-Charge. Mount stations so that their operating handles are 1220 mm 4 feet above the finished floor. Mount stations so they are located no farther than 1525 mm 5 feet from the exit door they serve, measured horizontally.
- c. Notification Appliance Devices: Notification appliance devices shall be fixed as required by NFPA 72 or as shown on the drawings. Mount assemblies on walls 2030 mm 80 inches above the finished floor or 150 mm 6 inches below the ceiling whichever is lower. Ceiling mounted speakers shall conform to NFPA 72.
- d. Smoke and Heat Sensors: Sensors shall be fixed as required by NFPA 72 and their listings or as shown on the drawings on a 100x100mm inch mounting box. Sensors located on the ceiling shall be installed not less than 100 mm 4 inches from a side wall to the near edge. Those located on the wall shall have the top of the sensor at least 100 mm 4 inches below the ceiling, but not more than 300 mm 12 inches below the ceiling. In raised floor spaces, the smoke sensors shall be installed to protect 20.9 square meters 225 square feet per sensor. Install smoke sensors no closer than 1525 mm 5 feet from air handling supply outlets.
- e. Graphic Annunciator: Locate the graphic annunciator as shown on the drawings. Surface mount the panel, with the top of the panel 1830 mm 6 feet above the finished floor or center the panel at 1525 mm or 5 feet, whichever is lower.
- f. Water Flow Detectors and Tamper Switches: Locate water flow detectors and tamper switches where shown on the drawings at each supervised sprinkler valve station.

- g. Firefighter Telephones: Locate wall mounted in each stair at each floor landing, in each elevator lobby, and in each elevator cab 1220 mm 4 feet above the finished floor.

9.7 FIELD QUALITY CONTROL

Tests

- a. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
- b. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
- c. Preliminary Testing: Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.
- d. Request for Formal Inspection and Tests: When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contracting Officer.
- e. Final Testing: Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. A final acceptance test will not be scheduled until the operation and maintenance (O&M) manuals are furnished to the Contracting Officer and the following are provided at the job site:
 - i. The systems manufacturer's technical representative
 - ii. Marked-up red line drawings of the system as actually installed
 - iii. Megger test results
 - iv. Loop resistance test results
 - v. Complete program printout including input/output addresses

The final tests shall be witnessed by the Fire Protection Engineer deputed by the Department or as instructed by project in charge. At this time, any and all required tests shall be repeated at their discretion. Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to the Contracting Officer for review and acceptance.

9.8 MINIMUM SYSTEM TESTS

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

- a. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.
- b. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
- c. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- d. Verify activation of all water flow switches.
- e. Open initiating device circuits and verify that the trouble signal actuates.
- f. Open and short signaling line circuits and verify that the trouble signal actuates.
- g. Open and short notification appliance circuits and verify that trouble signal actuates.
- h. Ground all circuits and verify response of trouble signals.
- i. Check presence and audibility of tone at all alarm notification devices.
- j. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
- k. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- l. Test each initiating and indicating device and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Testing of duct smoke detectors shall comply with the requirements of NFPA 72.
- m. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.
- n. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.
- o. Determine that the system is operable under trouble conditions as specified.
- p. Visually inspect wiring.
- q. Test the battery charger and batteries.
- r. Verify that software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided to the Contracting Officer.
- s. Verify that red-line drawings are accurate.
- t. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.
- u. Measure voltage readings for circuits to ensure that voltage drop is not excessive.
- v. Disconnect the verification feature for smoke sensors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke sensors shall be conducted using real smoke. The use of canned smoke is prohibited.

- w. Measure the voltage drop at the most remote appliance on each notification appliance circuit.

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S. No.	Details of Materials / Equipment	Manufacturer's Name
A.	<u>FAS SYSTEM</u>	
1.	Smoke / Multicriteria/Detectors	Notifier Edwards Honeywell (XLS-3000)
2.	Heat Detectors	Notifier Edwards Honeywell (XLS-3000)
3.	Control Modules / Monitor Modules / Fault Isolators	Notifier Edwards Honeywell (XLS-3000)
4.	Main Control Panel	Notifier Edwards Honeywell (XLS-3000)
5.	Manual Call Stations / Hooters /Speakers	Notifier Edwards Honeywell (XLS-3000)
6.	Sealed Maintenance free Batteries	Exide GS Batteries (Japan Storage Co. Ltd.) Hitachi
7.	PVC insulated copper conductor FRLS cable	National Polycab Skytone
8.	MS Conduits	AKG BEC
9.	Accessories for Metallic Conduit (ISI approved)	Sharma Sales Corporation Super Sales Corporation Prakash Sales
10.	Computer	IBM HCL. HP
11.	Colour Monitor (work stations)	Sony Panasonic Samsung
12.	Printer	NEC TVSE
13.	Mouse	Microsoft

TECHNICAL SPECIFICATION HVAC

1.0 BASIC SYSTEM DESIGN

1. SCOPE

- 1.1 Central air conditioning system has been proposed for the air conditioning of Super Speciality Hospital at West Bengal.
- 1.2 This system is designed to cater air conditioning requirement to the different areas of the building. The toilets are mechanically ventilated.

2. BASIS OF DESIGN

Location: Proposed Super Specialty Hospital at West Bengal.

2.1 Design Parameters

Outside Conditions	Summer	: 42.2°C DB; 25.5°C WB (26% RH)
	Winter	: 10.0°C DB; 6.6°C WB (60% RH)

2.2 Inside Conditions (Summer & Winter)	General	: 24.0°C ± 1.0°C DB (for General areas) RH not exceeding 55% in all areas.
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Inside Conditions (Temperature) : As per Table – I

Outdoor Air (Fresh Air) : As per Table – I & III

Lighting / Equipment Load/Occupancy : As per Table – II

Table: I

Function Space	Pressure Relationship to Adjacent Areas	Minimum Air Changes of Outdoor Air Per Hour	Air Exhausted Directly to Outdoors	Air Re circulated within room units	Inside Design Temp (°C)
Septic Operating room (100% Fresh Air)	Positive	45	Yes	No	21
Operating room (25% Fresh Air)	Positive	8	Yes	Partially	21
Septic Nursery (25% Fresh Air)	Positive	4	Yes	Partially	24
MICU / SICU	Positive	2	Yes	Partially	22
Pre / Post Operative	Positive	2	Yes	Yes	22
Labour Room	Positive	2	Yes	Yes	22
Super specialty ward	Positive	2	Yes	Yes	24

Table: II

S.N	Description	Light Load (W/Sqft)	Equipment Load (W/Sqft)	Occupancy (Sqft / Person)
1	Operation Theatre	4	3 KW	60
2	SICU/MICU	1.5	0.5	As per Arch. Layout
3	Super Specialty ward	2	0.5	As per Arch. Layout
4	Post/Pre Operative	2	0.5	As per Arch. Layout
5	X Ray/Ultrasound	2	5	50
6	Labs	2	4	40
7	Doctor Duty room/Account Section/Office	2	3	60
8	Conference	2	1	As per Arch. Layout

Table: III

S.No	Description	Fresh Air (cfm/person)
1	X Ray/Ultrasound	17
2	Labs	17
3	Doctor Duty room/Account Section/Office	13
4	Conference	5

2.3 Hours of Operation 18 hours per day

2.4 Roof Insulation All exposed roof shall be insulated with 50 mm thick Glass wool with density of 48 Kg/m³.

3.0 ESTIMATED LOAD

On the basis of data given above, the estimated load for the air conditioning system is summarized in Table-III.

(Tenderer shall work out the heat loads on their own and satisfy themselves that the plant specified in this tender shall be able to maintain the inside conditions as per specification.)

Table: III

S.No	Description	Area (Sq.ft.)	AC Load (TR)
1	Ground Floor	1450	12
2	First Floor	5830	42
3	Second Floor	9545	100
4	Third Floor	260	2.5
5	Fourth Floor	260	2.5
6	Total	17345	159.0

Total Tonnage of the building = 159.0 TR
 Considering Diversity @ 75 % = **119 TR**
120 (Say)

4.0 SYSTEM DESIGN

1. It is proposed to provide a central Air-conditioning system to maintain the specified inside design conditions during summer & monsoon for the building.
2. The total peak air conditioning load works out to 119 TR for all the floors. To cater this load, it is proposed to install 3 Nos. Screw type Air-cooled chilling machines (2W plus 1S) each having 60 TR capacity. One chiller shall be with desuper heater of 30 KW capacity and 2 nos. chillers without desuper heater.
3. It is also proposed to provide 1 No. of Hot Water Generator of 40 KW capacity for space heating & 2 Nos. of separate Hot Water Generators (1W+1S) of 20 KW capacity (each) with their own pumps for Operation theatres.
4. Air Cooled chilling machines shall work in conjunction with 3 Nos. chilled water pumps (2W plus 1S).
5. Chilled water produced shall be pumped to various Air-handling units and Fan coil units. Chilled water shall be pumped through insulated chilled water pipes installed in ceiling spaces and in vertical risers installed in pipe shafts. At each Air-handling unit balancing valves are provided for balancing. Chiller shall be placed on terrace of the building.
6. Double skin Air handling units consisting of centrifugal fan, cooling coil and filter section & VFD shall be provided for each area. Chilled water supply and return headers shall be tapped and connected to cooling coils. There would be automatic controls provided for AHUs to control inside conditions in summer and monsoon.
7. The conditioned air from the AHUs would be supplied through insulated ducts. The air would be diffused through extruded aluminum Grilles and diffusers. The return air would be taken back from the conditioned space to the AHUs through return air ducts or through ceiling spaces.
8. The stale air from the common toilets would be exhausted by means of mechanical exhaust system.
9. Motorized smoke and fire dampers shall be provided in accordance with ASHRAE/NFPA within supply air ducts and return air ducts/spaces to prevent spread of smoke / fire to adjacent areas.

5. INDOOR AIR QUALITY:

Due consideration has been given for good indoor air quality.

Outdoor air ventilation rates have been maintained as per ASHRAE standard 62.1.2004 (Ventilation for acceptable indoor air quality).

- 5.1 All utility areas like AC plant room, pump room etc., will be mechanically ventilated.
- 5.2 It is proposed to use centrifugal type blower for basement car parking ventilation.
- 5.3 All fire escape staircases and lift shafts shall be provided with pressurization system consisting of fans installed on terrace. These fans shall be actuated by smoke sensors in case of detection of fire on any affected floor.

2.0 AIR COOLED WATER SCREW/ SCROLL CHILLING UNITS

1. GENERAL

The contractor shall furnish and install where indicated on plans air cooled Rotary Screw/ Scroll water chilling units. Each unit shall be guaranteed by chilling unit manufacturer to produce a capacity of not less than specified tons of refrigeration at specified leaving water temperature with the temperature of ambient air entering the condenser not exceeding 110°F.(44 °C). The construction and rating of the chillers shall be in accordance with latest ARI standard 590 and shall comply with ANS. B 9.1 safety code, National Electrical code and ASME code. Necessary 3 ph.50 Hz, 220/415 volts, A.C. Power supply shall be made available for all units.

2. CODES & STANDARDS

ASHRAE 15	Safety code for Mechanical refrigeration
ASHRAE 23	Methods of testing and rating positive displacement refrigerant compressors and condensing units
ASHRAE 30	Methods of testing liquid chilling packages
ASME SEC VIII DIV I	Boiler and pressure vessel code
ANSI B 31.5	Code for refrigeration piping
AHRI 550/590 (2003)	Standard for Air Cooled Screw water chilling packages
AHRI 575	Standard for method of measuring machinery sound within an equipments space
ISO 1940	Mechanical vibration – Balance quality requirements of rigid rotors
ISO 10816-1	Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts. General guidelines
TEMA – C/R	Heat Exchanger with acceptable deviation
ASTM: C591	Specification for Polyurethane/ Ployisocyanurate Foam

3. BASIC UNIT

Each unit shall consist in general of multiple semi hermetic screw/scroll compressors, air cooled condenser coils, DX type water chiller, condenser fans, outer weather proof casing, automatic control panel and accessories.

3.1 Compressor (Screw)

3.1.1 Each unit shall have multiple rotary, double bolted hermetic screw compressor

The rotary screw shall be manufactured from forged steel with precision cast male and female profiles which are asymmetrical. The profile of screws shall permit safe operation up to a speed of 3000 RPM for 50 Hz operation. The compressor shall unload from fully loaded to the minimum capacity by means of hydraulically actuated slide valve positioned over both the male and female rotors.

The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the rotors and the housing.

The rotors shall be mounted on antifriction bearings designed to reduce friction and power input. There shall be multiple cylindrical bearings to handle the radial and axial loads.

There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent back spin during shut down.

There shall be oil pump or other means of differential pressure inside the compressor for forced lubrication of all parts during startup, running and coasting for shut down. An oil sump header shall be provided in the casing.

The units shall be complete with automatic capacity control mechanism, by use of slide value to permit modulation between 20% to 100% of capacity range.

3.2 Compressor (Scroll)

1. Each unit shall have multiple hermetic Scroll compressors (Where scroll compressors are used).
2. The fixed and orbiting Scroll/Screw be made of high strength cast iron, allowing minimum thermal distortion and having maximum efficiency. The orbiting Scrolls shall touch in all the dimensions to provide a highly enclosed compressor chambers for maximum efficiency.
3. The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the scrolls and the housing.
4. The rotors shall be mounted on plain bearings designed to reduce friction and power input.
5. There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent back spin during shut down.
6. There shall be oil pump or other means of forced lubrication of all parts during startup, running and coasting for shut down. An oil header shall be provided in the casing.
7. The compressor profile shall have provision to trap impurities and separate them.

4. COMPRESSOR MOTOR

- 4.1 The driving motor shall be Hermetic squirrel cage type protected against damage by means of built in protection devices.

5. CONDENSER

5.1 Condenser coil

The condenser coils shall have aluminum plate fins mechanically bonded to seamless copper tubes. The coil shall be circuited for sub-cooling. The coils shall be minimum 3 rows deep with at least 12 fins per inch.

5.2 Condenser fans

The units shall be furnished with necessary number of direct driven propeller type fans arranged for horizontal or vertical discharge. Condenser fan motor shall have class 'B' motor insulation, inherent protection device and shall be permanently lubricated type with resilient mounting. Each fan shall have a safety guard and shall have a low noise level.

6. COOLER

- 6.1 The cooler shall be direct expansion shell and tube type, with steel shell and seamless copper tubes. The refrigerant head shall be removable type. The tubes shall be supported in the shell by adequate stiff supports to eliminate vibrations and noise. The tube ends shall be fixed firmly into the tube sheets to prevent leakage of refrigerant gas.
- 6.2 The cooler shall be tested and stamped against leaks in accordance with ASME code for the refrigerant being used and otherwise tested and constructed in accordance with ASME or equivalent approved code requirements.
- 6.3 The cooler shall have a minimum of 2 independent direct expansion refrigerant circuits.
- 6.4 The cooler shall be factory insulated with 19 mm thick closed cell polyvinyl chloride and further protected by means of heater cables.

7. CONTROLS

- 7.1 All the controls shall be factory wired and located in a weather proof enclosure. These shall include fuses, selector switch, oil safety switch, high and low pressure cutouts, interlocks for crankcase heaters

and inherent motor protection devices, fan control thermostat, recycling pump-down circuit, high discharge temperature cutout indicator lamps shall be provided for the compressor units.

- 7.2 Necessary starters for compressor motors and condenser fan motors shall be included and provided within the unit. The compressor & the condenser fans shall be electrically interlocked such that the compressor can run only when at least one of the condenser fans are running.

7.3 Water Chilling Machine Control System

The water chilling unit shall be complete with microprocessor based type control system, which shall have the following features:-

Electric expansion valve for economic operation of the system

- 7.3.1 Self diagnostic capability to locate faults and give early warning.
- 7.3.2 Leaving chilled water temperature control and reset capability, with provision to accept over ride commands from a central BMS system.
- 7.3.3 Automatic sequencing of various functions for starting, running and stopping of the various components of the unit based on demand.
- 7.3.4 A programmable microprocessor complete with key pad and LED display window to perform the above functions.
- 7.4 The control package shall also consist of, but not limited to, the following components:
- 7.4.1 Low control voltage to unit.
- 7.4.2 Field power and control circuit terminal blocks.
- 7.4.3 ON/OFF switch.
- 7.4.4 Replaceable relay board.
- 7.4.5 Leaving chilled water set point board.
- 7.4.6 Diagnostic digital display module.
- 7.4.7 Microprocessor board.

Temperature reset board.

- 7.5 The control system shall have an extended module for control and monitoring from a central BMS including the reset of chilled water temperature, ON/OFF / Fault etc.

8. REFRIGERANT CIRCUIT

The refrigerant piping between compressors, chiller and condenser shall be of heavy gauge copper with brazed joints. The circuit shall include sight glass, moisture indicator, solenoid valves, electronic expansion valves, filter driers and necessary shut off valves with charging connections.

9. UNIT CASING

All the above components shall be housed in an outer casing fabricated from galvanized steel, zinc phosphate with multiple coats of baked enamel paint to make the whole casing weather proof for outdoor installation. Removable panels shall be provided for access to all working parts.

10. AHRI/ EUROVENT CERTIFICATION, IF APPLICABLE

The chilling unit shall be AHRI certified as per AHRI 550 / 590 – 2003 STANDARD. All suppliers shall furnish computer printouts along with their technical bids, giving details of capacity output at design conditions as given in tender.

11. MISCELLANEOUS

Each system shall be provided with the following:-

- 11.1 Necessary charge of refrigerant gas and lubricating oil.
- 11.2 Spring vibration isolators below the unit rated by the isolator manufacturers to absorb 90% of unit vibration and as approved by the engineer.
- 11.3 Dial type thermometers and pressure gauges for the inlet and outlet of the chilled water lines. **(Priced Separately)**.
- 11.4 Flexible connectors between chilled water lines and cooler inlet and outlet.
- 11.5 Water flow switch at the outlet of chilling unit **(Priced separately)**.
- 11.6 Butterfly valve at the outlet and balancing valve at the inlet of the chillers **(Priced separately)**.

12. LIMITATIONS

The fouling factor for the cooler shall be not more than 0.0005. (FPS units).

TITLE

CHILLER PACKAGE – DATA SHEET A

S.N.	Description	Requirement
1	Number Required	3 (2W+1S)
2	Location	As per drawing
3	Duty	Continuous (18 hrs/day) (Approximate)
4	Capacity required at specified design conditions per chilling package	60 TR apacity
5	Refrigerant	R134a / R410a
6	Full load IKW (at design condition)	1.3 KW/TR
7	Maximum noise level at a distance of 1.5 meters	80 dBA
8	Compressor – type & No. of compressor per chiller	Semi-hermetic/hermetic (minimum 2 nos. compressor per chiller)
9	Lubrication	Forced feed with an oil pump / differential pressure
10	Capacity control	Automatic in stages
11	Static and dynamic balancing of screws	As per ISO 1940
12	EVAPORATOR	
12.1	Type	Shell and tube, flooded/DX
12.2	Liquid to be cooled	Water
12.3	Chilled water quality	Potable water
12.4	Chilled water inlet temperature	54 Deg.F
12.5	Chilled water outlet temperature	44 Deg.F
12.6	Minimum chilled water flow per chilling package	144 USGPM
12.7	Fouling factor-water side (FPS unit)	0.0005
12.8	Chiller and suction line insulation	Closed cell polyvinyl chloride foam
12.9	Maximum water side pressure drop	20 Ft of water
13	CONDENSER	
13.1	Type	Air cooled
14	Motor	415 V +/- 10%, 3 phase, 50 Hz
15	Control Panel	Microprocessor based control panel
16	Control panel to be interfaced with building automation system	Provision to be available
17	Type of starter	Star Delta- Closed transition type
18	Type of Fan	Dual Speed / With VSD

CHILLER PACKAGE -DETAILS TO BE FURNISHED

BY TENDERER ALONG WITH OFFER – DATA SHEET B

S N.	Description	Tenderer To Furnish
1.0	Water Chilling Unit	
	General Data	
1.1	Number of chillers	
1.2	Location	
1.3	Make and country of origin	
1.4	Model number and year of introduction model	

1.5	Detailed list of installations of that model in India	
2.0	Operating Parameters	
2.1	Minimum refrigeration capacity (TR)	
2.2	Minimum chilled water flow rate (USGPM)	
2.3	Maximum chiller pressure drop (Feet of water)	
2.4	Entering chilled water temperature (deg F)	
2.5	Leaving chilled water temperature (deg F)	
2.6	Evaporating temperature (deg F)	
2.7	Fouling factor for chiller	
2.8	KW/TR at full load conditions	
2.9	Entering Air temperature (deg F)	
2.10	Leaving Air temperature (deg F)	
3.0	Compressor	
3.1	Manufacturer	
3.2	Model	
3.3	Type of compressor	
3.4	Speed (operating)	
3.5	Speed (maximum)	
3.6	Refrigerant used	
4.0	Evaporator	
4.1	Manufacturer	
4.2	Model (No)	
4.3	Shell dia. (mm)	
4.4	Tube length (m)	
4.5	No of tubes (No.)	
4.6	Material of tubes (Name)	
4.7	Dia. of tubes (mm)	
4.8	No of integral fins / cm (No.)	
4.9	No of refrigerant circuits (No.)	

S N.	Description	Tenderer To Furnish
4.10	No of water passes (No.)	
5.0	Compressor Motor	
5.1	Manufacturer	
5.2	Type	
5.3	Motor Voltage	
5.4	Rated output	
5.5	Power characteristics	
5.6	No of Motors	
6.0	Starter for Compressor Motor	
6.1	Manufacturer	
6.2	Type of starter	
7.0	Miscellaneous Details	
7.1	Type of capacity control	
7.2	Noise level of chiller (in dBA) at 1.5 m distance	
7.3	Equipments size (LXBXH)	
7.4	Equipments operating weight (kg) / pounds	
7.5	Full refrigerant charge quantity	
8.0	Documents to be furnished with bid.	
8.1	Computerized printout (certified) from chiller manufacturer indicating power consumption in IKW/TR at full load and various part load conditions as per AHRI format	
8.2	Catalogues furnishing detailed technical data for compressor, evaporator, condenser, microprocessor or micro-computer control panel etc.	

3.0 PUMPS - SPECIFICATIONS

1. SCOPE

- 1.1 This section of specification covers the supply, installation, testing, commissioning of water pumps along with accessories conforming to these specifications and in accordance with requirement of drawings, 'Technical Schedule of Equipment' and of the 'Schedule of Quantities'

2. CODES AND STANDARDS

- 2.1 The design, materials of construction, manufacture, inspection, performance and testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. The equipment supplied shall comply with the latest applicable Indian, American, British or equivalent standards.

3. TYPE

- 3.1 All chilled, condensing water pumps shall be of capacity and size in accordance with the requirements indicated in the drawings and 'Schedule of Quantities' Pumps shall conform to relevant IS standards/codes.

4. MATERIAL OF CONSTRUCTION

- 4.1 The pumps shall be of centrifugal back pull out / monoblock type as specified in "Schedule of Quantities" with the following material of construction.

Type	End Suction Back Pull Out	Monoblock
Duty	Chilled Water Supply	Chilled water supply
Casing	Cast Iron	Cast Iron
Impeller	Bronze / Gunmetal machined to close tolerance	Bronze / Gunmetal machined to close tolerance
Shaft	High quality alloy steel EN8 grade	High quality alloy steel EN8 grade
Bearings	Heavy duty ball/roller	Heavy duty ball/roller
Base plate	Cast iron/fabricated MS channel in all welded construction	Cast iron/fabricated MS channel in all welded construction
Seal	Mechanical	Mechanical
Flanges	Standard companion As per IS standards IS -1536/1960	Standard companion As per IS standards
Speed (Max)	1450 RPM	2900 RPM
Drive	TEFC Motor upto 7.5 HP	TEFC Motor upto 7.5 HP
Starter	DOL below 7.5 HP ; Star Delta for 7.5 HP and above	DOL below 7.5 HP: Star Delta for 7.5 HP and above
Other Components	Wearing rings, sleeves and any other standard accessories	Wearing rings, sleeves and any other standard accessories

5. ACCESSORIES AND FITTINGS

Pump shall be complete with

- 5.1 Lubrication fittings
- 5.2 Gland drains (25mm min) piping upto nearest floor drain point.
- 5.3 Test and air vent cocks.
- 5.4 Water seal piping connections
- 5.5 Suction, discharge pressure gauge (not less than 150 mm diameter) of appropriate range, with globe valves.
- 5.6 Suction and discharge shut off valves.
- 5.7 Discharge check valve
- 5.8 Y type strainer at suction of each pump
- 5.9 Flexible couplings (at suction & discharge) with control rods.
- 5.10 However quantities of item (e) to (i) are separately quantified under 'Schedule of Quantities' and as such, cost of these valves should not be included in the cost of pump.

Also GI gland drain piping (Item b) upto nearest drain point will be paid under piping item, as such cost of same should not be included in the cost of pump.

6. DESIGN REQUIREMENTS

- 6.1 The pump shall be capable of developing the required total head at rated capacity for continuous operation.
- 6.2 Pumps shall run smooth without undue noise and vibration. The noise level shall be limited to 85 db A at a distance of one meter.
- 6.3 The guaranteed output of the pump shall be at that frequency of electric supply, which is normally available at site, instead of rated frequency of 50 Hz, if, specified in Data Sheet 'A'.
- 6.4 Pump motor shall be suitable for 415 +/- 5% V, 3-phase 50 CPS AC power supply.

7. FEATURES OF CONSTRUCTION

- 7.1 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be interchangeable.
- 7.2 Mechanical seals shall be provided

8. INSTALLATION & TESTS

- 8.1 The pump sets shall be mounted on cement concrete foundation, which shall be provided by other agencies. However, grouting nuts, bolts, channels, shims etc shall be provided by the HVAC contractor.

9. MECHANICAL BALANCING

- 9.1 The impeller shall be statically and dynamically balanced.

10. VISUAL INSPECTION

- 10.1 Pumps shall be offered for Visual inspection (if specifically asked for) before dispatch. The components of the pumps shall not be painted before inspection.

11. MATERIAL TEST CERTIFICATE

- 11.1 Materials of the various pump components shall be tested in accordance with the relevant standard and Test Certificates shall be furnished along with the Pumps.

12. FIELD TESTING

- 12.1 After installation, the pumps shall be subjected to testing at site also. If the performance does not meet the requirements regarding capacity, power consumption, vibration and noise etc. as specified, then the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the CUSTOMER.

13. TENDER DRAWINGS

13.1 The following drawings shall be submitted by the tenderers along with their Bids: -

- 13.1.1 Preliminary outline dimensional drawing of pump. (Suction and discharge connections and foundation details shall also be indicated).
- 13.1.2 Performance curves (capacity vs. total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.
- 13.1.2.1 Pump Catalogues.

14. NAME PLATE

14.1 Each pump shall be provided with a name plate indicating the following details:-

- a) Design capacity
- b) Total head
- c) Speed
- d) Motor rating
- e) Model number
- f) Manufacturer's serial number
- g) Weight of equipment
- h) Tag number

15. PAINTING

- 15.1 All ferrous surfaces shall be painted with one coat of red oxide primer paint followed by two coats of synthetic enamel paint (approved shade).

16. INSULATION

- 16.1 The Pump casings for chilled water along with its accessories and fittings shall be insulated as specified in section on insulation. The cost of this insulation should be included in the cost of the pump.
- 16.2 Pumps shall be insulated only after they have been tested and test results have been approved by the engineer.

Note: - All the hardware required for the installation and equipments required for testing & commissioning shall be supplied by the Contractor.

CENTRIFUGAL PUMPS-DATA SHEET A

Design Parameters	S.N	Pump Designation	Chilled Water Pumps	Hot Water Pumps (Monoblock)
	1	No. of Pumps	3 (2W + 1 S)	2 (1W + 1 S)
	2	Design Capacity	144 USGPM	30 USGPM
	3	Total Head	100 Ft	90 Ft
	4	Location	As per drawings	As per drawings
	5	Max. Rated Sped (AT 50 Hz)	1450 RPM	1450 RPM
	6	Liquid Handled	Water	Water
Features of Construction	7	Type of Pump	End Suction Back Pull Out	End Suction Back Pull Out
	8	Seal	Mechanical	Mechanical
	9	Nozzle Orientation	End Suction - Top Discharge	End Suction - Top Discharge
	10	Flange Drilling	As per ISI	As per ISI
Materials of Construction	11	Parts	Material	Material
	11.1	Impeller	Bronze IS 318GR2	Bronze IS 318GR2
	11.2	Casing	CI-IS210 GR FG 200	CI-IS210 GR FG 200
	11.3	Shaft	Steel	Steel
	11.4	ST. Box Packing	Graphite Asbestos	Graphite Asbestos
	11.5	Base Plate	Cast iron / Fabricated steel	Cast iron / Fabricated steel

**CENTRIFUGAL PUMPS- DETAILS TO BE FURNISHED
BY TENDERER ALONG WITH OFFER –
DATA SHEET B**

S. N.	ITEM DESCRIPTION	
1.	Make	
2.	Model	
3.	Design Capacity	USGPM (M ³ / Hr)
4.	Total Head	FT WG (MWC)
5.	Shut off head	FT WG (MWC)
6.	Hydrostatic test pressure	KG/SQCM (MWC)
7.	Pump efficiency at duty point	%
8.	Power input to pump at duty point	(BHP) (KW)
9.	Motor efficiency at duty point	%
10.	Power input to motor at duty point	(HP) (KW)
11.	Rated speed	RPM
12.	NPSH required	FTWG(MLC)
13.	Material of construction as per specification, If no, indicate deviations	YES / NO
14.	Suction size	
15.	Discharge size	
16.	Impeller type	
17.	Pump weight	Kg
18.	Pump set weight	Kg
19.	Pump size	Mm
20.	Pump Foundation size	Mm

4.0 HOT WATER GENERATOR – SPECIFICATIONS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of hot water generator along with its accessories, conforming to these specifications and in accordance with requirements of drawings and of the 'Schedule of Quantities'.

2. CODES AND STANDARDS

The design, manufacture, testing and performance of the Hot Water Generator shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The Hot water generator shall also conform to the latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

3. CONSTRUCTION

The hot water generator shall be vertical/horizontal type comprising of steel shell, heating elements, controls, control panel, mounting frame etc.

3.1 Shell

The shell shall be of welded construction, fabricated from 10mm thick MS sheet. The shell shall be complete with baffles to provide adequate velocity to water.

3.2 Mounting Frame

The hot water generator shall be mounted on a robust fabricated steel frame of 16 SWG MS sheet and complete with hinges, locks to make a compact assembly. The base frame shall be fabricated out of ISMC 100x50 and shall be suitable for level foundation.

3.3 Heating Element

3.3.1 Heaters shall be of approved make and made of chromium coated mild steel mounted in electrically resistant u-tubes and shall be immersion type to be in direct contact with water.

3.3.2 These shall be easily removable without opening the terminal plates.

3.3.3 Heaters shall be of adequate rating and equally distributed for uniform heat transfer.

Heating elements shall be suitable for 415 V +/- 10%, 3 phases, 50 HZ, AC supply and conforming to IS.4159.

The Hot water generator should have at least 5% spare heater capacity, which can be used in case of failure of running heater.

3.4 Control Panel

3.4.1 The control panel shall be fabricated out of 14-gauge MS sheet built in with the hot water generator.

3.5 Insulation

3.5.1 The hot water generator shall be insulated with 50-mm thick fiberglass of density 32 kg/cu.mt. and clad with 0.63 aluminum sheet on MS frame welded to generator body.

3.6 The hot water generator shall be provided with lifting lugs on top for easy transportation and handling.

4. PRESSURE TESTING

The Boiler Shall Be Tested In The Factory For Leak At a Hydraulic Pressure of 350psig

5. CONTROLS AND ACCESSORIES

One 100 mm dial type thermometer, mercury in bulb type, at inlet and outlet with tubing. Range of thermometer shall be 0-100 Deg c.

One dial type pressure gauge with globe valve at inlet and outlet of the boiler with tubing. Pressure gauge shall have range of 0-10 kg/sq. cm.

Spring loaded safety valve for pressure relief in case of high-pressure build up in the Hot Water Generator. The outlet of safety valve shall be piped to the nearest drain.

Inlet and outlet connections with matching flanges.

Drain connection with 25mm-gate valve.

De-scaling valve

Automatic air vent valve

Step controller.

High temperature cutout

Electronic low water level switch.

Vibration isolators with at least 90% efficiency.

6. CONTROL PANEL

The hot water generator shall be provided with electrical control panel, factory mounted directly on mainframe, completely wired and tested. The panel shall conform to Indian I.E rules.

The panel shall be provided with accessories. Conforming to the approved list of makes. The panel shall be suitable for 415 V +/-10%, 3ph, 50 Hz AC electric supply.

The control panel shall comprise of: -

- (a) Incoming MCCB of suitable rating.
- (b) Copper bus bar
- (c) Ammeter with current transformers and selector switch.
- (d) Voltmeter with selector switch
- (e) Contactors
- (f) On/ Off indication lamps for individual banks.
- (g) Phase indication lamps with control fuses.
- (h) Fault indication lamps.
- (i) On/Off toggle switch for operating individual banks.
- (j) Alarm with reset push button.

(k) Push button for lamp test and heater reset.

(l) Copper connection with cables and control cabling.

The doors of electrical controls panel shall be operable only when incoming power supply is cut off.

7. PAINTING

7.1 All external welds should be de-rusted, cleaned and applied with two coats of necessary red oxide primer. Then it shall be powder coated in approved shade.

8. TESTING

8.1 The unit shall be tested at site to ensure the specified output of hot water generator after satisfactory installation.

HOT WATER GENERATOR - DATA SHEET A

S. N.	Description	Requirement	
1.0	Design Features	General Areas	Operation Theatres
1.1	Application	Winter Heating	Heating
1.2	Minimum capacity	40 KW	20 KW
1.3	Location	Terrace	Terrace
1.4.	Numbers Required	(1W + 0 S)	(1W + 1 S)
2.0	Features of Construction		
2.1	Type	Vertical / Horizontal	Vertical / Horizontal
2.2	Heaters	Chromium Coated MS	Chromium Coated MS
3.0	Material of construction		
3.1	Shell	10 mm thick MS	10 mm thick MS
3.2	Dished ends	15 mm thick MS	15 mm thick MS
4.0	Insulation		
4.1	Material	Fiberglass	Fiberglass
4.2	Thickness	50 mm	50 mm
4.3	Density	32 KG / cum	32 KG / cum
4.4	Finish	24 G Aluminium cladding	24 G Aluminium cladding
5.0	Testing		
5.1	Hydrostatic test	At 350 PSIG for leaks	At 350 PSIG for leaks
5.2	Performance test	Standard running test	Standard running test

HOT WATER GENERATOR - DATA SHEET B

S.N.	Description	
1	Application	
2	Make	
3	Design Capacity KW	
4	Type	
5	Model	
6	Banks No / KW	
7	Vessel size Mm	
8	Thickness	
8.1	Shell (mm)	
8.2	Dished ends (mm)	
9.0	Insulation	
9.1	Material	
9.2	Thickness (mm)	
9.3	Density (Kg/CUM)	
9.4	Finish	
10.0	Dimensions (L x W x H) (mm)	
11.0	Heaters	
11.1	Make	
11.2	Model	
12.0	Electrical Characteristics	
13.0	Test Pressure	
14.0	Controls	
14.1	All provided YES / NO	
14.2	Any deviation from specification (Please indicate specifically) YES / NO	
14.3	Qty: Reqd.: Nos:	
14.4	Mandatory service clearance required.	

5.0 HORIZONTAL FLOOR MOUNTED

AIR HANDLING UNITS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction air handling units along with its accessories, conforming to these specifications and in accordance with requirement of the 'Schedule of Quantities', Drawings and 'Technical Schedule of Equipment'.

2. TYPE

The air handling units shall be double skin modular, draw through type comprising of various sections such as mixing chamber (wherever R .AIR and F.AIR are ducted.), pre filter section, chilled water coil section, fan section supply air plenum as per details given in Drawings and Schedule of Equipment.

3. CAPACITY

The air handling capacities, maximum motor HP, static pressure shall be as shown on Drawings and as indicated in 'Schedule of Quantities'.

4. CONSTRUCTION

4.1 AHU HOUSING / Casing:

4.1.1 The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type with 0.8 mm pre painted GSS/ pre-plasticized on the outside and 0.8 mm galvanized sheet inside with 40 mm thick PUF insulation or equivalent material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

4.1.2 Framework for each section shall be joined together with soft Neoprene rubber gasket in between to make the joints airtight. Suitable airtight access doors /panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on roller-formed GSS channel framework having pressure die cast aluminum jointers.

4.2 Drain Pan

The drain pan shall be of 18 G aluminum/stainless steel with necessary slope to facilitate fast removal of condensate. It shall be provided with drain connection of suitable size complete with 25 mm rigid insulation. Necessary arrangement will be provided to slide the coil in the drain pan. The drain pan shall be insulated with 12 mm thick close cell Nitrile insulation (self adhesive) or equivalent.

4.3 Cooling / Heating Coil

The chilled /hot water coil shall be of seamless copper tubes not less than 0.5 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11to 13 FPI. The coils shall be tested against leaks at a hydraulic pressure of 21-kg/sq. cm. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be complete with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS.

4.4 Fan Section With Fan

The fan shall be backward curved, double inlet double width type. The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame & pillow block heavy-duty ball bearings. The fan shall be selected for a speed not exceeding 1000 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 MPM. Fan housing with motor shall be mounted on a common extruded aluminum base mounted inside the air handling housing on anti vibration spring mounts or cushy foot mounts of at least 90% vibration isolation efficiency. The fan outlet shall be connected to casing with the help of fire retardant double canvas or Neoprene rubber of imported Origin. The fan shall be selected for a noise level of less than 70 DB (A) at one meter distance.

4.5 Filter Section

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size. Filters shall have aluminum frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

5. FRESH AIR INTAKES

Extruded aluminum construction duly anodized fresh air louvers with bird screen and extruded construction dampers shall be provided in the clear opening in masonry walls of the air handling unit room having at least one external wall. Fresh air louver, damper, pre filters, ducts and fresh air fan with speed regulator (wherever specified in 'Schedule of Quantities') shall be provided. Fresh air dampers shall be of the interlocking, opposed blade louver type. Blades shall be rattle free. Damper shall be similar to those specified in 'air distribution'. Fresh air fans and fresh air intakes shall be as per the requirements of 'Schedule of Quantities'.

6. ACCESSORIES

Each air handling unit shall be provided with manual air vent at highest point in the cooling /heating coil. In addition, the following accessories may be required at air handling units.

Their detailed specifications are indicated in individual sections and quantities separately identified in 'Schedule of Quantities'.

- (a) Stem type thermometer at each AHU coil inlet and outlet with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'
- (b) Pressure gauge with globe valves at inlet and outlet of each AHU coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.
- (c) Butterfly valves at inlet and outlet of the each coil.
- (d) PICB valves at the outlet of each coil.
- (e) Y strainer at inlet of each coil.
- (f) Union and condensate drain piping from the unit up to the drain trap as described in section piping.
- (g) Motorized three way mixing valves located in chilled /hot water lines connected to the coil. This valve shall be operated by the cooling/heating thermostat and shall control the flow of chilled/hot water as per section 'automatic controls and instruments'.
- (h) Cooling /heating thermostat as per section
'Automatic Controls and Instruments' shall be located in return air stream.
- (i) Flexible connection between the fan outlet and duct.
- (j) Vibration isolators of at least 90% efficiency.

7. SAFETY FEATURES

Each handling unit must have safety features as under:-

- (a) The fan access door must have micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

The access door shall further have wire mesh screen as an added feature, bolted on to the unit frame.
- (b) Fan and motor base shall be properly earthed from the factory.
- (c) All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

8. DRIVE

Fan drive shall be 3phase-squirrel cage totally enclosed fan cooled motor suitable for $415 \pm 10\%V$, 50 HZ AC supply. Motor shall be specially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement with required no. Of belts for power transmission without slippage. Belts shall be of oil resistant type of approved make only.

9. DESIGN DATA FOR AIR HANDLING UNITS

- (a) Fan outlet velocity shall not exceed 500 MPM.
- (b) The air velocity across coil shall not exceed 150 MPM.
- (c) The air velocity across air pre filter shall not exceed 150 MPM.

Motor ratings are only tentative and shall be suitable for the duty but not less than the specified HP. The motor shall be selected with a safety factor of at least 20% over and above the brake power.

The AHU fan shall be selected for a total static pressure as indicated in 'Schedule of Quantities'.

10. INSTALLATION

Air Handling Unit shall be installed inside the AHU room to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation and mounted on serrated rubber pads. The serrated rubber pads shall be in two layers with 16G GI sheet sandwiched in between.

11. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing, commissioning of the installation.

12. TESTING

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

13. VARIABLE FREQUENCY DRIVES (For AHUs):

13.1 It comprises the following:

- (a) Built in dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus of the Variable Frequency Drive.
- (b) Built in EMC filters (electro magnetic compatibility filters) for restriction of conducted emissions to comply with IEC61800:3 (un restricted distribution) :2004 Category C 1 (50 meter).

- (c) Three feedback PID controller having capability to simultaneously accept 3 feedback signals from temperature sensors or pressure sensors for process optimization and accordingly control the speed of the AHUs or pumps.
- (d) Integral graphical keypad.

*Note: (i) Cost of temperature sensor and control cables not included.
(ii) Separate Starter not required for switching on motor and pump.*

- 13.2 Product compliance** – The drive shall have comply to the following standards
Low Voltage Directive 73/23/EEC with supplements
EMC Directive 89/336/EEC with supplements
Quality assurance system ISO 9001 and ISO 14001
CE, UL, ULc and C-tick

13.3 Mechanical Protection

- 13.3.1 The enclosure shall be plastic type and tested in UL tests according to the ball impact test stated in UL746C.

The protection class shall be IP55.

13.4 Operating Parameters

The drive shall be suitable for an ambient temperature of 40 deg C.

The drive shall give an alarm signal when the heat sink temperature of the drive reaches 90 deg C and shall trip when the temperature reaches 95 deg C.

To predict the noise level of the motor switching frequency shall be user selectable and can be selected according to the load conditions: 4 kHz or 8khz (for low noise operations)

Overload Capacity: The drive shall be able to deliver 100% of the nominal current and 110% for 1 min. every 10 mins. (if repeatability is not mentioned, the drive shall be selected to ensure the proper RMS current rating)

The drive shall have at least 2 critical frequency (band) selection to avoid the mechanical resonance problem.

The drive shall have at least 7 programmable constant speeds ranging from 0-250 Hz.

13.5 Programming

Control Panel : The drive shall have an alphanumeric control panel with LCD display and multiple languages. The control panel can be connected to and detached from the converter at any time. The panel can also be used to copy parameters to other converters with the same software revision.

It shall be possible to view the Output Current, % Torque, the reference Frequency and one output variable (frequency, voltage etc. as per requirement. If Not, then separate display shall be provided to view the above parameters.

At any point of time the status of the drive can be known through the Control Panel, i.e. remote/local, run/stop/fault etc.

The drive shall have a sleep function to provide energy saving at low frequency. When the reference falls below a certain level, the drive shall go in energy optimizing mode.

The drive shall have a **Fan controller**.

13.6 Protection features

Over current
Over voltage
Under voltage
Over temperature
Output earth fault
Output short circuit
Input phase loss (3 phase)
I/O terminal short circuit protection

Motor overload protection: If the motor current I (out) exceeds nominal current I_N of the motor for a prolonged period, the drive shall automatically protects the motor against overheating by tripping. The trip time shall depend on the extent of the overload (I out / I_N), the output frequency and f_{nom} . Times given shall also apply to a “cold start”. Drive shall provide overload protection in accordance with the National Electric Code (US).

Output over voltage protection: In the event of an overload, the drive shall first show an alarm and then trip.

Stall protection
Under load

13.5.13

Stall protection
Output over current
Output short circuit
Ground fault, motor cable
Under load
Network failure
Low input signal level ($AI < \min$)
Panel fault
Over voltage
Under voltage
External fault
Automatic fault reset, under voltage
Automatic fault reset, over voltage, over current
Fault history 3

13.7 Functions

Start; normal/flying/torque boost
Start; premagnetising
Stator resistance (IR) compensation
Stop; ramp/coasting
Stop; DC brake
DC hold

U/f -ratio; linear/square
Acceleration/deceleration 1 (s) 0.1 ... 1800
Acceleration/deceleration 2 (s) 0.1 ... 1800
S-ramp; fast/medium/slow
7 Preset speeds
2 Critical frequencies
Slip compensation
Parameters in logical menus
Motor field optimization for energy optimization
Selectable switching frequency 4 / 8 kHz

13.8 Mains Connections

Voltage: 3-phase, 380-480V +/-10%
Frequency: 48-63hz
Power Factor: 0.9

13.9 Motor Connections

Voltage: 3-phase from 0 – U supply
Frequency 0-250hz
Acceleration time: 0.1 to 1800 secs
Deceleration time: 0.1 to 1800 secs

13.10 Programmable control connections: The drive shall have atleast the following inputs and Outputs.

13.10.1 Two analog inputs:

- Voltage signal: 0 (2) to 10 V, 200 kW single-ended
- Current signal: 0 (4) to 20 mA, 500 W single-ended
- Potentiometer reference value: $\pm 10\text{ V} \pm 2\%$ max. 10 mA, 1 kW & R $\pm 10\text{ kW}$
- Response time: $\leq 60\text{ ms}$
- Resolution: 0.1%
- Accuracy: $\pm 1\%$

13.10.2 One analog output: 0 (4) to 20 mA, load <500 Auxiliaire voltage: 24 V, max. 250 Ma

13.10.3 Five digital inputs:

- 12 V... 24 V DC with internal or external supply, PNP and NPN
- Input impedance: 1.5 kW
- Response time: $\leq 9\text{ ms}$

13.10.4 Two relay outputs:

- Switching voltage: 12 to 250 V AC or max 30 V DC/0.5 A
- Maximum continuous current: 10 mA to 2 A

Serial communication for the control panel or external control: Seamless communication with Modbus or N2 protocol on RS485

Design features

The drive shall have an in-built choke at the DC input side.

The distance between the motor and the drive is approximately 100 mts. An output choke shall be used as applicable.

HORIZONTAL FLOOR MOUNTED

AIR HANDING UNITS – DATA SHEET B

1.0	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	

2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

6.0 VERTICAL FLOOR MOUNTED

AIR HANDLING UNITS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction air handling units along with its accessories, conforming to these specifications and in accordance with requirement of the 'Schedule of Quantities', Drawings and 'Technical Schedule of Equipment'.

2. TYPE

The air-handling units shall be vertical double skin, comprising, pre filters, chilled water coil, fan as per details given in Drawings and Schedule of Equipment.

3. CAPACITY

The air handling capacities, maximum motor HP, static pressure shall be as shown on Drawings and as indicated in 'Schedule of Quantities'.

4 CONSTRUCTION

4.1 AHU HOUSING / Casing:

4.1.1 The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type with 0.8 mm pre painted GSS/ pre-plasticized on the outside and 0.8 mm galvanized sheet inside with 40 mm thick 40 kg / m³ PUF insulation or equivalent material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight. The corner joints shall be nylon glass fiber reinforced.

4.2 Drain Pan

The drain pan shall be of 18 G aluminum/stainless steel with necessary slope to facilitate fast removal of condensate. It shall be provided with drain connection of suitable size complete with 25 mm rigid insulation. Necessary arrangement will be provided to slide the coil in the drain pan.

4.3 Cooling / Heating Coil

The chilled /hot water coil shall be of seamless copper tubes not less than 0.5 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11to 13 FPI. The coils shall be tested against leaks at a hydraulic pressure of 21-kg/sq cm. This pressure shall be maintained for a period of at least 2 hours. No drop should be

observed indicating any leaks. The water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS.

4.4 FAN SECTION WITH FAN

Fan section shall have two Nos. blowers.

The fans shall be backward curved, double inlet double width type. The fan shall be selected for a speed not exceeding 1000 RPM. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 MPM. Fans & motor shall be mounted above the coil /sections. The fan outlet shall be connected to casing with the help of fire retardant canvas.

The fan shall be selected for a noise level less than 70 DB (A) 1M away from the unit.

4.5 Filter Section

Each unit shall be provided with a factory assembled filter section containing 48 thick synthetic media washable air filters with efficiency of 90% down to 10-micron particle size. Filters shall have aluminum frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

5. FRESH AIR INTAKES

Extruded aluminum construction duly anodized fresh air louver with bird screen and extruded construction dampers shall be provided in the clear opening in masonry walls of the air handling unit room having at least one external wall. Fresh air louver, damper, pre-filters, ducts and fresh air fan with speed regulator (wherever specified in 'Schedule of Quantities') shall be provided. Fresh air dampers shall be of the interlocking, opposed blade louver type. Blades shall be rattle free. Damper shall be similar to those specified in 'air distribution'. Fresh air fans and fresh air intakes shall be as per the requirements of 'Schedule of Quantities'.

6. ACCESSORIES

Each air handling unit shall be provided with manual air vent at highest point in the cooling /heating coil. In addition, the following accessories may be required at air handling units. Their detailed specifications are in individual sections and quantities separately identified in 'Schedule of Quantities'.

- (a) Stem type thermometer at each coil inlet and outlet with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'
- (b) Pressure gauge with globe valves at inlet and outlet of each coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.
- (c) Butterfly valves at inlet and outlet of each coil.

- (d) PICB valve at the outlet of each coil.
- (e) Y strainer at inlet of each coil.
- (f) Union and condensate drain piping from the unit up to the drain trap as described in section piping.
- (g) Motorized three way mixing valves located in chilled /hot water lines connected to the coil. This valve shall be operated by the cooling/heating thermostat and shall control the flow of chilled/hot water as per section 'automatic controls and instruments' for detailed specification.
- (h) Cooling /heating thermostat as per section

'Automatic Controls and Instruments' shall be located in return air stream.
- (i) Double Flexible connection of fireproofs material between the fan outlet and duct.
- (j) Vibration isolators of at least 90% efficiency.

7. SAFETY FEATURES

Each handling unit must have safety features as under:-

8. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing & commissioning of the installation.

9. TESTING

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

VERTICAL FLOOR MOUNTED

AIR HANDING UNITS – DATA SHEET B

1.0	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

7.0 CEILING SUSPENDED

AIR HANDLING UNITS

1. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of ceiling mounted air handling units, conforming to these specifications and in accordance with requirements of drawings and of the 'Schedule of Quantities'.

2. TYPE

The air-handling units shall be double skin ceiling suspended, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and Schedule of Equipment.

3. CAPACITY

The air moving and coil capacities shall be as shown on the drawings and indicated in 'Schedule of Quantities'.

4. UNIT CONSTRUCTION

The ductable unit shall be ceiling suspended type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong & self supporting frame work for various sections.

40mm thick double skin panels shall be made of 0.8 mm pre-plasticized GSS sheet on outside and 0.8 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 40 Kg./m³ density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 25mm thick thermo Cole or 12mm thick closed cell Nitrile rubber.

5. FAN AND MOTOR

The fan shall be DIDW centrifugal backward curved fan having single-phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced. The fans shall carry AMCA certification.

The fan motor shall be single-phase squirrel cage suitable for 415V +/- 10%, 50 Hz, 3-phase AC supply as specified in "Schedule of Quantities". Fan and motor may be directly coupled or may be belt driven.

6. COIL

The chilled water coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sq.cm. This pressure shall be maintained for period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth should be in two equal parts.

7. FILTER

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size. Filters shall have aluminium frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent bypass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

8. ACCESSORIES

Each air-handling unit shall be provided with manual air vent at highest point in the cooling coil. In addition; the following accessories may be required at air handling units. Their detailed specifications are in individual sections and quantities separately identified in 'Schedule of Quantities' (except items I to L).

Stem type thermometer at inlet and outlet of each coil with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'

Pressure gauge with globe valves at inlet and outlet of each coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.

Butterfly valves at inlet and outlet of each coil.

PICB valve at the outlet of each coil.

Y Strainer at inlet of each coil.

Union and condensate drain piping from the unit up to the drain trap as described in section piping.

Motorized three way mixing valves located in chilled water lines connected to the coil. This valve shall be operated through the cooling/heating thermostat and shall control the flow of chilled/hot water as per section 'Automatic Controls and Instruments' for detailed specification.

Cooling /heating thermostat as per section

‘Automatic Controls and Instruments’ shall be located in return air stream.

Double Flexible connection of fire retardant Hessian between the fan outlet and duct.

Vibration isolators of minimum 90% efficiency.

Motor & drive package

Air purge valve on top of coil header and drain valve at bottom.

9. DESIGN DATA FOR AIR HANDLING UNITS

Fan outlet velocity shall not exceed 550 MPM.

The air velocity across coil shall not exceed 150 MPM.

The air velocity across air pre filter shall not exceed 150 MPM.

Motor rating is tentative only and shall be suitable for the duty but not less than the specified HP. Motors shall be selected considering at least 20% margin over the break power.

The AHU fan shall be selected for a total static pressure as indicated under Technical Schedule for Equipment’.

10. INSTALLATION

Unit shall be installed above the false ceiling in a manner so as to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer’s recommendation. Rubber in shear type suspension hangers shall be provided for vibration isolation.

11. PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing & commissioning of the installation.12.

TESTING

Cooling/heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

CEILING SUSPENDED AIR HANDING UNITS
DATA SHEET B

1.0	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

8.0 FAN COIL UNITS – SPECIFICATIONS

1. SCOPE

This section covers the technical requirements for manufacture, testing at works, and delivering at site, testing after installation, commissioning of fan coil units conforming to these specifications and in accordance with the requirement of the drawings and 'Schedule of Quantities'.

2. TYPE

The fan coil unit shall be horizontal type to be mounted within ceiling space. The units shall have horizontal discharge and complete with chilled water coil, one or more centrifugal fans and motors, cleanable fabric filters, double skin insulated condensate drain pan. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan.

2.1 Capacity

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

2.2 Cabinets

Cabinets shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bowdlerized and painted with approved shade of powder coating finish and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

2.3 Interior Chassis

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bowdlerized and painted with approved shade of powder coating finish. All ceiling suspended fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units, fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

2.4 Fan Section

This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced.

The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds

A GI plenum shall connect fan outlet to the coil.

2.5 Cooling Coil

The coil shall be of seamless copper tube of minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with air vent. All coils shall be factory tested at 21 kg per sq.cm. (300psig) air pressure when submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically/ hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations. The copper tube or pipe should not be manufactured from reprocessed or recycled copper

2.6 Drain Pans

Primary drain pan shall be of double skin construction fabricated from 18 gauge stainless steel with all corners enclosed. An additional inner bottom panel of 18 G thick stainless steel sheet shall be provided to prevent damage to insulation. The pan shall be insulated with minimum 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to prevent condensation. The pan shall be of sufficient size to accommodate cooling coil supply and return water header and bends and control valves.

The auxiliary condensate drain pan shall be similar in construction to primary drain pan and size larger than primary drain pan to catch all overflows in case primary drain pan gets choked. Drain from auxiliary drain pan shall be connected to drain from primary drain pan through a tee connection and piped to vertical risers.

2.7 Motor

Motor shall be $220 \pm 6\%$ volts, 50 cycle, single phase, six poles, shaded pole type, rpm not exceeding 1000 at maximum airflow. Motor shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

3. AIR FILTER

The filter shall be cleanable type 12mm thick AL. wire mesh and mounted behind the pan in a filter plenum of GI sheet.

4. PAINTING

The fan coil units shall be powder coated in approved colour.

5. CONTROLS

All units shall be complete with following controls
Motorized two way valve in water lines

Wall mounted thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ winter air conditioning

'Y' strainer, ball valve and globe valve as shown on drawings and 'schedule of quantities'

6. PERFORMANCE DATA

Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium / high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

7. TESTING

Cooling capacity of various fan coil unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury -in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

CEILING MOUNTED FAN COIL UNITS –

DATA SHEET B

1.0	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	

3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

9.0 EVAPORATIVE COOLING UNIT - DOUBLE SKIN

SPECIFICATIONS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction evaporative cooling packaged type unit, conforming to these specifications and in accordance with requirements of drawings, 'Technical Schedule of Equipment' and of the 'Schedule of Quantities.'

2. TYPE

The evaporative cooling unit shall be double skin construction draw through type comprising of various sections such as filter section, humidifier section, supply air fan section, fine filter plenum, factory fabricated (wherever required) as per details given in Drawings and 'Schedule of Quantities.'

3. CAPACITY

The cooling capacities, motor HP, static pressure shall be as shown on Drawings and in 'Schedule of Quantities'.

4. CONSTRUCTION

HOUSING/CASING

The housing /casing of evaporative unit shall be of double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong and self –supporting framework for various sections.

25 mm thick double skin panel shall be made of 0.6 mm plasticized /pre coated PVC sheeted GSS on outside and 0.6mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

Framework for each section shall be joined together with soft rubber gasket in between to make the joints airtight. Suitable airtight access doors/panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on extruded aluminium channel framework having pressure die cast aluminium joints.

5. DRAIN PAN

Drain pan shall be constructed of 18 g stainless steel with necessary both way slope to facilitate fast removal of drain water.

6. MOTOR DRIVE

Fan motors shall be suitable for $415 \pm 10\%$ volts, 50 cycles 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection. Motor shall be especially designed for quiet operation and motor speed

shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement. Belts shall be of oil resistant type.

7. FAN

The fan shall be backward curved, double inlet, double width type. The wheels and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings. The fan shall be selected for a noise level less than 85-DB (A).

The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 7.62m/sec. Fan housing with motor shall be mounted on a common extruded aluminium base mounted inside the housing on anti vibration mounts. The fan outlet shall be connected to casing with the help of double fire retardant fabric acting as a flexible connection for anti vibration.

8. WET DECK HUMIDIFIER

Wet deck humidifier pads shall be of cellulose paper minimum 200 mm deep to provide at least 90% saturation efficiency at 2.5 MPS or less air face velocity. The cellulose paper pads shall be housed in a galvanized steel casing complete with water distribution header and interconnecting heavy duty flexible PVC / GI pipes between pump and distribution header.

9. WATER CIRCULATING PUMPS

Water circulating pumps shall be vertical type. The suction portion shall be at the bottom with proper seal arrangement to directly pick up water from the stainless steel drain pan. The pump shall be suitable to operate at $415 \pm 10\%$ V, 50 HZ AC supply.

Necessary water bleeding arrangements shall be incorporated with separate drain connection provided in the stainless steel drain pan to bleed small percentage of total circulated water in order to ensure compulsory water change over during running of the system.

10. FILTERS

Each unit shall be provided with a factory assembled filter section containing washable air filter having bonded expanded aluminium media with aluminium frame. Filter media and frame shall be rust proof and corrosion resistant. Filter face velocity shall not exceed 150 meter per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These shall be held with in the frames by sliding the cells between guiding channels.

11. FRESH AIR INTAKES

Anodized extruded aluminium construction (20 microns and above) fresh air intakes louvers with bird screen and extruded aluminium low leakage construction damper shall be provided for FA. Blades shall be made of extruded aluminium. Construction shall be rattle free. Fresh air fans and fresh air intakes shall be as per the requirement of 'Schedule of Quantities'.

12. SAFETY FEATURES

Each evaporative unit must have following safety features:-

The fan access door shall be equipped with micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

13. PERFORMANCE DATA

Evaporative cooling units shall be selected for optimum operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the system.

14. TESTING

Performance of evaporative cooling unit shall be computed from the measurements of air flow and dry and wet bulb temperature of air entering and leaving the unit. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated electronic instrument. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

10.0 KITCHEN EXHAUST SCRUBBER – SPECIFICATIONS

1. GENERAL

The kitchen scrubber shall be complete in all respects and shall generally comply with the following specifications given below:

2. AIR WASHERS

- 2.1 The scrubber shall be of 16G G.I. Sheet metal fan section, mixing box and SS-304 made spray section, filter section and eliminators.

2.2 Enclosure/Housing

- 2.2.1 Enclosure shall be made of powder coated 18 gauge GI sheet with riveted and soldered lap joints casing angles shall also be of 40mm x 40mm. Angle shall be riveted and soldered to the casing.
- 2.2.2 The front panels shall be easily openable for servicing the fan sections. It should provide easy access to remove air filters for cleaning.
- 2.2.3 The opening for access doors and gaps between sections shall be provided with the neoprene rubber T-gaskets fixed in grooves in the extruded sections.
- 2.2.4 The panels shall be fixed to the frame work with self tapping stainless steel screws and both ends of the screw shall be provided with rubber caps.
- 2.2.5 The access door to fan section is to be provided with a switch to shut the fan when the door is open.

2.3 Fan Section

- 2.3.1 The impellers of the fan or fan shall be of GI sheets, double inlet forward curved centrifugal design, both statically and dynamically balanced. The fan housing shall be of sturdy construction made from 16G (1.6mm) GI sheet with smooth air inlets. The fan shall be mounted on properly aligned shaft and mounted on self aligning bearing blocks. The casing of the cab section shall be made of 16G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall be either be folded GI sheets or of hot dipped galvanized iron.

2.4 Spray Section

- 2.4.1 Spray section and tank shall be fabricated from 18 G 304 A stainless steel sheets with bolted construction having suitable stiffness.
- 2.4.2 The section shall be complete with SS 304 water distribution header having ports and sized for uniform and adequate water flow through perforated SS 304 pipes. The spray nozzles shall be of brass construction.
- 2.4.3 The tank shall be fitted 3/4" (20 MM) float valve of commercial grade brass.
- 2.4.4 The spray section shall have provision for fixing one or two sets of air filters as specified later.

2.5 Water Sump

- 2.5.1 The water sump below the spray section shall be of 3mm MS plate with welded joints. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line. The tank shall be given 2 coats of corrosion resistance paint and final coat of black enamel paint.

2.6 Drift Eliminators

- 2.6.1 Drift eliminators shall be of PVC supported at the top and bottom fixed to the spray section by means of GI notched bars. Eliminators shall be a set of vertical plates with a series of bends and deflections to give large surface area on which water drops and dust shall be impinge. Eliminators shall be properly stiffened at the sides.

2.7 Distribution Plate

- 2.7.1 Distribution plate shall be GI 18G with sufficient number of circular opening uniformly spaced for even distribution of air for spray type air washer.

3. PUMPS

- 3.1 The water distribution pumps shall be of heavy duty, vertical type mounted inside the tank. It shall be complete with adjustable bleed of arrangement to prevent concentration of undesirable salts.

4. GREASE FILTER & CARBON FILTER

- 4.1 The standard pre-filters shall be with 5 layers of SS-304 wire mesh, fixed in a 22 G GI frame with handles for ease of removal.

The above set of filters shall be fixed in filter frames made of 22 G.I. sheets, shaped to prevent air leakage. The filters shall be easily removable. The filter section may form part of the spray section or may be bolted separately to the spray section.

- 4.2 Carbon filter shall be installed to eliminate the particles in the smoke.

5. MOTORS AND STARTERS

- 5.1 The motor for each blower, shall be totally enclosed, fan cooled, squirrel cage induction type and conform to specifications as given under section 3.

- 5.2 The starters shall be “direct on line” type upto 7.5 H.P. All larger starters shall be of fully automatic star delta type.

- 5.3 The pumps shall be provided with single phase, self tripping starter of “North West” make.

6. MISCELLANEOUS

Necessary accessories shall be provided wherever necessary for proper operation and shall also include.

- 6.1 PVC eliminator fixed to the spray section to avoid water spillage.
- 6.2 Necessary piping for water circulation.
- 6.3 Vibration isolators for the blowers and pumps.
- 6.4 Canvas connections at the outlet of each fan.
- 6.5 Nuts, bolts, shims etc., as required for the grouting of the equipment.
- 6.6 Float valve in the spray tank, along with quick fill connection.
- 6.7 Gate valves in drain, make up, quick fill line etc, as required.
- 6.8 Built in isolator switches for the fan and pump motor and wiring from the isolators upto the respective motors.

7. LIMITATION

7.1 The air velocity limits are as follows:-

7.1.1 Velocity across scrubber not exceeding 2.54 m/s (500 FPM).

7.1.2 Velocity at blower outlet-not exceeding 10.16 m/s (2000) FPM.

11.0 INLINE & PROPELLER FANS – SPECIFICATIONS

1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of centrifugal and inline fans conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

2 TYPE

Centrifugal and inline fans shall be of type as indicated in drawings and 'Schedule of Quantities'

3 INLINE FANS

Inline fan shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. The fan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions.

All single-phase fans shall be provided with speed regulators while all three phase fans shall be provided with opposed blade dampers in GSS construction at fan outlet for air balancing.

4 PROPELLER FANS

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for 415 \pm 6% volts. 50 cycle 3-phase power supply and for smaller fans shall be suitable for

220 \pm 6% volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and Schedule of Quantities.

Propeller fans shall be provided with following accessories: -

Wire guard and bird-screen

Gravity louvers at outlet

Regulator for controlling fan speed for single-phase fan motor.

Single-phase preventors for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

5 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6 TESTING

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

12.0 VENTILATION FAN SECTIONS – SPECIFICATIONS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of ventilation fan sections conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

2. TYPE

Ventilation fan sections shall be complete with Centrifugal Fans, belt driven fans complete with motor drive and housing with weatherproof cowl.

3. UNIT CONSTRUCTION

3.1 Housing

The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6 mm size on all discharge cowls around the outlet areas.

3.2 Fan

Fan shall be forward / backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced. Fan shall conform to specifications as given in specification No.SPC/CF – PF/01

3.3 Motor

Motors shall be suitable for $415 \pm 10\%$ volts, 50 CPS, 3 Phase AC supply totally enclosed fan cooled motor provided with class 'F' insulation. Motor shall be designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be through belts.

3.4 Back draft Damper

Where called for in schedule of quantities the ventilation fan section shall be provided with a rattle free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatterproof under all conditions.

4. VIBRATION ISOLATION

The motor and fan assembly shall be isolated from base through Dunlop/Resistoflex vibration isolators.

5. PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6. TESTING

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

13.0 AXIAL FLOW FANS – SPECIFICATIONS

1. SCOPE

This section covers the technical requirements for manufacture, testing at works, delivery at site, testing after installation, commissioning of axial flow fan equipments for ventilation and exhaust system. Their location shall be as given in 'Schedule of Quantities' and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following: -

- (a) Suction and discharge side flanges and counter flanges suitably drilled, complete with bolts & nuts, direct driving electric motor, suspension hangers (for ceiling hung fans only) for vibration isolation (rubber in shear type). Any structural steel and hardware required for assembly, installation, supporting of fan or accessories. 2 mm thick flexible connectors, fire resistant type at suction and discharge end, Foundation bolts and vibration isolators (in case of floor mounting only).

Gravity louvers

2. APPLICABLE SPECIFICATIONS STANDARDS AND CODES.

Documents listed below should be read along with the technical data given in the 'Schedule of Quantities' and shall be applicable to the material, manufacture, testing and installation of axial flow fans and accessories.

- (a) I.S.S.: 3588 – 1986; specifications for electric axial flow fans.
- (b) ANSI/ASHRAE: standard 51
- (c) ANSI/AMCA: standard 210 for preparing performance curves, charts and testing of fans
- (d) IS-2312 – Propeller type A.C ventilation fans
- (e) BS – 848 – Methods of performance test for fans

3. DESIGN & MANUFACTURING

Fan and Components

3.1 The fan shall be designed to handle the quantity of air against the static pressure and at conditions indicated in the technical data. The fan shall have optimum efficiency at operating conditions and shall have performance characteristics to match the approved performance curves.

3.2 The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quiet, stable and vibration free operation at the prescribed conditions of flow, static and speed.

3.3 The casing shall be fabricated from heavy gauge sheet steel with suction and discharge ends flanged and complete with counter flanges, G.I. nuts and bolts. The flanges and counter flanges shall be matched and drilled suitably to receive flexible PVC connections. An inspection door with handle and neoprene gaskets shall be provided. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts.

Impeller & Blades

The impeller shall be cast aluminum; aerofoil type with well-balanced blades made from cast aluminum alloy or cast steel construction.

3.4 Drive

The fan hub and blades shall be directly mounted on the shaft of a totally enclosed motor, rotor of fan motor shall be well balanced. The motor shall be TEFC, squirrel cage, IP 55 0– class F and suitable for $415 \pm 10\%$ V, 50 HZ 3 phase AC power supply. The motor shall be dual speed wherever called for in 'Schedule of Quantities'. The maximum motor speed shall be limited to 1450 RPM. Motor conduit box shall be mounted on exterior of fan casing and lead wires from motor to conduit box shall be protected from air stream by enclosing in a flexible metal conduit.

4. TECHNICAL SPECIFICATIONS

4.1 The firm shall submit the technical data and performance characteristics with operating points duly marked for approval prior to fabrication. The supplier shall supply the test certificates of all the fans.

5. GENERAL REQUIREMENTS

5.1 Static, dynamic balancing and vibration: the individual fan impeller, blades, motor shall be statically and dynamically balanced independently. After assembly the entire fan motor unit shall not give rise to any vibrations. The balancing shall be as per ISO: 1940 GR 6.3.

5.2 **NOISE LEVEL:** The tenderer shall indicate the noise level generated by the fan/motor unit in terms of decibel units to be measured at 3M from the unit. This shall fall in line with best engineering standard.

6. PAINTING

All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

7. PACKING

The fans shall be dispatched in packed condition to avoid damage during transportation to site. Transit insurance for the fans shall be included in this offer.

8. INSPECTION & TESTING

All fans shall be subjected to inspection and testing requirements as given below. The contractor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of Client may be tested at the factory in his presence.

The performance of the fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves

Airflow capacity

Static head developed

BHP requirement

Vibration and noise level

14.0 AUTOMATIC CONTROLS AND INSTRUMENTS – SPECIFICATIONS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with requirement of drawings and 'Schedule of Quantities'

2. PRODUCTS

2.1 PICB /Two / Three Way Valve

PICB/Two way or Three way motorized / modulating valve for each air handling units shall be provided in chilled water line at each air handling units as shown on the Drawings and included in Schedule of Quantities. Each valve shall be actuated by a space or duct mounted thermostat. Constant space condition shall be maintained by continuous proportional modulation of the chilled water through the coil. The valve shall revert to fully by pass position when fan is shut off. Motor shall be proportional modulating motor. Motor shall be suitable for 24 volts supply and shall have a cover mounted 220/24 volts transformer factory- installed. The unit shall be suitable for outdoor installation in the open space.

Two way or Three-way motorized valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in Schedule of Quantities. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall revert to fully bypass position when fan is shut off.

Valve shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.

2.2 **Flow switches** shall be provided in the condensing water line (outlet) and chiller water line (outlet) only near the chilling machine. The control supply of chilling units shall be interlocked with these flow switches.

- 2.3 **Thermostats** shall be electrical mode, fixed differential type with sensing element located in the return air stream.
- 2.4 **Proportional control thermostats** for air conditioning application for actuating the two ways or three way modulating valve at each air-handling units, as shown on drawings and included in Schedule of Quantities. Thermostat shall be similar to Honeywell model T921B/T92A or equivalent, line voltage-cooling thermostat. Range shall be 56-84 degree F, differential shall be 3 degree F.
- 2.5 SNAP acting fixed differential thermostat for FCU shall be of Honeywell make and model T649A or T4039 cooling thermostat or any approved equivalent with temperature range of 13-29 degree C differential 37 deg C with ON/OFF, HI/LOW fan switch, normal-cool setting switching off must break fan circuit.

3. INSTRUMENTS

- 3.1 **Thermometer:** Thermometers shall be dial type 100 mm dia or V form industrial type. Body shall be aluminum alloy, anodized gold colored surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0 deg C to 60 deg C & +32 deg F to 150 deg F. Graduation of scale shall be 1 deg in both readings. Ranges of scales shall be 30-90 degrees F (0-50 deg C) for all conditioning applications of cooling only.

Thermometer shall be suitable for 15mm connection. Thermometer for chilled water shall be with long stem so that thermometer is removable without damaging the insulation ms socket to be welded on pipes shall be provided with thermometer. Thermometer shall be installed of chilled water supply and return at each air handling unit, supply and return of each chiller, condenser.

- 3.2 **Pressure gauge:** shall be installed on suction header and at discharge side of each pump in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller. Suction side gauge at pump suction header shall be compound gauge with 150 MM dia, range 75 cm vacuum to 10 kg pressure. Discharge side gauge at pumps and at all other locations shall be 150mm range 0-10 kg per sq cm (0-150 PSI) Pressure.

15.0 SHEET METAL WORKS AND ACCESSORIES - SPECIFICATIONS (MANUAL FABRICATION)

1. SCOPE

The scope of this section includes supply, fabrication, installation & testing of all sheet metal ducts, supply, installation, testing & balancing of all grills & diffusers as per specifications & drawings.

Except as otherwise specified all ductwork and related items shall be in accordance with these specifications.

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

2. DUCT MATERIALS

The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) and with a galvanizing thickness of nominal 120 gm. per SQM surface area.

- 2.1 Only new, fresh, clean (unsoiled) and bright GI/Aluminum sheets shall be used. The Owner / Consultants reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines.
- 2.2 All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with Amendment-I (1971 Edition)

size of Duct	thickness	Joints	
50		ge	
100		3 mm angle iron frame with 8 mm Dia nuts & bolts	33 MM @ 1M
150		5 mm angle iron frame with 8 mm Dia nuts & bolts	55 MM @1M
200		5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	33 mm @ 1.2m to be braced diagonally.
above		5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	33 mm @ 1.6m diagonally braced

- 2.3 Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.
- 2.4 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.
- 2.5 All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom

3. INSTALLATION

- 3.1 All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration
 - 3.1.1 Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section 'Insulation' and as indicated in 'Schedule of Quantities. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in 'Schedule of Quantities'.
 - 3.1.2 Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.
 - 3.1.3 All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint.
 - 3.1.4 Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.
 - 3.1.5 Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.
 - 3.1.6 All sheets metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size.
 - 3.1.7 Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside.
 - 3.1.8. Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing.
- 3.2 During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.
 - 3.2.1 Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.
 - 3.2.2 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow.
 - 3.2.3 The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
 - 3.2.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.
 - 3.2.5 The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the engineer-in-charge. The Contractor shall verify all measurements at building and shall notify the Engineer-in-Charge of any difficulty in carrying out his work before fabrication.

- 3.2.6 Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.
- 3.2.7 All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angel/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles / channels shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats.
- 3.2.8 Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening.
- 3.2.9 All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.
- 3.2.10 Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 3.2.11 The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

4 DAMPERS

At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable level links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper frames shall be constructed of 16 gauge steel

After completion of the ductwork, dampers are to be adjusted and set to deliver the required amount of air as specified in the drawings.

5 ACCESS PANEL

A hinged and gasket access panel shall be provided on ductwork before each control device that may be located inside the ductwork. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak tightness of the joints. Access door/panels shall be provided: - Near each smoke sensor Any other place specifically mentioned in the drawing or if asked by Owner/Consultants during execution stage.

6 MISCELLANEOUS

Sponge rubber gaskets also to be provided behind the flange of all grills.

Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Engineer-in-Charge.

Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.

Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-Charge.

All duct supports, flanges, hangers and damper boxes etc. Shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

All angle iron flanges are to be welded electrically and holes to be drilled.

All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers.

7 GRILLS / DIFFUSERS

SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be made of extruded aluminum section as specified in BOQ. The diffusers shall be powder coated in finish. Supply air diffusers shall be provided with screw operated opposed blade volume control devices of extruded aluminum in black anodized finish. The diffusers shall be suitable for concealed fixing arrangement and as approved by Architect/Consultant.

The diffusers shall be provided with removable central core.

All diffusers shall be selected as per selection curves and in consultation with Architect / Consultant. All diffusers shall have soft continuous rubber/foam gasket between the periphery of the diffusers and the surface on which it has to be mounted.

LINEAR GRILLS:

Linear continuous supply or return air grills shall be extruded aluminum construction with fixed horizontal bars at 15° inclination with flanges on both sides. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The grille shall be suitable for concealed fixing and horizontal bars of the grille shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminum construction in black anodized finish shall be provided in S.A. duct collars.

DOUBLE ADJUSTABLE LOUVERED SUPPLY / RETURN AIR GRILLS WITH HORIZONTAL/VERTICAL OR VERTICAL/ HORIZONTAL LOUVER ARRANGEMENT:

The grille shall be adjustable as each louver shall be pivoted to provide pattern with 00 to plus or minus 150 ARC upto 300 deflection down towards. The louvers shall hold deflection settings under all conditions of velocity and pressure. The rear louver of the register shall be in black shade. Volume control device of extruded aluminum construction with black anodized finish shall be provided in S.A. grills.

EXHAUST AIR REGISTER:

Exhaust air register shall be made of extruded aluminum with fixed horizontal louvers at 40 degree angle setting on a 20 mm louvers pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminum construction with black anodized finish shall be provided.

MULTI SLOT CEILING DIFFUSERS:

Multi slot ceiling diffuser shall be made of extruded aluminum with various slot width and air pattern deflectors. Deflectors in each slot provide an adjustable air pattern of 180 degree full. A special plenum shall be provided for each supply air diffuser. The linear diffuser shall have alignment strips to give straight look while installation.

Hit & miss type volume control damper of extruded aluminum construction with mill finish shall be with multi-slot supply air diffuser.

LINEAR CEILING MOUNTED DIFFUSERS:

Linear ceiling mounted air terminals shall be made of extruded aluminum surface mounted one way or two way pattern. The linear terminal shall have alignment strips to give straight look while installation. Volume control device of extruded aluminum construction in mill finish shall be provided in S.A. diffuser.

FRESH AIR INTAKE LOUVERS:

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 45° on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

8. MOTORIZED COMBINED SMOKE & FIRE DAMPERS – SPRING RETURN

All supply and return air ducts at AHU room crossings (or ducts as applicable) and at all floor crossings shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI ROORKEE as per UL 555:1973

Fire damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be provided on both ends using chrome-plated spindles in self-lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 g galvanized sheet steel. For preventing smoke leakage side seals will be provided.

In normal position damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU room/R.A. duct/damper. The A/C Contractor shall also provide smoke detector. The fire damper shall also close due to Temp. rise in S.A. ducts thru the electric temp. sensor factory set at 165 Deg. F micro switches with bake lite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorized actuator.

Each dampers in case of motorized smoke-cum-fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from power supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/temp. sensor & reset button. Additional terminal will be provided to have signal (sound beep or visual) in central control room.

Damper actuator shall be spring return 'belimo' make so as to close the damper in the event of power failure automatically and open the same in case of power being restored.

Spring return action of the actuator shall be an in-built mechanism and shall not be mounted externally.

The damper shall be installed in accordance with the installation method recommended by the manufacturer.

9 PAINTING

All grilles, and diffusers shall be powder coated in color as approved by Architect/Consultant before installation.

All ducts immediately behind the grilles/diffusers etc. Are to be given two coats of black paint in Matt finish.

10 TESTING

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

16.0 SHEET METAL WORKS –

(FACTORY FABRICATED)

1. GENERAL

- 1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.
- 1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
- 1.3 Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2. DUCT MATERIALS

- 2.1 The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).
- 2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

Governing Standards

- 2.3 Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards (“HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995” SMACNA)

3. RAW MATERIAL

3.1 Ducting

- 3.1.1 All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill test Certificates.
- 3.1.2 Galvanizing shall be of 120gms/sq.m. (total coating on both sides).
- 3.1.3 In addition, if deemed necessary, samples of raw material, selected at random by owner’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor’s expense.
- 3.1.4 The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

3.2 Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized)/

4. FABRICATION STANDARDS

- 4.1 All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be Rolastar factory-fabricated or Techno Fabriduct. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply.

- 4.2 Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.
- 4.3 All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines.
- 4.4 All edges to be machine treated using lock formers, flanges and roller for fuming up edges.
- 4.5 Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

5. SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with 1" (250 Pa)w.g. static norms as per SMACNA.

All transverse connectors shall be the Rolamate 4-bolt slip-on flange system or Techno Fabriduct imported makes of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used.

The specific class of transverse connector and duct gauge for a given duct dimensions will be 1"(250 Pa) pressure class.

Non-toxic, AC-applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification.

6. DUCT CONSTRUCTION

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

- 7 **Dimensional Tolerances:** All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.
- 7.1 Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.
- 7.2 Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
- 7.3 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the tum without appreciable turbulence.
- 7.4 Plenums shall be shop/factory fabricated panel type and assembled at site.
- 7.5 Factory Fabricated ducts shall have the thickness of the sheet shall be as follows.

Sl.	Size of Duct	Sheet Thickness	Fastner Size	Type of Joints		Bracing with GI tie rods of following sizes	Support Angle
				For Rolastar duct & Rolamate flanges	For Techno Fabriduct and flanges		
6.5.1	Upto 750 mm	0.63 mm	3/8"	Fabricated out of G.I. sheet of 24 gauge at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	25x25x3 mm
6.5.2	751 mm to 1000 mm	0.80 mm	3/8"	E-24 type flange, shall be fabricated out of 24 G sheet at every 1.2 m internal.			25x25x3 mm
6.5.3	1001 mm to 1500 mm	0.80 mm	5/8"	E-22 type flange, shall be fabricated out of 22 G sheet at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	40x40x5 mm
6.5.4	1501 mm to 2250 mm	1.00 mm	5/8"	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			40x40x6 mm angle
6.5.5	2251 mm and above	1.25 mm	5/8"	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			50x50x6 mm with MS rods of 12 mm dia.

7.7 The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

7.8 Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

7.9 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

7.10 All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

8. INSTALLATIONS

8.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

8.2 Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

8.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

8.4 The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

- 8.5 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.

- 8.6 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
- 8.7 Flanges bracings and supports are to be Rolamate or Techno Fabriduct. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 8.8 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.
- 8.9 Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- 8.10 Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- 8.11 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.
- 8.12 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
- 8.13 Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

9. DOCUMENTATION TO MEASUREMENTS

For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

10. TESTING

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA-“HVAC Air Duct Leakage Test Manual: (First Edition).

Pre Insulated Ducts

SCOPE

The scope of this section comprises the supply and application of insulation conforming to these Specifications.

Insulation material shall be non toxic , chemically inert , non combustible, non ignitable, shall have zero ozone depletion potential, zero calorific value no heat evolution and shall be inherently proof against rotting , mould and fungal growth and attack by vermin.

The materials shall comply with following standards.

BS 476: Part 4 – Non Combustible

BS 476: Part 5 – Not easily Ignitable (Class P)

BS 476: Part 6 – Fire propagation Index ($I < 12$)

BS 476: Part 7 - Surface spread of flame (Class 1)

The material should comply to Class 'O' fire rating as per BS 476 part 6&7.

The product shall be able to work effectively at ambient temperature range of -100°C to 150 °C

DUCT THERMAL

MATERIAL

Insulation material of Duct shall be factory laminated Aluminum foil faced resin bonded fiberglass wool. The Thermal conductivity of the insulation material shall not exceed 0.034 W/m K at 25 deg C mean temperature. The thickness of insulation shall be so selected as to prevent any condensation and should be able to meet R-Value requirements.

The minimum thermal resistance (R-Values) for insulation of ducts (as per Ashrae 90.1-2004 and ECBC 2007) shall be as described below:

Supply Air Ducts $R = 1.4 \text{ m}^2 \text{ deg. /W}$ (Thickness requirement for glasswool 50MM)

Return Air Ducts $R = 0.6 \text{ m}^2 \text{ deg. /W}$ (Thickness requirement for glasswool 25MM)

The nominal density of Resin Bonded Fiberglass insulation shall be 24 kg/m³

The minimum thickness of material used for duct thermal insulation shall be 25mm.

The installation guideline for glasswool duct-wrap:

- The duct surface should be cleaned with suitable solvents and rendered free from all physical and chemical impurities.
- The duct should be inspected and all joints should be sealed against leakages.
- For ducts having width greater than 0.6m, heavy duty self-adhesive pins are to be applied to the duct at appropriate intervals (max 300mm) as per manufacturer's Installation Manual.
- The duct should be covered with two coats of cold applied bitumen adhesive ENIFIX BA60 M/s. Paramount Polytrete Chemicals Pvt. Ltd approved product.
- The insulation of specific R-value and thickness should then be cut to appropriate length and stuck to the duct while the adhesive is still wet. For proper laying technique, refer to manufacturer's Installation Manual.
- All longitudinal joints and circular overlaps should be sealed with aluminium foil tape (50mm width) to make the installation leak proof. For large ducts, where adhesive pins have been used, speed washers/clips should be covered completely with Aluminium foil-tape to have an air-tight finish.

- The insulation should then be secured over the duct using mechanically fastened nylon/steel straps (12mm/50mm) at appropriate intervals (max 1.2m).
- After the installation the vapour retarding foil should be inspected and all tears should be sealed with Aluminium foil-tape to prevent air leakage.

DUCT ACOUSTIC LINING

Insulation material for Duct Acoustic Lining shall be resin bounded fiberglass wool with one side factory laminated either Black Glass Oven Cloth or Black Glass Tissue. The Thermal conductivity of the fiberglass for air-conditioning application shall not exceed 0.034 W/m K at 25 deg C mean temperature and average Noise Reduction Coefficient (NRC=1, frequency range from 100 Hz to 8000Hz). The density of insulation material shall be either 32 Kg./m³ and thickness of insulation material shall not less 25mm.

The installation guideline for glasswool in Duct Acoustic Lining :

- 1> The inside duct surface should be cleaned with suitable solvents and rendered free from all physical and chemical impurities.
- 2> Fix 22 gauge G.I. channels & angle frame work 25mm wide x depth equal to thickness of insulation at 600mm centre, screwed to the sheet metal by means of brass metal screws.
- 3> Cut the panels of fiberglass wool insulation material & fix in framed work using two coats of cold applied bitumen ENIFIX BA-60 approved product.
- 4> The inner most surface of insulation material shall be covered with factory laminated either Black Glass Oven Cloth or Black Glass Tissue.
- 5> Finally cover the insulation with 0.5 mm thick perforated aluminum sheet having 20% perforation with joints overlapped and screwed to the frame by means of brass metal screws, to produce an even surface.

PIPING INSULATION:

Chilled water and drain piping shall be insulated with rigid Glass wool preformed pipe section. The insulation material shall be confirmed these specifications.

The Fiberglass wool insulating material shall be applied for Chilled Water pipes as under.

Rigid pre-formed molded sections of fiberglass wool having a uniform density of 80 Kg/m³.

and thermal conductivity shall not be more than 0.030 W/mK at 25° C mean temperature. The material for piping insulation shall be factory laminated one side with Aluminum foil on the outside, and fused to the insulation material, as specified. The Aluminum foil shall extend by a minimum 50 mm on one side of the pipe section along the length to seal all longitudinal joints. Bonding of insulation material shall be with a cold setting compound. Adhesive ENIFIX BA60 used for setting the insulation shall be non-flammable, vapour proof adhesive. The thickness of insulation material shall be selected with diameter of pipe as below.

Pipe Dia (NB)	Thickness (MM)
20 -100	25
100-150	40
150-250	50
300 -450	65
450 & above	75

ETHOD OF INSULATION APPLICATION:

1. Pipes shall be thoroughly cleaned with wire brush and rendered free from all foreign matter and grease and primer coated as in item piping.
2. The pipe should be inspected and all joints should be sealed against leakages.
3. Two coats of cold applied bitumious based adhesive ENIFIX BA60 shall be applied on the cleaned pipe surface.
4. Fiberglass wool rigid sections shall be fixed tightly to the surface. All joints to be sealed properly. Fixing and sealing compound shall be ENIFIX BA60. All joints of Aluminum foil shall be sealed properly by means of 75 mm wide self adhesive aluminium tape of approved make.
5. Dip 100-200 gram m² thick glass fiber fabric in to Starbond 30-36 and wrap over the insulation.
6. Press gently by hand to avoided wrinkles in dipped fabric, and make surface smooth.
7. Apply 1st coat of Starbond 30-36 by brush after curing the dipped fabric.
8. Apply finel coat of Starbond 30-36 by brush once 1st coat is cured
9. The total spread of Starbond 30-36 shall be not less than 1.2 m² per kg with three coats.

17.0 PRE-INSULATED DUCT WORK

PRE-INSULATED GLASS WOOL DUCT WORK FOR THERMAL/ ACOUSTIC APPLICATION

Duct thermal

Pre-insulated duct board (Plus –R) shall be made of high density of rigid resin bonded fire safe glass wool with both side factory laminated aluminum foil, outer facing foil is having - Reinforced aluminum + Kraft+ glass veil and inner facing foil - Aluminum + Kraft + glass veil.

Duct Acoustic

Pre-insulated duct board-(Neto) shall be made of high density of rigid resin bonded fire safe glass wool with both side factory laminated aluminum foil, outer facing foil is having - Reinforced aluminum + Kraft+ glass veil and inner facing - Black glass textile.

Density of above both pre insulated glass wool duct board shall be $75-80\text{Kg/m}^3$ and at the edge of panels shall have density of 150Kg/m^3 . Size of panels for duct construction as below.

Thickness(mm)	Length(m)	Width(m)
25	2.9	1.19

The thermal conductivity of duct board shall not be exceeding 0.033 W/m K at 10 deg C means temperature and thermal resistance should be more than $0.6\text{ m}^2\text{K/W}$.

Glass wool duct panels shall be tested as per EN 13403

Vapour permeance of duct panels should be approximate value: $0.013\text{ g/m}^2\cdot\text{day mm Hg}$ (outer facing)

Mechanical stiffness: R5 rigidity, according to EN 13403 (European Standard for non metallic ducts) this rigidity is the maximum level of the ones established by this standard.

Duct board should withstand pressure under 800 Pa with no evidence of fissures or swelling (test according to EN 13403)

Fire test: Panels shall be tested as Euroclass: Euro class C-s1, d0

- s1: null smoke emission

- d0: non flaming droplets / particles.

Joint System: Duct boards should have exclusive design with male / female edges, in order to provide greater strength for joints, easy installation and shall reduce the number of cutting operation & exceptional inside finish.

Tools and Accessories for Installation of Duct Boards shall be followed as per recommendation of manufacturer's manual.

Duct Support: Duct board shall be installed, using support as described in installation manual of manufacturers. Maximum distance between hangers / support shall not exceed for horizontal ducts as

- 900 mm inner dimension maximum distance of hanger 2.4 m
- 900-1500 mm inner dimension maximum distance of hanger 1.8mm
- Above 1500 mm inner dimension maximum distance of hanger 1.2 m

INSPECTION AND TESTING

Duct dimensions shall be checked based on the duct dimension / layout drawings duly approved by the Architects/ Consultants.

The ducts, branches elbows etc. shall be inspected and the joints and connection shall be checked properly before these are assembled in position. After assembly the system shall be checked for tightness of male/female joints to avoid the leakage

Climaver Al. tape of 75mm thickness shall be applied on each male / female joint to avoid the leakage of air

Full sized standard dimension sheet as specified are to be used and any patched or made-up pieces of duct work are liable to be rejected. Joints between male/ female connections shall be fitted properly and Al. tape of 75 mm thickness shall be applied on joints.

Test points shall be provide at the discharge of each air handling unit and at each individual zone of the duct work system. Test points shall consist of 25mm diameter sockets fitted with sealing plugs which can be removed for the fitting of measuring devices. Test points shall be insulated as for the duct work and shall be provided with identification labels.

Rectangular risers should be free supported by angles or channels secured to the sides of the duct flanges with bolts or sheet metal screws or blind rivets. The supporting angle or channel should be freely resting over the slab cut-out. Riser support intervals should be limited to one storey height.

To ensure the air tightness, all ducts shall be checked with Leak Test after completion of duct fabrication but before installation of duct system.

18.0 QUALITY CHECKS ON DUCTING

	DESCRIPTION	OK	RKS
	Material adheres to Fabrication Standards as specified (Form Quality Sheets)		
	Construction Drawings. at site.		
	Bracing, bracings / reinforcements are as per standard.		
	Tightness of transverse / Longitudinal Joints ensured.		
	Use of heat resistant sealant for kitchen exhaust duct.		
	Use of gaskets for pharmaceutical and clean room projects		
	Use of gaskets used		
	Following aspects of duct supporting system		
	Spacing		
	Bolts size and quality		
	Painting of supports		
	Allowable load on trapeze angle for bigger ducts		
	Whether contractor has provided		
	Use of elbows		
	Use of collar at take Offs		
	Use of		
	Transitions & offsets slopes & fabrication.		
	Whether the installed ducting is as per layout approved, check locations, headroom etc.		
	Whether grilles / diffusers are as per approved shade.		
	Whether the method of installation for Grilles / Diffusers		
	Whether paint damaged surfaces.		
	Whether the coordination of following activities as per the given sequence:-		
	Ducts Cut for taking collars		
	Whether / Fabricate collar taking false ceiling framework for diffuser into account		
	Whether grilles / diffuser framework in false ceiling		
	Whether the collar		
	Whether diffuser		
	Whether elbows / turning points and branches to be properly supported		
	Whether door is provided at serviceable position for fan and fire		

	damper		
	ancing for room is studied		
	acement is considered for air exhausted from room.		
	r stainless steel material is used for corrosive fume exhaust system.		

DESCRIPTION	OK	RKS
min netting installed for louvers removable and serviceable.		
r gas vent outlet is not installed near air intake louver.		
exhaust is not short circuited to outdoor air intake louver.		
room pressure is slightly below the surrounding area.		
level of fan is studied.		
velocity for louvers / grills / diffusers is studied.		
tribution of the room is studied.		
break all flat surfaces to prevent vibrations or buckling due to air flow.		
f ducts having collar for grills should not be cross broken to facilitate alignment of grills.		
ds and collars should have vanes.		
passes through fire chamber increase sheet thickness.		
exhaust ducts to be tapered at bottom for oil / grease collection.		
flanged joints in kitchen exhaust duct above false ceiling.		
aluminum ducts are used with steel angles, steel to be painted with Zinc chromate paint		
check nuts with duct hangers		
below 250 mm should not be more than 1 m long to facilitate proper joining.		
s should have flanged and bolted ends for rigidity and easy maintenance.		
U' bends in ducts		
long radius bends and offsets.		
ars to be taken from top.		
duct spool pieces near equipment for easy removal.		

19.0 PIPING AND FITTINGS – SPECIFICATIONS

1 SCOPE

The scope of this section comprises the supply and laying of pipes required for chilled water; condenser water & drain water conforming to these specifications and in accordance with the requirement of the 'Technical Schedule of Equipments' and 'Schedule of Quantities'

2 WATER PIPING

MATERIAL

Water piping fittings and valves shall be of the following makes or approved equal make and shall conform to IS standards as indicated below.

Pipes UPTO150MM	MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992
& ABOVE	Black Steel Pipe Class 2 (6.35 MM Thickness). As per IS 3589 (LATEST)

All welding shall be done by qualified welders and shall strictly conform to Standard Code of practice for manual metal arc, welding of Mild Steel.

First butt weld of each welder shall be fully radio graphed by HVAC contractor under guidance of Client/Consultant for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

All welded joints (except pipe welded end-to-end) shall be made by use of forged one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All jobs welding shall be done by the electric arc welding process in accordance with the following: -

All joints shall have 45-degree bevel type, pipe mill-beveled or machine-beveled by the contractor.

All scale and oxides shall be removed with hammer, chisel or file and bevel left smooth and clean.

Pipe lengths shall line up straight with abutting pipe ends concentric.

Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means as to prevent induced

current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

GATE & GLOBE VALVES

Make: As approved shall be heavy duty non rising spindles as per IS 780, 778 and flanges as per is 1536 and factory tested for 10Kg/ sq cm test pressure

S.No	Size	Construction	Ends
A	15 TO 40 MM	Gun metal body	Screwed
B	50 MM and above	Cast Iron Body & spindle valve, seat wedge etc., of Brass or Gun Metal	Flanged

BALANCING VALVES

The balancing valves control and shut off valves with built in pressure drop and flow measuring facility shall be provided in the water outlet pipes of condensers and chillers, AHUs or wherever shown in tender drawings.

15-50 mm Size: Gunmetal ASTM B-6 2 Screwed ends conforming to BS 5154

65mm and above: Cast iron, flanged ends with stainless steel trim.

The valves shall have PTFE/SS disc with special erosion/corrosion proof sealing. The valves shall have temper proof adjustable and lockage arrangement for required water quantity after commissioning. The valves shall be complete with pressure test cock and drain cocks.

To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programs to provide the following functions:-

To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

To store the results of balancing.

To log measured values from a valve (differential pressure, flow rate or temperature)

To printout saved data in computerized measurement protocol (CMP) consisting of:-

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- AP at BV
- Flow at BV
- Design Flow

Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable rubber insertion gaskets (minimum 3 mm thick).

BUTTERFLY VALVES

Body: Cast Iron

Seat: Resilient lining moulded black nitrile rubber

Disc: SG Iron conforming to IS: 1865 SG 400/12 & BS 2789 GR 420/12 Nylon Coated

The handle shall have arrangement for locking in any position.. Valve shall be suitable for 16 Kg/Cm² working pressure.

BALL VALVES

All ball valves and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions. These are separately identified in Schedule of Quantities.

NON RETURN VALVES

Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications

Size	Construction	Ends
50 to 150 mm	Body cast iron, gun metal plate	Flanged
200 to 450 mm	Body cast iron, plate carbon steel with 13% chrome overlay	Flanged

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be suitable for not less than 10 Kg per sq. cm. gage working pressure.

STRAINERS

- a. Strainers shall be 'Y' type or Pot type Strainers as shown on drawings and included in BOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be pressure tested at 10 kg/cm² and shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gauge SS sheet with 3 mm perforation. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and included in BOQ.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet / outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and included in BOQ. The strainer body shall have two

separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gauge SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently to flush out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint watertight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as detailed below:-

Size (mm)	Pot Dia. (mm)	Pot HT (mm)	Element Dia. (mm)	Element HT (mm)	MS Plate Thickness (mm)
50	300	400	200	240	6
80	350	450	250	250	6
100	450	500	300	280	6
125	500	600	330	340	8
150	540	700	360	390	8
200	610	815	400	470	8
250	800	955	550	510	8
300	1000	1105	750	580	8
350	1190	1300	895	678	12
400	1350	1500	1020	785	12
450	1518	1700	1060	890	12
500	1690	1800	1100	900	12

600	2000	2200	1500	1160	12

Each pot strainer shall be provided with a Test Certificate.

- b. All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section "Insulation".

AUTO AIR VENT VALVES

- a. Air vent valves shall be provided at all higher points in piping system for venting and of following sizes:-
Up to 100 mm dia pipes : 25 mm dia.
- b. Air vent valves shall be Gun metal and tested up to pressure of Class I pressure rating.

FITTINGS

The dimensions of the fittings shall conform to IS 1239/69 Part II (as per latest amendment) unless otherwise specified in specification.

All bends in sizes up to and including 150 mm dia shall be readymade of heavy-duty, wrought steel of appropriate class.

All fittings such as branches, reducers etc in all sizes shall be fabricated from pipes of same dia and thickness and length at least twice the dia of pipe.

The branches may be welded straight to main line.

Blank ends are to be formed with flanged joints and 1 mm thick blank insertion of rubber gasket between flange pair for 150 mm and over in case where a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on with additional cross stiffeners.

The tender drawings show schematically the size and location of pipes but this is for contractor's guidance only. Pipe runs may be changed to meet the site conditions.

3 PIPING INSTALLATION

- a. All piping work shall be carried out in workman like manner causing minimum disturbance to the existing services.
- b. Piping shall be of steel, primer coated with rust preventive paint and finished with approved shade. Pipe supports shall not exceed the following spacing: -

MAXIMUM SPACING OF PIPE SUPPORTS

Pipe Size (MM)	Spacing (Mtr)	Rod Size
25	2	10 mm
30 to 75	2.5	10 mm
100 and above	3.0	12.5 mm

Pipe hangers shall be fixed on walls and ceiling by means of metallic Raw bolts or approved shear fasteners.

- c. Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The contractor shall adequately design all the brackets, saddle, anchors, clamps and hangers and be responsible for their structural sufficiency.
 - d. Vertical risers shall be parallel to walls and columns. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 10 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall also have a duck foot elbow or steel support welded to the pipe at the lowest point. On risers drain valves shall be provided at heels.
 - e. Pipe sleeve of 50 mm larger than the pipe diameter shall be provided wherever pipes pass through walls and the annular space filled with felt and finished with retaining rings. In case of an insulated pipe the diameter shall be inclusive of insulation.
 - f. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.
- Metal sheet shall be provided between the insulation and clamp, saddle or roller extending at least 150 mm on both sides of clamp, saddle or roller.

PRESSURE GAUGES AND THERMOMETERS

- a. One pressure gauge each shall be provided to measure pressure at the inlet and outlet of each cooling coil, shall be not less than 100 mm Dia and shall be complete with shut off (globe) valve. Care shall be taken to protect pressure gauge during pressure testing, range shall not exceed 50% above normal measurement.
- b. Thermometer shall be stem type and shall be provided at inlet and outlet of each cooling coil.

4 TESTING

- a. All water piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure but not less than 10 kg/sq cm for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Consultant.
- b. Pipes repaired subsequent to above pressure shall be retested in same manner.
- c. Piping may be tested in section and such sections shall be securely capped.
- d. The Contractor shall ensure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipments in the system concerned. If proper circulation is not achieved due to air bound connections, the 'Contractor' shall rectify the defective connections. He shall bear all the expenses for carrying out above rectifications involving tearing up and refinishing of floor walls etc as required.
- e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Engineer in- charge at site.
- f. The contractor shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser / chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.
- g. After the piping has been installed, tested and run for at least three days of eight hours each, all un-insulated exposed piping in plant room shall be given two finish coats, 3 mills each of approved colour,

conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to insulation section.

- h. After testing, all systems shall be chemically cleaned. After cleaning, the pipe work should be rinsed multiples times until the system is neutral. The contractor shall make a report conforming the above to Engineer in charge for records.
- i. The Contractor shall provide all materials tools equipments, services and labour required to perform the test and to remove water resulting from cleaning and testing.

5. BALANCING

- a. After completion of the installation, all water systems shall be adjusted and balanced to deliver water quantities as specified.
- b. Instruments required for the water balancing (computerized balancing instrument) shall be accurately calibrated in an approved manner before taking any measurements. Calibrated orifices and portable flow meters shall be used to balance the water flow. Orifices used for testing and balancing shall be installed with straight length up stream and down stream as recommended by the manufactures and shall be left permanently installed in the system.
- c. Automatic control valve and three way valves shall be set for full flow conditions during balance by procedure. Water circuit shall be adjustable by balancing cocks provided for balancing. These shall be permanently marked after balancing is completed so that they can be restored to their correct positions of disturbed.

6 PAINTING

- a. In case of pipes to be insulated after thorough anti grease and rust removal treatment, clean the pipe and then apply two coats of epoxy primer before applying in insulation treatment as specified elsewhere. All uninsulated pipes after de rusting will be provided with two coats of epoxy primer followed by epoxy paint of approved shade.

20.0 INSULATION – SPECIFICATIONS

1 SCOPE

The scope of this section comprises supply and fixing of insulation conforming to these specifications

2 MATERIAL OF INSULATION

The insulation material of following kind shall be used for insulation. The product shall have temperature range of -50⁰C to +115⁰C.

2.1 Duct Work Insulation

Type I

Insulation material shall be closed Resin bonded fibre glass wool. The thermal conductivity of the insulation material shall not exceed 0.031 W/MK at an average temperature of 23⁰C and density shall be not less than 24 KG/Cubic Meter. Material shall have factory laminated aluminium vapour barrier, self extinguishing and non dripping property. Thickness of the insulation on ducting shall be as detailed below: -

	Conditioned Space	Unconditioned Space
1 Supply Air Duct	25 mm insulation.	40 mm insulation

2	Return Air	Nil	40 mm insulation
(a)	Conditioned Exhaust Air	To be completely insulated with 12 mm thick insulation	
(b)	Plenums	To be insulated from outside with 40 mm thick insulation or lined internally with 25 mm thick insulation.	
(c)	Fresh air duct	To be completely insulated with 25 mm thick insulation	

Type II

Duct insulation material shall be duly laminated aluminum foil of mat finish closed cell Nitrile rubber (class "O") insulation on existing duct after applying two coats of cold setting adhesive (CPRX compound). The joints shall sealed with 50 mm wide and 3 mm thick self adhesive nitrile rubber tape insulation complete as per specifications and as required.

2.2 Application Of Insulation

The application of insulation shall be carried out as under: -

DUCT INSULATION

- Clean the duct surface (to be insulated) by scrapping carefully with wire brush etc. to make the surface completely free of mill scale, dirt, dust, grease and other foreign materials, taking special care so that all duct joints are sealed against any leakage.
- Apply rubber based adhesive CPRX compound.
- Seal all longitudinal joints and circular overlaps with and including Aluminium foil tape 50 mm wide, to make the insulation leak proof.
- Secure the insulation with and including mechanically fastened nylon/steel straps of size 12 mm/50 mm at maximum intervals of 1.2 mtr.

3. DUCT ACCOUSTIC LINING

The ducts so identified and marked on drawings and in 'Schedule of Quantities' shall be provided with acoustic lining of thermal insulation material as follows: -

3.1 Material for Duct Lining

The material to be used for duct lining shall be 12/25 mm thick resin bonded glass wool having a density of 32 kg/cu.mt and covered with 26 gauge thick perforated aluminum sheet with at least 20% perforation. The value at 32° c shall not be less than 0.034 KCAL / HR / MTR / Deg C

3.2 Application

- Clean inside surface of the duct.
- Apply a coat of CPRX compound.
- Fix the board inside the duct provided with GI channel 25 x 25 mm screwed on duct surface with self tapping screws to make grid of 600 x 600 mm.
- The inner surface should now be covered with fiberglass RP tissue.
- Cover the insulation boards with 26 G perforated aluminium sheet with at least 20% perforation.

- f) Secure the insulation board and aluminium sheet with cadmium plated bolts and washers.
- g) Seal the ends completely so that no insulation material is exposed.

4. FIRE BREAKS INSULATION

Firebreaks shall be provided in all ducts for internal lining/external thermal insulation after a run of 10 m center to center. There shall be a discontinuity of the insulating material in the form of MS angle of a minimum of 50 mm x 50 mm x 3 mm size. At the interface of the MS angle and insulating material, proper care of tucking in of the insulating material shall be taken so as to prevent erosion.

5. PIPE INSULATION

5.1 Chilled Water Pipe Insulation Type - I

The insulation for chilled water piping, pump, expansion tank etc. shall be carried out from rigid polyurethane foam having a 'K' value of 0.018 W/mk at mean temperature of 10°C and a density of 27.2 to 39.9 kgs/cubm. The material shall be factory faced on one side with aluminium foil on the outside, reinforced with kraft paper and fused to the insulation material. The aluminium foil shall be extended by a minimum of 50 mm on one side of the pipe section along the length to seal all longitudinal joints.

The aluminium foil facing shall be replaced with kraft paper facing wherever the pipe is to be covered with tar felt.

The thickness of the insulation for chilled water pipes shall be 40mm for 80 to 150 mm dia.

5.2 Chilled Water Pipe Insulation Type - II

The insulation of chilled water piping shall be carried out from resin `bonded fiber glass pipe section insulation having density 80 kg/cum duly covered with a layer of 120 gm/sqm polythene sheet (vapour barrier) on existing pipe and finally applying 0.63mm aluminium sheet cladding complete with type3 , grade 1 roofing feltstrip(as per IS:1322 as amended up to date) at joints etc. as per specifications and as required.

5.3 Chilled Water Pipe Insulation Type-III

The insulation for chilled water piping shall be carried out from flexible pipe sections/sheets of PUF insulation having a 'K' value of 0.018 W/mK at a mean temperature of 10°C and a density of 27.2 to 39.9 kgs/cubm Meter.

The thickness of insulation shall be 30 mm upto 65 mm dia.

6. OVER DECK INSULATION

1. Clean the surface and apply a coat of Primer.
 2. Apply Waterproofing membrane.
 3. Loosely place Insuboard (XPS) of minimum thickness of 50mm.
 4. Seal the joints with tape.
 5. Cover the Insulboard with plastic film (100 micron) as vapor barrier.
 6. A plastic net is then fixed over the vapor barrier over which a layer of PCC/Screed is laid to maintain proper slope.
7. A layer of Kota stone or cement tile or a layer of gravel can be put depending upon the requirement with suitable grouting.

21.0 SAFETY CODES - SPECIFICATIONS

1. SCOPE

The scope of this sub-section is the minimum safety requirements to be observed during manufacture and erection of the HVAC system as specified herein in addition to the safety norms generally followed:-

2. I.S. STANDARDS

The safety code for mechanical refrigeration IS: 660 and safety code for air conditioning IS: 659 shall be observed.

3. SAFETY REQUIREMENTS

Some of the important safety requirements are as under but not limited to the same:-

- a) There shall be maintained in a readily accessible place, first aid appliances including adequate supply of sterilized dressings and cotton wool.
- b) The injured person shall be taken to a public hospital without loss of time.
- c) Suitable and strong scaffolds shall be provided for workmen for all works that cannot be safely done from ground.
- d) No portable single ladder shall be over 8 meters in length. The width between side rails shall not be less than 30 cm (clear) and the distance between two adjacent rings shall not be more than 30 cms, when a ladder is used, an extra mazdoor shall be engaged for holding the ladder.
- e) The excavated material shall not be placed within 1.5 meters of the edge of the trench or half of the depth of trenches whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.
- f) Every opening in the floor of a building or in a working platform to be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter.
- g) No. Floor, roof or other part of the structure shall be so overloaded with debris or material as to render it unsafe.
- h) Workers employed on mixing and handling materials such as asphalt, cement mortar or concrete & lime mortar shall be provided with protective footwear and rubber hand gloves.

Those engaged in welding works shall be provided with protective eye shields and glove.

No paint containing lead or lead products to be used except in the form of paste or readymade paint.

Suitable facemasks shall be supplied for use of workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scraped.

Overalls shall be supplied by the Contractor to the painter and adequate facilities shall be provided to enable the working painter to wash during cessation of the work.

The ropes used in hoisting or lowering material or as a means of suspension, shall be of adequate quality and adequate strength and free from defects.

All site personnel shall wear safety helmets whenever they are in the construction/erection areas.

22.0 TECHNICAL SCHEDULE OF EQUIPMENTS

The capacity/ratings of various equipments in this contract are for guidance purpose only. a/c contractor shall check in details the design/selection of equipments. a/c contractor shall be finally responsible for maintaining the desired inside conditions and shall not deprive him of the responsibility if selection of equipments is not thoroughly checked. in case of shortfall the a/c contractor shall replace/modify equipments for achieving desired parameters without any extra cost to owner/employer.		
1.0	WATER PIPES	
	i. Material	MS
	ii. Class	'C'
	iii. Wall Thickness	
	25 MM TO 40 MM	4
	50 MM TO 65 MM	4.5
	75 MM	4.8
	100 MM TO 150 MM	5.4
	200 MM TO 610 MM	6.35
2.0	GSS DUCTING	
	i. Class of Galvanizing	VIII (120 GM/SQM)
	ii. Code of Fabrication	IS - 655 (LATEST)
	iii. Material of Hangers	MS
	iv. Quality of Sheet	LFQ
3.0	INSULATION	
	A) DUCTS	
	i. Material	Fibre Glass wool
	ii. Density	32 Kg/m3
	B) ACCOUSTIC LINING	

i. Material	Fiberglass	
ii. Density	32 KG/CU.M (minimum)	
C) PIPE INSULATION		
i. Material	TF' Quality Expanded Polystyrene	
ii. Density	18 KG/CU.M (minimum)	

23.0 TEST READINGS

23.1 CHILLER TEST REPORT

PROJECT _____
UNIT _____
LOCATION _____
MANUFACTURER _____
MODEL _____ SERIAL NO. _____
CAPACITY _____ REFRIGERANT _____
STARTER _____ HEATER SIZE _____

COMPRESSOR	DESIGN	ACTUAL	MOTOR STARTER	DESIGN	ACTUAL
Make/Model			Make/Model		
Serial No.			Type		
Type (Reciprocating / Centrifugal / Screw / Scroll)					
Piping Material			Amps		
Suction Pr/Tem			O/L Release Range		
Discharge Pr/Temp					
Refrigerant			EVAPORATOR	DESIGN	ACTUAL
Oil Pump Type			Make/Model		
Oil Pressure			No. of Passes		
Oil Failure Switch Pressure			Ref. Level		
Unload Arrangement			Ref: Pressure/ Temperature		
Unload Set Points			Ent. Water Temp/ Pressure		
Drive			Leaving Water Temp/ Pressure		
Compressor Speed			Temperature Difference		
Oil Level			Pressure Difference		
Oil Temperature			Water Quantity GPM		
L P Setting			Relief Valve Setting		
H P Setting			IKW / Ton		
Anti Freeze Setting					
Purge Unit Type					
Purge Operation Checked					

Make/Model			Make/Model		
Type			No. of Passes		
Voltage			Ref: Pressure/ Temperature		
Motor Rated Current			Ent. Water Temp/ Pressure		
COMPRESSOR MOTOR	DESIGN	ACTUAL	CONDENSER	DESIGN	ACTUAL
			No. of Fans		
Motor F L Current			Fan Material		
			Fan Diameter		
REMARKS					
TEST DATE _____					
READING BY _____					
Note : Please Furnish test report for all chillers separately.					

3.2 PUMP TEST REPORT

<u>PROJECT</u>				

DATA	PUMP NO	PUMP NO	PUMP NO	PUMP NO
Location				
Service				
Manufacturer				
Model Number				
Serial Number				
GPM/Head				
Req. NPSH				
Pump RPM				
Impeller				
Mfr./Frame				
Motor				
Mfr./Frame				
Motor HP/RPM				
Volts/Phase/Hertz				
F.L Amps				
Seal Type				
Pump Off-Press				

Valve Shut Diff				
Actual Impeller Dia				
Valve Open differential				
Valve Open GPM				
Final Dischg.Pressure				
Final Suction Pressure				
Final Δp				
Final GPM				
Voltage				
Amperage				

REMARKS

TEST DATE _____ READINGS BY _____

Note : Please Furnish test report for all CHW pumps.

23.3 AIR HANDLING EQUIPMENTS TEST REPORT

PROJECT _____						SYSTEM / UNIT _____							
LOCATION _____													
UNIT			DATA			MOTOR			DATA				
Make/Motor No.						Make / Frame							
Type/Size						H.P / RPM							
Serial Number						Volts/Phase/Cycles							
Arr./Class						F.Lamps.							
Discharge						Pulley Dia/Bore							
Pulley dia/ Bore						Pulley/ Distance							
No. Belts/make/Size													
No. Filters/type.Size (Pre.)													
No. Filters/type.Size (secondary)													
TEST DATA			DESIGN		ACTUAL		TEST DATA			DESIGN		ACTUAL	
Total Cfm							Discharge S.P						
Total S.P													
Fan RPM							Cooling Coil S.P						
Motor Volts							Filters S.P						
Out air Cfm													
Return air Cfm													
REMARKS.													
TEST DATE _____													

READINGS BY _____

Note : Please Furnish above report for all AHU.

23.4 RECTANGULAR DUCT **TRAVERSE REPORT**

PROJECT _____ **SYSTEM** _____

LOCATION / ZONE _____ **ACTUAL AIR TEMP.** _____ **DUCT S.P.** _____

DUCT	REQUIRED	ACTUAL
SIZE _____	FPM _____	FPM _____
SQ.FT. _____	CFM _____	CFM _____

POSITION	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2													
3													
4													
5													
6													
7													
8													
VELOCITY SUBTOTALS													

TEST APPARATUS

25.0 MODES OF MEASUREMENTS

1. UNIT PRICES IN THE SCHEDULE OF QUANTITIES

The item description in the 'Schedule of Quantities' is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.

THE UNIT PRICE OF THE VARIOUS ITEMS SHALL INCLUDE THE FOLLOWING:

All equipments, machinery, apparatus and materials required as well as the cost of any tests which the Consultant may request in addition to the tests generally required to prove quality and performance of the equipments.

All the labour required supplying and installing the complete installation in accordance with the specifications.

Use of any tools, equipments, machinery, lifting tackle, scaffolding, ladders etc. Required by the Contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipments foundations from the building structure, wherever necessary.

Storage and insurance of all equipments apparatus and materials.

The Contractor's unit price shall include all equipments, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipments, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

2. MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS ETC.

2.1 Sheet Metal Ducts

- 2.1.1 Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface areas shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.

- 2.1.2 For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway large and small diameter shall be adopted, the length of tapered duct section shall be the center line distance between the flanges of the duct section.
- 2.1.3 For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.
- 2.1.4 The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel. Splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

2.2 Grilles/Diffusers

Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

Diffusers - cross section area for airflow at discharge areas, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

Linear diffusers - shall be measured by cross - sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

Fire dampers - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel No special allowance shall be payable for extension of cross section outside the air stream.

Flexible connection - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

Exhaust Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipments. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

DAMPERS

Measurement of dampers shall be as per internal cross sectional area of the damper

4. MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS

4.1 Pipes

- 4.1.1 All pipes shall be measured in linear meter (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g., tees, bends, reducers, elbows etc. Deduction shall be made for valves in the line.
- 4.1.2 The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specifications and 'Schedule of Quantities'.
- 4.1.3 Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces. Wherever specified or required by the project engineer.
- 4.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter with no additional allowance being made for providing the same.
- 4.1.5 The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all through the fittings (e.g., tees. Bends, reducers, elbows, etc.) As through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges section 3.2 below applies.

4.2 Valves and Flanges

- 4.2.1 All the extra CI & CM flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur.
- 4.2.2 All gun metal (gate & globe) valves shall include two nos. Of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves and other welded to the MS Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp., grade and all items specified in the specifications.
- 4.2.3 The rates quoted shall be inclusive of making connections to the equipments, tanks, pumps etc. And the connection made with an installed pipe line shall be included in the rates as per the 'Bill of Quantities'.

4.3 Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and 'Schedule of Quantities'.

4.4 Insulation

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centerline measurements described herewith.

a) Pipe Insulation

This service shall be measured in units of length along the centerline of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation.

It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centerline of pipe and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b) Duct Insulation and Acoustic Lining:

This service shall be measured on the basis of surface area along the centerline of insulation thickness. Thus the surface areas of externally thermally insulated or acoustically lined duct shall be based on the perimeter comprising centerline (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centerline length including tapered pieces, bends, tees, branches etc. as measured for bare ducting.

26.0 FORMATS FOR INFORMATION TO ACCOMPANY BIDS

26.1 DEVIATIONS

This is to confirm that our bid is strictly in conformity with the general conditions of the Contract, technical specifications, special conditions, bill of quantities and tender drawing except to the extent of deviation given under:

.....

Reference	Extent of Deviation		Reason
Section	Page	Clause No. of BID Document	

.....

1. Technical

2. Contractual

Company Seal

Signature _____

Designation _____

Company _____

Date _____

26.2 CONTRACTOR'S CONFIRMATION

1. SAFETY CODES

We confirm that we shall strictly follow the safety codes as given in subsection 2.3

2. DESIGN CONFIRMATION

- 2.1 Except for the deviation contained in enclosed format 3.1, we agree to all the conditions of the Contract, special conditions, technical specification, makes and BOQ
- 2.2 The design on which this bid is prepared has been verified by us and we guarantee to maintain the inside conditions as stipulated in the Contract documents with the system offered. We further confirm that design meets with the requirements of all government, semi-government, municipal, local and other authorities, whose permission would become necessarily for completion of the project. In our opinion the design is economical and safe and we have nothing further to suggest either by way of effecting further economy or providing additional safety.
- 2.3 The space allocation shown on the drawings for the various equipments has been checked by us and it will be possible for us to install our equipments in the space allocated.
- 2.4 Routing of ducting as shown in tender drawings is feasible and can be executed by us without any additional space requirements.
- 2.5 The technical information on the equipments / material offered by us and any other information / clarification required by you or your Consultants will be furnished strictly in conformity with the tender documents within two weeks from date of receipt of letter of intent.

**26.3 DETAIL OF WORKS OF SIMILAR NATURE &
MAGNITUDE CARRIED OUT DURING LAST 3 YEARS.**

OF WORK ONE	ATED COST	STARTED	COMPLE TED	OF COMPLET ION AS / CONTRAC T	NS TO WHOM REFERENCE MAY BE MADE
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EAL OF COMPANY

SIGNATURE OF THE BIDDER

DESIGNATION _____

COMPANY _____

DATE _____

26.4 TRAINING OF OWNER'S PERSONNEL

1. The Vendor/Contractor shall train the Owner/Purchaser's engineering personnel in the shops, where the equipments will be manufactured and or in their collaborator's works and where possible, in any other plant where equipments manufactured by the Vendor/Contractor or his collaborator is under installation or test to enable those personnel to become familiar with the equipments being furnished by the Vendor/Contractor, either at his works or at his Sub-Vendor's/Sub-Contractor's works or at site.
2. The period of training shall be adequate and mutually agreed upon by the Owner/Purchaser and the Vendor/Contractor.
3. The training shall be so oriented as to make the Owner's/Purchaser's personnel proficient in operating the equipments.
4. The Owner's/Purchaser's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing and replacement procedures to be adopted for the equipments offered.
5. The Vendor/Contractor shall train the Owner's/Purchaser's personnel in carrying out minor repairs, if need arises, during the operation of the equipments.
6. The charges for training the Owner's/Purchaser's personnel, if any, be included in the price for supply of erection, testing and commissioning.

**27.0 TECHNICAL INFORMATION
REQUIRED WITH BID**

al Data Shall be furnished as follows along with manufacturers Capacity charts, Catalogues and Selection Data		
1.	FAN (CENTRIFUGAL) FOR TOILET EXHAUST	
1.1.1	Manufacturer And Model No.	
1.1.2	Fan Discharge Position	
1.1.3	Double or Single Inlet	
1.1.4	Fan Impeller DIA (INCH)	
1.1.5	Forward/Backward Curved	
1.1.6	CFM	
1.1.7	Fan Speed (BHP)	
1.1.8	Motor (HP) And Speeds	
1.1.9	Static Pressure (INCH WG)	
1.1.10	Balance (Static And Dynamic)	
1.1.11	Performance Curves	
2	FAN (PROPELLER)	
2.1.1	Manufacturer And Model No.	
2.1.2	Blade Dia (INCH)	
2.1.3	CFM	
2.1.4	Fan Speed	
2.1.5	Motor (HP)	
2.1.6	Static Pressure (INCH WG)	
2.1.7	Accessories	
a)	Speed Regulator	
b)	Gravity Louvers	
c)	Bird Screen	
d)	Wire Guard	
3	FILTERS (FOR AIR HANDLING UNITS)	
3.1	Type and Material	
3.2	Gross Filter Area (SQFT)	
3.3	Velocity Through Filter (F.P.S.)	
3.4	Pressure Drop Through Filter When New (INCHWG)	
3.5	Efficiency	
4.0	INSULATION	
4.1	Manufacturer and Type	
4.2	Material	
4.3	K Value Density at 10 Deg C Mean Temp.	
4.4	Thickness	
4.5	AHU Room Insulation	
4.6	Under deck Insulation	
5.0	DUCT LINING	
5.1	Manufacturer and Type	
5.2	Material	
5.3	K Value density at 10 Deg C Mean Temp.	
5.4	Thickness	

6.0	INLINE FANS	
6.1	Manufacturer	
6.2	Type	
6.3	Capacity (CFM)	
6.4	Fan dia	
6.5	Fan make	
6.6	Fan Type	
6.7	Motor make	
6.8	Overall dimensions	
6.9	Motor Electrical characteristics	
6.10	RPM	
6.11	Operating Weight	
6.12	Noise Level	
6.13	Type of Drive	
7.0	CONTROLS	
7.1	THERMOSTAT (EACH TYP	
7.1.1	Quantity	
7.1.2	Make & Type	
7.1.3	Model No.	
7.1.4	Range and Differential	
7.1.5	Voltage Requirement	
7.1.6	Pipe insulation	
7.2	MODULATING MOTOR	
7.2.1	Quantity	
7.2.2	Make & Type	
7.2.3	Model No.	
7.3	MODULATING VALVES	
7.3.1	Quantity	
7.3.2	Make & Type	
7.3.3	Size	
7.3.4	Capacity	
7.4	OTHER CONTROLS	
7.4.1	Quantity	
7.4.2	Make & Type	
7.4.3	Model No.	
8.0	GRILLS	
8.1	Make	
8.2	Material	
8.3	Gauge	
8.4	Grills	
8.5	VCDs	
8.6	Fire Dampers	
9.0	ELECTRIC MOTORS	
9.1	Name of Manufacturer	
9.2	Type of Motor & Frame Size	
9.3	Rated Output (KW)	
9.4	Range or Working Voltage	
9.5	NO of Phases & Phase Connections	
9.6	Nominal Frequency	

9.7	Rated Speed (RPM)	
9.8	Rated Current (AMPS)	
9.9	Class of Insulation	
9.10	Temp. Rise With Ambient Air AT 40 DEG C	
9.11	Efficiency & Power Factor At	
	100%	
	75%	
	50%	
	25%	
10.0	PIPING	
10.1	PIPES & FITTINGS	
10.1.1	Manufacturer	
10.1.2	Class	
10.1.3	MS OR GI	
10.1.4	ISI Makes	
10.2	VALVES	Make & Material
	Pressure	Test
		Standard (IS/BS)
10.2.1	Gate Valve	
10.2.2	Globe Valve	
10.2.3	Check Valve	
10.2.4	Balancing Valve	
10.2.5	Butterfly Valve	
10.2.6	Pot Strainers	
10.2.7	'Y' Strainers	
10.2.8	Ball Valve and w/o Strainers	
10.2.9	Pot Strainers	
10.2.10	Pressure Independent Valves	
Note:	Contractors shall submit manufacturers test certificates of all equipments and material with delivery of respective lot	

HVAC WORKS TECHNICAL SPECIFICATIONS

28.0 LIST OF BUREAU OF INDIAN STANDARD CODES

IS 1239 (Part– I) 1979	Mild Steel Tube
IS 1239 (Part – I) 1982	Mild Steel Tubular and Other Wrought Steel Pipe Fittings
IS 4736 – 1986 (Reaffirmed)	Hot Dip Zinc Coatings of Steel Tubes
IS 823-1964	Code of Procedure For Manual Metal Arc Welding of Mild Steel
IS 780-1984	Service Valves For Water Works Purpose
IS 778-1980	Copper Alloy Gate, Globe and Check Valves For Water Works Purpose
IS 1536-1976	Flanges Configuration
IS 5312 (Part –I) 1984	Swing Check Type Reflux Non Return Valves For Water Works
IS 2379-1963	Color Code For Identification of Pipelines
IS 554-1975	Dimension For Pipe Thread Where Pressure Tight Joints Are Required On Threads
IS 655-1963 (Reaffirmed 1991)	Metal Air Ducts
IS 277-1992	Galvanized Steel Sheet For Fencing
IS 4064 Part II-1978	Specific Requirements For Direct Switches of Individual Motors
IS 3854-1969	Switches For Domestic & Similar Purpose
IS 732 (Part III-1902)	Inspection and Testing of Installation
IS 659 – 1964 (Reaffirmed 1991)	Air Conditioning Safety Code
IS 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS 4894 – 1991	Test Code For Centrifugal Fan
IS 3103 – 1975 Reaffirmed 1994	Code of Practice For Industrial Ventilation
IS 7240 – 1981	Application & Finishing of Thermal Insulation Material
IS 325	Specifications For Three Phase Erection Motor
IS 3142 – 1993	V Grooved Pulley
BS-EN-779 – 1993	Particulate Air Filters For General Ventilation

IS 702 – 1988	Industrial Bitumen
IS 8183 – 1993	Bonded Mineral Wool
IS 2494 – 1993	V Belts For Industrial Purposes
IS 2062 – 1992	General Purpose Steel
ASHRAE Hand Books	<p>American society of heating, refrigeration and air conditioning books</p> <ul style="list-style-type: none"> - Applications 1999 - Fundamentals 1997 - System and equipments 1996 - Indoor air quality 62 – 1999

29.0 SYSTEM TESTING ADJUSTMENT AND BALANCING

1. SCOPE

- a) Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
- b) Testing, adjusting and balancing of HVAC Hydronic system at site.
- c) Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:

ASHRAE: 1999 HVAC Application

SMACNA: Manual for the Balancing and Adjustment for air distribution
System

2. PERFORMANCE

- a) Verify design conformity.
- b) Establish fluid flow rates, volumes and operating pressures.
- c) Take electrical power readings for each motor.
- d) Establish operating sound and vibration levels.
- e) Adjust and balance to design parameters
- f) Record and report results as per formats specified.

3. DEFINITIONS

Test: To determine quantitative performance of equipments.

Adjust: To regulate for specified fluid flow rates and air patterns at terminal Equipments (e.g. reduce fan speed, throttling etc.)

Balance: To proportion within distribution system (sub mains, branches and Terminals) in accordance with design quantities.

4. TESTING, ADJUSTING AND BALANCING (TAB) PRECEDURES

The following procedures shall be directly following in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the Project Manager about his ready to conduct the TAB procedures in the format given in these specifications.

5. DESCRIPTION OF SYSTEM AND REQUIREMENT

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

- All supply, return and outside air systems.
- All exhaust air systems
- All chilled water systems.
- All cooling tower (condenser) water systems.
- Emergency purge systems

6. AIR SYSTEMS

a) Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results.

- Inlet air Dry and Wet bulb temperatures.
- Outlet air Dry and Wet bulb temperatures.
- Air leaving dew point temperature
- Sensible heat Pickup
- Latent heat Pickup
- Sensible hat factor

b) Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

c) The Preparatory work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals.

All outside air intake return air and exhaust air dampers are in proper position.

All system volume dampers and fire dampers are in full open position.

All access doors are installed & are airtight.

Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for transverse measurements are available.

All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

7. HYDRONIC SYSTEM BALANCING

The Hydronic system shall involve the checking and balancing of all water pumps. Piping network (main & branches), the heat exchange equipments like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

The essential preparation work, must be done by the HVAC contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following:

Availability of co-ordinate drawings and approved submittals and system sketch with design water flows specified thereon.

Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.

Hydronic system is vented.

The contractor shall confirm completion of the basic procedures and prepare checklists for readiness of system balance.

Check pumps operation for proper rotation and motor current drawn etc.

Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.

Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the Consultant / Project manager for approval.

8. READINESS FOR COMMENCEMENT OF TAB

Prior to commencement of any test, the readiness to do so should be recorded as per the prescribed checklist.

9. TAB INSTRUMENTS

1. Air measuring Instruments

- a) For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.
- b) For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air Volume readings.
- c) Pitot tube.
- d) Electronic Rotary Vane Anemometer TSI make or equivalent.
- e) Accubalance Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have NIST testification (US Institute of Science and Technology) Calibration Certificate]

2. Hydronic Measuring Instruments

For measurement of water flow differential pressure and temperature, CBI measuring instrument Tour & Anderson AB Sweden or equivalent shall be used. The instrument shall have a built-in-microcomputer capable of giving readings for pressure differential flow rate and temperature.

3. Rotation Measuring Instrument

Electronic Digital Tachometer

4. Temperature & RH Measuring Instrument

TSI VelociCalc model 8386 and VelociCalc model 8345 or equivalent.

5. Electrical Measuring Devices

Clamp on Volt ammeter
Continuity Meter

Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipments vibration, bearing housing vibration, and other test as directed by the Project Manager.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Project Manager. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The contractor shall submit test equipments data and reporting forms for review. In order to reduce the ambient noise level the readings

shall be taken at night. All test shall be performed in the presence of Consultant / Project Manager.

24.0 APPROVED MAKES OF EQUIPMENT & MATERIALS

S.No	Equipment / Material	Approved Makes
	<u>HVAC WORKS</u>	
1	Water Chilling Machine – Screw Chillers (Air Cooled)	Clivet/ York / Trane/ Danhubush
2	Chilled Water Pump	ITT Bell & Gossette / Grundfoss / Mather & Platt
7	Air Handling Units	Flaktwood/ VTS/ Edgtech
8	Fan Coil Units	Flaktwood/ VTS/ Edgtech
9	Cooling/Heating Coils	Flaktwood/ VTS/ Edgtech
10	Axial Flow Fans	Humidin/ Kruger / Brightflow /Nicotra
11	Centrifugal Fans	Humidin/ Kruger / Brightflow /Nicotra
12	Evaporating Units/ Air Washers	Flaktwood/ VTS/ Edgtech/ Brightflow
13	Inline Fans	Caryaire / Kanalfakt / Kruger
14	Prefilters	Thermadyne / Mech Mark/ Supercut
15	Piping (Chilled/Drain) Upto 200 MM Dia	Jindal Star/ Tata/ Sail
17	Y- Strainers	Rapidcontrol / Sandhu / Maharaja/ C & R
18	Butterfly Valves(Water Duty)	Audco / Advance / Castle/ C & R
19	Check Valves(Water Duty)	Advance / Inter Valve / Castle
20	Balancing Valves(Water Duty)	Audco/ Advance / Castle / C & R
21	PICV	Danfoss/ Siemens /Johnsons / Honeywell
22	Pressure Gauges	H.Guru / Feibig/ Sant Engg
23	Thermometers	H.Guru/Emerald / Japsin / Fiebig
24	Water Flow Switch	Rapid control / Anergy
25	Modulating Motor	Honeywell / Johnson / Belimo / Rapid Control
26	Proportional Thermostat	Honeywell / Johnson / Siemens
27	Air Distribution/Ducting GI Sheets	Sail / Tata / Jindal
28 a	Factory Fabricated Duct & Flanges	Rolastar / Zeco / Ductofab / Technofab
28 b	Pre-insulated Ducts	Up Twiga/ Owens Corning / Kimcco
29	Extruded Aluminium Grills/Diffusers	Air Track Control/ Caryaire / Trox
30	Fire / Smoke Dampers	Air Track Control/ Caryaire / Trox
32	Insulation : a) Fibre Glass – Aluminum faced	UP Twiga / Owens Corning/ Styrene Packaging
	: b) Polyurethane Fome(PUF)	UP Twiga / Owens Corning/ Styrene Packaging
	: c) Nitrile Rubber	A-flex/ Armacell/ K-flex
	: d) XLPE	Supreme/ Vidoflex/ Trocellene
33	Electric Motors	Siemens / ABB / Crompton
34	RP Tissue	UP Twiga / Styrene Packing
35	Red Oxide, Zinc Chromate Primer	ICI / Berger
36	CPRX	Shalimar / Equivalent make
37	Dash Fasteners	HILTI / Fischer / Cannon / Wurth
38	Extruded Aluminium Sections	Mahavir / Jindal
39	Ball valves (with & W/o strainers)	Rapid control / castle / Advance
40	Automatic Air Vent	Anergy / Rapid Control
41	CO Sensor	Siemens / anergy

Note: 1. For any other item required for successful completion, but not included in the above list the Contractor shall take prior written approval from the Consultant/ Owner

71. TECHNICAL SPECIFICATION FOR LIFTS

1 INSTRUCTION & SPECIAL CONDITIONS FOR SUBMISSION OF TENDER

SUBJECT: Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum (Package-I)

INTRODUCTION: It is proposed to Supply, Installation, Testing and Commissioning of Lift with all accessories etc. as per Schedule of Quantities given in the tender.

1.1 GENERAL:

- A) This specification covers manufacturer, testing as may be necessary before dispatch, delivery at site, all preparatory work, assembly and installation, final testing, commissioning, putting into operation including one year guarantee period for the following Work.
- B) Name of Work: Supply & Installation of Lift.

1.2 GUARANTEE:

All equipments shall be guaranteed for a period of 24 months from the date of acceptance and taking over of the installation by the Department against unsatisfactory performance and/or breakdown due to defective design, material, manufacture, workmanship or installation. The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk & cost of the contractor. The decision of Engineer-in-charge in this regard shall be final.

1.3 PAYMENT TERMS:

1.3.1 MOBILISATION ADVANCE:

The Contract value for calculating the mobilization advance, shall be taken as Rs.Lac. The CONTRACTOR shall be paid Mobilization Advance as follow:- @ 10% (Ten Percent) of Contract Value within one week of submission of the Bank Guarantee, in approved performa, for the equivalent amount.

i) 10% of contract value shall be paid within one week of submission of the bank guarantee, in approved performa, for the equivalent amount.

The mobilization advance shall be recovered from CONTRACTOR'S Bills on pro-rata basis in such a way that the whole amount is recovered when 90% of the job gets paid i.e. 11.2% in each Bill.

1.3.2 RETENTION MONEY/SECURITY DEPOSIT:

Retention Money / Security Deposit at the rate of 5% of the value of the work done shall be deducted from RA Bills. The Earnest Money Deposit shall be accounted for in the Security Deposit. The Security Deposit amount shall be released on successful completion of one year of the Defect Liability Period.

1.3.3 EXTRA ITEM/ADDITIONAL ITEM:

The rates for any extra items/additional works under this contract agreement shall be fixed as under:

- a) In case similar item exists in the Bill of Quantities, then the same rates shall be adopted and paid.
- b) If no such similar item exists, then the rate shall be based as per the actual cost of materials (excluding cost of materials being supplied by OWNER to be incorporated into works) and reasonable labour and 15% contractors profit and overhead.

1.3.4 WATER & ELECTRICITY:

Water & Electricity shall be supplied free of cost by the owner at one point only.

Any further distribution shall be arranged by the CONTRACTOR at his own cost. The Electricity shall be used for project only and not for any other purpose i.e. fabrication of shuttering plates etc.

The supplies shall be limited to the time & quantum as supplied by State Electricity Board / Local Authority.

In the event of breakdown of Power Supply from State Electricity Board, the CONTRACTOR shall make adequate suitable alternative arrangements of dieselised equipment & diesel generating set at his own cost to keep up the Schedule of completion. Nothing extra shall be payable on this account, and such causes, shall not be accounted for delays in completion of works.

1.3.5 PAYMENTS IN R.A. BILLS:

The ENGINEER-IN-CHARGE is authorized to make part rate payments for the work executed / measured in R.A Bills related to the stages of items of work done.

The payment may be released under the following stages for items of work done (as per B.O.Q.)

a)	Advance as per clause - 1.4.1	:	10%
b)	Supply of Material	:	60%
c)	Erection / Installation	:	10%
d)	Testing & Commissioning	:	15%
e)	As Built Drawing & Handing Over	:	5%
	Total	:	100%

The charges for maintenance of Sulabh Shauchalaya (if provided by OWNER) for labours usage shall be borne by the CONTRACTOR, which shall be recovered from his Bills @ 0.20% of Contract Value.

NOTE: The Performa for Bank Guarantees shall be as approved by OWNERS.

1.4 VALIDITY:

The tender shall be valid for acceptance for a period of 90 days from the date of submission of the tender.

1.5 COMPLETION PERIOD:

The completion period shall be -----Month from the date of Letter of Intent.

1.6 SHOP DRAWING:

On the award of the work, the Contractor shall immediately proceed with the preparation of detailed working drawings showing the detail of each equipment that are to be installed and the associated

works that are to be carried out. All the works are deemed to be included in various items of bill of quantities as applicable.

Three sets of all such working drawings dully signed by the head of the planning & design department of the tenderer shall be submitted to the consultants / Engineer-in-charge for approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. All the drawings shall be received by the Consultants/ Engineer-in-charge for approval within 04 (Four) weeks from the date of award of work. The approval of the drawings by the Consultants / Engineer-in-charge shall in no way relieve the Contractor from his obligations to provide a complete and satisfactory plant installation, testing and commissioning as per intent and purpose as laid down in the specifications.

Any omissions and / or errors shall be made good or rectified whether or not the drawings are approved. Contractor shall obtain written approval for samples as cable tray, cable tag, and other materials before placing the order.

The Contractor shall also fix operation schedule chart, in the Operating / Maintenance Room, neatly typed and framed, instructions in details, for the starting and running of the electrical equipment.

1.7 AS BUILT DRAWING:

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit three (04) sets to the Engineer-in-charge, layout drawing drawn at appropriate scale indicating the complete Electrical System "as installed".

1.8 INSTRUCTION/MAINTENANCE MANUAL:

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for use, operation and the maintenance of the supplied equipment and installations, and submit to the Engineer-in-charge in three copies at the time of handing over. The manual shall generally consist of the following:

- a) Description of the Project.
- b) Operating instructions.
- c) Maintenance instructions including procedures for preventive maintenance.
- d) Manufacturers catalogues.
- e) Spare parts list.
- f) Trouble shooting charts.
- g) Drawings.
- h) Type and routine test certificates of major items.
- i) One (1) set of reproducible 'as built' drawings.

1.9 PRICES,UNIT RATES & TAXES / DUTIES ETC:

- a) The prices and unit rates quoted by the bidder in the bid shall be firm and deem to be adequate to cover the entire responsibility involved in the execution and completion of work. The rates shall be complete in all respects including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, contingencies, breakage, wastage, sundries, scaffoldings, insurance & all government levies such as excise, sales tax, WCT, VAT, SERVICE TAX etc.
- b) The contract value shall be inclusive of custom duty, CVD etc on Imported Equipments & also inclusive of excise duty & inclusive of VAT / local sales tax on indigenous Equipments / Materials and inclusive of octroi duty or any other duties or fees levied by government or any public or local bodies.
- c) The contract value shall remain firm during the currency of the contract and shall be subject to statutory variation in sales tax on works contract or on rate of custom duty / excise duty applicable on refrigeration equipments only. In case assessable values are increased by the manufacturer of refrigeration equipment during the currency of contract, the client shall not pay any increase in quantum of excise duty on account of

change in assessable value. No increase in prices due to change of rate of excise duty on bought all items shall be paid. No increase due to change in daily wages of labour be paid, due to any reasons whatsoever.

- d) The total contract price quoted by the bidders shall be inclusive of works contract / turnover tax if applicable & shall be deducted by the Client at source & certificate shall be issued for the same. The works contract price quoted shall remain firm till completion of job and handing over the same in working condition to the client.
- e) The price should not be changed subject to exchange rate variations.
- f) The rates quoted shall be deemed to allow for all minor extras and constructional details, which are not specifically shown on drawings or given in the specifications but are essential in the opinion of the Engineer-In-charge for the execution of works to con-form to good workmanship and sound engineering practice.
- g) The Engineer-In-charge decision to clarify any item under minor changes, minor extras and constructional details shall be final, conclusive and binding on the Contractor.
- h) The rates quoted by the Contractor shall be net so as to include all the requirements described in the contract agreement and no claim whatsoever due to fluctuations in the price of materials and labour will be entertained.
- i) In case the rates of identical items under different sub-heads / parts are different, the lowest of these will be taken for the purpose of making the payments.
- j) The contractor shall provide all equipments, instruments, labour and such other assistance required by the Engineer-in-charge for measurement of the works, materials etc.

1.10 VARIATION IN QUANTITIES & TENDER DRAWINGS:

The quantities for ancillary works given in the schedule and / or in drawings are for the guidance of the tenderer. The contractor shall be paid on the basis of actual quantities of works carried out. However the contractor shall check these quantities before quoting and will bring to the notice of Consultants / Engineer-In charge for any major variation. Drawing issued with the tender are diagrammatic only and indicate the general arrangement only. The data given in the drawings and specifications is as exact as could be secured, but its accuracy is not guaranteed. The contract shall be on works contract basis and the Client reserves the right to add / delete any items of work during the currency of contract.

1.11 PERFORMANCE BOUND CONTRACT:

The contract will be a performance bound contract. The drawings enclosed with the tender documents shall be only tentative layout plans and for guidance purpose only. The detailed shop drawings shall be prepared and submitted for approval to the Client / Consultant.

The contractor shall guarantee that the capacity of various components.

1.12 REPAIRS / REPLACEMENT OF PARTS DURING GAURANTEE:

Any defects or other faults which may appear within defect liability / guarantee period of twelve months from the date of handing over the system in a satisfactory working conditions to the Client (except for normal wear and tear) arising in the plant from material or workmanship not in accordance with the contract specification will be rectified by the contractors free of cost & nothing shall be paid extra on any account.

1.13 TESTING:

All testing instruments, shall be arranged by electrical contractor at his own cost.

On the completion of the installation the Contractor shall arrange to carry out various initial tests as detailed below, in the presence of and to the complete satisfaction of the Consultants or his representative / Engineer-In-charge, any defect or short-coming found during the tests

shall be speedily rectified or made good by the Contractor at his own expenses. The initial tests shall include, but, not be limited to the following:

- a. To operate and check proper functioning of all equipment.
- b. To test and check the proper functioning of all equipment, electrical switchgears, safety and other controls to ensure their proper functioning.
- c. To check & set the all relay as per design data.
- d. Contractor shall have to submit the capacity test of all equipment at site.
- e. On the satisfactory completion of all 'Initial' tests the plant shall be considered 'Virtually Complete' for the purpose of taking over by the Client & balance payment shall be released against BG.

It is clarified that guarantee period shall start after successful completion of commissioning & handing over.

1.14 TRAINING OF PERSONAL:

The contractor shall impart training to the minimum three technical staffs appointed by the Department free of cost during erection and commissioning of the plant.

1.15 INSPECTIONS & TESTING:

All the major equipments may be got inspected & tested before dispatch if desired by the client at the manufacturers work.

The Contractor shall intimate to the Department minimum 10 days in advance about the date of readiness of equipment for inspection & testing at a date to be mutually agreed upon by the client & the Contractor.

The manufacturer of these equipments must have a facility of testing the equipments at the test bed on full load at their works. All the test readings mutually taken shall be recorded & evaluated with the technical data furnished by the Contractor.

1.16 STORAGE OF MATERIAL / EQUIPMENT:

The Site office, Storage Yards etc. and the labour camps shall be established by the CONTRACTOR outside site premises.

1.17 CONTRACT AGREEMENT:

The successful bidders shall prepare agreement on stamped paper within ONE WEEK from the date of Letter of Intent. Four copies of the agreement duly bound shall be prepared at successful bidder's cost & shall be submitted to consultant / engineer in charge for approval.

The following documents shall constitute the contract agreement:

- a) Invitation to tenders.
- b) Special conditions of the contract, tender document, drawings.
- c) Complete correspondence between the successful bidder and the Client / Consultant shall be consolidated in one letter by the bidder which shall form part of the contract agreement.
- d) Any other documents necessary for completion of contract agreement.

1.18 INSURANCE:

The contractor shall be responsible for the storage and safe custody of all equipment / materials brought to site from time to time till the plant is taken over by the department. The contractor may provide adequate and comprehensive insurance coverage for storage and execution.

The contractor shall be responsible for any injury or damage to persons, buildings, structures, property etc., which may arise from any act of omission on part of the contractor or his servants or sub contractors or his employee etc. The contractor shall indemnify and keep indemnified the owner and hold him harmless in all respects of all and any expenditure liability, loss, claims or proceeding arising from any such injury or damage to persons or property as aforesaid.

The contractor may undertake all risk policy including earthquake risk with an insurance company approved by the owner in the joint names of owner and contractor at his own expense.

1.19 DESCREPANCIES AND ADJUSTMENT OF ERRORS:

The several documents forming the contract agreement are to be taken as mutually explanatory of one another. In case of non-availability/discrepancy the following order of precedence shall be observed:-

- a) Description in Bill of Quantities.
- b) Specifications.
- c) Drawing (Detailed drawings to be followed in preference to small scale drawings and figured dimensions in preference to scale drawings)
- d) CPWD specifications.
- e) I.S. Codes.
- f) Commercial Terms & Conditions.
- g) General Conditions of Contract.

1.20 FIRE OFFICER APPROVAL:

It shall be the responsibility of the contractor to remain present at the time of inspection by Delhi Fire Services and if required (or as per by fire officers) Must shows the function of fire man switch indicative marking etc. IF also asked must show the installation of Lift equipment as per fire norms.

1.21 LICENCE:

Inspection fee for the inspection of the elevator to the Lift Inspector shall be payable by the Owner. The contractor shall provide all necessary arrangements for inspection of the Lift by the Lift Inspector. All necessary assistance and follow up for obtaining licence will be responsibility of the contractor.

1.22 APPROVALS:

Statutory approvals and NOC from Delhi Fire Service shall not in scope of Contractor only, approval from Lift Inspector, Delhi Administration etc. shall be obtained by Contractor. Contractors will pay any licensing fee or submission fee payable to statutory authorities for obtaining above approvals etc.

1.23 MINOR CIVIL WORKS:

The costs for execution and completion of related Minor Civil Works such as cutting holes and making good for hall buttons, indicators including laying of sill in position and providing dash fasteners for fixing car and counter weight rail brackets shall be borne by the contractors.

All double scaffolding work required for the erection / installation of lifts in the pit and hoist way shall be arranged by the contractor at his own cost. All structural work including facia plates, bolts, rag bolts, nuts, channels, angles, beams, shall also be arranged & executed by the contractor at his own cost. (required for erection & commissioning within the lift shaft & in machine room).

After completion of patch work in shaft contractor shall do white washing with lime (three or more coats) on new work to give an even shade at his own cost.

1.24 TESTING:

Tests for the various items of equipments shall be performed at the contractor's cost and test certificate to be furnished by the contractor (for Motor, Machine Break-tests Controller & Steel wire Ropes). If required by the Engineer-in-Charge, the Contractor shall permit the Owner's authorized representative to be present during any of the tests. After notification to the Owner that the installation has been completed the contractor shall make under the direction and in the presence of the Engineer-in-Charge such test and inspections as have been specified or as the Engineer-In-Charge shall consider necessary to determine whether or not the full intent of the requirements of the plans and specifications have been fulfilled. In case the work does not meet the full intent of the specifications and further tests shall be considered necessary the contractor shall bear all the expenses thereof.

1.25 INTRODUCTION APPENDIX HEREINBEFORE REFERRED TO SPECIFICATIONS

Supply and fixing of steel work like
machine supports, bearing plates,
buffer supports and separator girders.
Facia Plates, Nuts / Bolts, Rag Bolts,
Angles, T'S & any other structural
steel.

- To be included in the offer

Minor Building work.

- To be included in the offer.

Scaffolding.

- To be included in the offer.

Over-Head Beams.

- To be excluded from the offer. (Lifting
hook shall be provided by owners)

Site Test.

- As per IS: 4666:1968 Clause 24.3

Free Maintenance.

- 2 (Two) Years.

NOTE:- CONTRACTOR MUST ENSURE FIXING OF STEEL WORK IN SUCH A MANNER SO THAT NO RCC WALL OR OTHER STRUCTURE MEMBERS ARE DAMAGED.

Guarantee.

- Two Year.

Insurance of Materials.

- Cost to be included.

Completion Time.

- ----- MONTHS from 7th day of
issue of Letter of Intent.

Validity of Tender.

- 90 Days.

Taxes (Sales Tax, Excise, Octroi)

- All inclusive F.O.R. destination.

Terms of Payment.

- As per Tender / Agreement Terms &
Conditions.

Safety.	-	As per Tender.
Type of Buffers.	-	Spring / Hydraulic Buffers.

**THE TENDERER SHOULD ALSO INDICATE ONE YEAR MAINTENANCE CHARGES
BEYOND THE INITIAL FREE MAINTENANCE OF 2 YEARS**

1.26 ARBITRATION:

Any disputes or difference arising out of, from or relating to anything contained in the resulting document, shall be referred to the sole arbitration of Client. The award made by the sole arbitrator shall be binding on the parties hereto. Such arbitration shall be governed by the provisions of the Arbitration Conciliation Act, 1996 or any statutory modification or re-enactment thereof of the being in force. The venue of the arbitration shall be at Delhi.

1.27 FORCE MAJEURE:

In the event that the Contractor / vendor or any of its subcontractors or the Purchaser is delayed in performing any of their respective obligations under the Contract, and such delay is caused by Force Majeure, including but not limited to war, civil insurrection, fires, floods, epidemics, earthquakes, quarantine restrictions and freight embargoes, such delay may be excused as provided in Article 12 and the period of such delay may be added to the time of performance of the obligation delayed.

If a Force Majeure situation arises, the Contractor / vendor shall promptly notify the Purchaser in writing of such condition and the cause thereof. Unless otherwise directed by the Purchaser in writing, the Contractor / vendor shall continue to perform its obligations under the Contract as far as is reasonably practical, and shall seek all reasonable alternative means for performance not prevented by the Force Majeure event.

1.28 LABOUR LAW AND SAFETY REGULATION:

The Contractor will be required to make good for any damage caused during the awarded work. Any injury / casualty to any skilled / unskilled worker during the work execution will be the entire responsibility of the Supplier / Vendor and your labour should be duly insured.

Contractor will be responsible for the compliance of the provisions of the various labour laws (status) applicable to workmen deployed by the contractor party in relation with the subject services. Following rules / regulations may be concerned in particular.

- Employees Provident Fund and Miscellaneous Provisions Act, 1952.
- Employees State Insurance Act, 1948.
- Payment of Wages Act, 1936.
- Minimum Wages Act, 1948.
- Equal Remuneration Act, 1965.
- Contractor Labour (Regulation and Abolition Act), 1970.
- Payment of Bonus Act, 1965.
- The Workmen's Compensation Act, 1923.

2 TECHNICAL SPECIFICATION OF EQUIPMENTS

2.1 LIFT:

General:

The lifts shall be A.C. variable voltage variable frequency micro processor controlled machine room.

Size & Speed:

Passenger Lifts	- 13 passenger – Speed 1.0M/sec
Car Size	1100mm(W) x2000mm(D) x 2300mm(H)
Lift door size	800mm(W)
Passenger Lifts	- 8 passenger – Speed 1.0M/sec
Car Size	1100mm(W) x13000mm(D) x 2300mm(H)
Lift door size	800mm(W)
Bed Lift	- 20 passenger – Speed 0.75M/sec
Car Size	1300mm(W) x2400mm(D) x 2300mm(H)
Lift door size	1200mm(W)
Goods Lifts	- 1 ton – Speed 0.50M/sec
Car Size	1400mm(W) x1800mm(D) x 2300mm(H)
Lift door size	1200mm(W)

Stops & Openings:

Lifts shall be required to serve the floors as shown in attached drawing of Lift plan and sections.

Travel:

The travel of lifts shall be as specified.

Tenderer shall note that all dimensions are as indicated in the enclosed drawings and his design shall be based on the same. These specifications have been based on Indian standard and equipments available locally as per Indian codes and rules. Equipment from other countries will be acceptable if it is of better quality and competitive in price and conforms to International Standards. The size of hoist way and car enclosure will, however be the same as specified namely.

Configuration of Lifts shall be as following

LIFT TYPE	CAPACITY	SPEED	CAR	NOS.	STOPS	TOTAL	APPROX.
			ENTRANCE		GROUND+4		TRAVEL DISTANCE
Passenger Lift	8passenger	1.0 M/sec.	1100	1	5	5	20.00 m.
Passenger Lift	13 passenger	1.0 M/sec.	1100	1	5	5	20.00 m.
Bed Lift	20 passenger	0.75 M/sec.	1300	1	5	5	20.00 m.
Goods Lifts	Weight 1 Ton	0.50 M/sec	1400	1	5	5	20.00 m.

Controls:

Doors power operated, Operation of Lifts shall be ACV VVF as specified in BOQ

Driving Mechanism:

The lift shall be provided with A.C, variable voltage, variable frequency, microprocessor controlled motion and drive control system. The tenderer shall indicate the model No. name of manufacturer and country of origin being provided, and the cable size required.

Operation:

Each car shall be arranged so that momentary pressure of one or more of its buttons shall cause that car to start.

A car cannot be started unless the car door is in the closed position and all hoist way doors for that car are locked in the closed position.

All the lifts shall be provided with fireman switch.

Operation with Attendant:

When the key switch is in position of "without Attendant" the elevator shall operate as described above.

With the key switch in the position of "with Attendant" the direction lights and buzzer shall be operative and "up" direction and the "down" direction buttons in the regular car operating panel shall be effective for the attendant operation.

When on attendant operation, the car and hoist way doors shall open automatically at each stop but the closing of the above shall be subject to the "up" or "down" direction buttons.

As a visual signal to the attendant, the "up" or "down" direction-jewel shall illuminate upon registration either car or landing calls to indicate the travel direction of the car. The attendant shall operate the lift normally in the direction indicated by the direction -jewel. Travel may be realised by the pressure of a car button for a landing in that direction from the car and the direction button in the car operating panel for that direction.

When the key-operated independent service switch is "on" the corresponding car shall operate only from its car button and shall be entirely independent of the other car. The other car shall then operate as a Simplex Collective Elevator responding to its own car calls and all landing calls.

The pressure of direction button shall cause the doors to close and start the car in the direction desired, provided a car on landing call is registered for the direction. If pressure of the direction button is released before the car starts, the doors shall reopen. After the car has started, the direction button can be released and the car shall answer car and landing button calls.

Continuous pressure of the non-stop button shall cause the car to by-pass all landing calls and respond only to registered car calls.

In order to have a car available at the main floor while both lifts are in operation "with Attendant" a "down" light signal shall be registered. Automatically in the first car which clears all its calls. This signal shall indicate to the attendant that this car should be started "down" and pressure of the "down" direction button shall move the car automatically to the main floor.

The car shall also have emergency stop and alarm push buttons. In the machine room manual Cranking device shall be provided.

MACHINE:-

The lift machine shall be placed directly above the hoistway upon machine room slab and steel beam and directly above the Car Lift Suitable material like rubber pads of required thickness shall be used below the lift machine to reduce noise and vibrations. The machine shall be of gear type. It shall include a motor, electro mechanical brake, sheave shaft and sheave all completely mounted on a common bed plate. The hard alloy cast iron or steel sheave shall have rope grooves to ensure proper traction and minimize rope wear. Suitable means of lubrication shall be provided for all the bearing. Means for manual operation of the lift car shall be made by providing wiring wheel suitably marked to indicate the direction of the movement of car to enable the

lift car to be brought to the nearest landing manually in the event of stoppage of lift due to any reason with a warning display for switching off the electrical supply before operating manually.

MOTOR:-

The motor shall be particularly designed for elevator service with high starting torque at low speed and low running current.

BRAKE:-

The drive machinery shall be provided with an electromagnetic brake. It shall be spring applied and electrically released type.

The brake shall be capable of operating automatically by the various safety devices, current failure, the failure of any of the several units of the equipment to function in a proper manner and by normal stopping of the car. It shall be so designed that it is capable of stopping and holding the car with load. The operation of brake shall be smooth, gradual and noiseless.

Details of brake installation should be given alongwith bid.

CONTROL:-

The control shall be variable voltage variable frequency.

CONTROLLER:-

Electro magnetic controller shall be provided with microprocessor with fully computerised control system in machine room to control starting, stopping and to automatically apply the brake in the event of power failure or on operation of safety device. The electrical contacts shall be suitable materials for long life and reliable operation without excessive wear.

CAR FRAME SAFETY GEAR AND GOVERNOR:-

The car frame which supports the car platform and enclosure shall be made of structural steel and equipped with suitable guides and car safety device mounted underneath the car platform. The safety gear shall be of instantaneous type. Car safety, to stop the car whenever excessive descending speed is attained, shall be operated by a centrifugal speed governor located at the top of the hoistway and connected to the governor through a continuous steel rope. Suitable means shall be provided to cut off power from the motor and apply the brake on application of safety. Indicate when the safety gear to stop the car shall become instantaneously operative.

RELAYS:-

Overload relays to protect the driving motor against overloads shall be provided.

TERMINAL AND FINAL LIMITS:-

Terminal switches shall be provided to stop the car at the terminal landings. These terminal switches shall act independently of the operating device or final limit switches. Ultimate or final limit switches shall also be provided to automatically cut off the power and apply brake in case the car travel beyond terminal landings.

TERMINAL BUFFER:-

Suitable spring buffers shall be installed to stop the car and counter weight at the extreme limits of travel. Buffer must be suitable for installation in the space available.

HOIST ROPES:-

Round stranded steel wire ropes shall be used for lift suspension. The number and sizes of the hoisting rope shall be so selected to ensure proper factor of safety and proper operation of the elevator. The suspension ropes shall correspond to relevant Indian Standard. Governor ropes shall also be of steel.

CAR PLATFORM:-

The car platform shall be framed construction and designed on the basis of rated load evenly distributed. Car platform shall be suitably designed to cater for specific designed stone floors.

CAR AND LANDING DOOR OPERATOR:-

An electric door operator for opening and closing the car door and the landing door shall be provided. It shall consist of a machine on the elevator car, operating the door when the car is stopping at a landing. The car door and the landing door shall be mechanically connected and shall move simultaneously in opening and closing. Every landing door shall be provided with a locking device which shall comply with the following requirements:-

- a) It shall not be possible to open the landing door from the landing side until the lift car is within that particular landing zone. However, provision shall be made for opening the door by means of special key for use in case of an emergency.
- b) It shall not be possible for the car to be started or kept in motion unless all the landing doors and car door are closed and locked except when the car is coming to a stop at that landing within the levelling.
- c) The electrical and mechanical parts of all locking devices shall be substantial design and construction.
- d) An electric contact for the car door shall be provided which shall prevent car movement away from the landing unless the door is in closed position.

The car door and landing door shall open automatically as the car is stopping at a landing. The closing of car door and landing door must occur before the car is set in motion. A device shall be provided to stop and reverse the doors during their closing motion.

DOOR HANGERS AND TRACKS:-

The car and the landing door shall be provided with two point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be of steel with moulded nylon cellar and shall include shielded ball bearing. Tracks shall be suitable steel section with smooth surface. The landing doors shall also consist of heaters, sills, frames, etc. as required.

CAR DOOR SAFETY:-

Infra Red Electronic Door Detectors shall be provided for all the elevators.

CAR OPERATING PANEL IN THE CAR:-

The car operating panel in each car shall be stainless steel sheet of suitable thickness flush mounted. The panel shall contain the following:-

- a) A series of push buttons numbered to correspond to the landings served.
- b) An emergency stop button.
- c) An emergency call button connected to a bell to serve as an emergency signal.
- d) A two position key operated switch marked to indicate with attendant and without attendance.
- e) A buzzer.
- f) Up and down (visual) direction light jewels.
- g) A nonstop button.
- h) A door open button.
- i) A fan switch.
- j) All fixtures to be in stainless steel.

CAR DIRECTION INDICATOR:-

Signal indication in the car shall be provided by the appropriate arrow being illuminated to indicate the direction in which the car shall next travel.

CAR POSITION INDICATOR:-

Suitable signal indication in the car shall be provided by the appropriate numeral being illuminated when the car is passing the corresponding door. This indicator shall remain illuminated when the car is stopped at a floor. The cover of the indicator unit will be stainless steel sheet of suitable thickness:-

EMERGENCY LIGHT IN CAR:-

A battery operated emergency light point with incandescent lamp shall be provided in the car which shall operate automatically in case of power failure.

ALARM BELL:-

An emergency alarm bell should be provided. The alarm bell shall be located in the ground floor landing and push for the same shall be in the car operating panel. The system shall be operated by batteries with trickle charger and the bell / siren should work the moment the alarm button in the car is pressed.

CALL BUTTON IN LANDINGS:-

An up push button and a down push button at each intermediate landing and a single push button at each terminal landing shall be provided to call the lift car in a particular landing for travelling in a direction desired. The push buttons shall have call registration lights and shall illuminate when a button is momentarily pressed to indicate that the call is registered and the direction of the call. The button shall remain illuminated until the call is answered. The top covers of landing push button boards shall be of stainless steel sheet of suitable thickness.

FLOOR POSITION INDICATOR:-

Suitable signal indication at all landing shall be provided by the appropriate numeral being illuminated when the car is pressing the corresponding floor. The indicator shall remain illuminated when the car is stopped at a floor. The top cover of the floor position indicator units shall be stainless steel sheet of suitable thickness.

DETAILED INSTRUCTIONS:-

Inside the lift car suitable instructions for passenger on metallic plate shall be displayed. Such plates in lift car shall indicate capacity, nos. of persons, No smoking and such other instructions as are suitable for proper and safe operation of the lifts.

FIREMAN SWITCH:-

Each lift will have fireman switch with glass front break for access of fireman. The operation of this switch shall cancel all calls to this lift and lift will stop at the next nearest landing if travelling upward. The doors will not open at this landing and the lift will start travelling to ground floor. In case of its travel in the downward direction when the fireman's switch is operated, it will go straight to ground floor direct without stopping enroute. The emergency stop button inside the car will become in-operative during the journey. Once the car has reached the ground floor, it shall be solely under the command of fireman by car buttons, landing calls being isolated. The lift can be put to normal use by putting the fireman switch in its original position.

EMERGENCY STOP SWITCH:-

On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel. Similar switches shall also be provided in the car operation of these switches shall render the car and landing buttons in-operative and cancel all registered calls.

MICRO SELF-LEVELING: -

The lifts shall be provided with a Micro Self-Levelling feature that shall automatically bring the car to the floor landings. This Micro Levelling shall within its zone, be entirely automatic and independent of the operating device and shall correct for over-travel or under-travel and rope stretch.

PAINTING: -

All lift metal work shall be given one shop coat of rust inhibiting paint in the factory and painted with finishing coats on site. Factory finished powder coated paint to desired shade is acceptable. Any damage caused during erection of the equipment shall be repaired to restore it to required finish.

AUTOMATIC RESCUE DEVICE (ARD): -

All the lifts shall be programmed for ARD (Automatic Rescue Device) which shall enable the lifts to stop at the nearest floor in the event of power failure/ shutdown/ breakdown and the doors to be opened, so that any passengers in the lift would not be trapped inside the lift cars in such eventuality.

WEIGHT FOR CAR INTERIOR: -

Car interior work weight should not exceed 300 kg.

ELECTRICAL EQUIPMENT AND WIRING

SCOPE:-

The scope of this section comprises supply, installation and wiring of all electrical equipment including control wiring. Power supply at 415 V, 3 phase, 50 Hz, 4 wire with double earthing will be supplied by the Owner in the machine room with a MCCB in sheet steel enclosure for each lift. All further wiring to motors and controllers, hall buttons, alarm bell, car position indicators etc. shall be provided by the lift Contractor.

A separate DB shall also be provided in the lift machine room for lighting, socket outlets, drilling machine, etc. by the Electrical Contractor.

WIRING:-

All wires and cables shall be insulated with polyvinyl chloride base insulation rendered flame retardant armoured and rated for 1100 volt service and suitable for use in dry and wet locations. Makes of wires and cables shall be subject to the approval of the Consultant before delivery.

All control wiring shall be of copper.

Wires and cables subject to movement and abrasion shall be protected by flexible galvanized steel conduit.

Traveling cables shall be of best grade for the service and shall originate at steel junction boxes in hoist way and at steel junction boxes on the car, hung so that the proper size loop may be obtained. they shall have a fire and moisture resistant outer covering and contain a steel supporting strand. Traveling cables shall be suitably suspended to relieve strains in individual conductors. Traveling cables shall be provided for telephone, signals, controls, lights, fans, alarm bell, emergency circuit, music and communication with control room etc.

Earthing of all equipment is in the scope of the lift contractor.

SCHEDULE OF REQUIREMENTS

		8PASSENGER LIFTS	13 PASSENGER LIFTS	20 PASSENGER BED LIFTS	GOODS LIFT (1 TON)	
1.0	ELEVATORS					
1.1	Designation	Passenger Elevators	Passenger Elevators	Bed Elevators	Goods Elevators	
1.2	Location					
1.3	Nos	1	1	1	1	
2.0	PERFORMANCE RATING					
2.1	No. of Passengers	1X8	1X13	1X20	One ton	
2.2	Weight @ 68 kg/ person	544	844	1360	1 ton	
2.3	Speed (mps)	1.0	0.75	0.75	0.50	
2.4	No. of Landings	5	5	5	5	
2.5	No. of openings	5	5	5	5	
2.6	Home Landing	G.F	G.F	G.F	G.F	
2.7	Travel (m) approx..	20.00	20.00	20.00	20.00	
3.0	TYPE					
3.1	With Machine Room	Yes	Yes	Yes	Yes	
5.0	CAR	To be mentioned by Lift Operator & not less than specified in IS: 14665(Part I)	To be mentioned by Lift Operator & not less than specified in IS: 14665(Part I)	To be mentioned by Lift Operator & not less than specified in IS: 14665(Part I)	To be mentioned by Lift Operator & not less than specified in IS: 14665(Part I)	
5.2	i) Door (Wx H) (mm x mm)	800x2300	800x2300	1000x2100	1200x2100	
	ii) Type	C. O	C. O	C. O		
	iii) opening side	ONE	ONE	ONE	ONE	

5.3	Car size (W x D x H)	1100x1300x2300	1100x2000x2300	1300x2400x2300	1400x1800x2300	
	i) No.	1	1	1	1	
	ii) Material					
6.0	FINISHES					
	i) Enclosure	SS Hairline Polish sides and toughened glass in rear	SS Hairline Polish sides and full ht mirror in rear	SS Hairline Polish sides and full ht mirror in rear	SS Hairline Polish sides and full ht mirror in rear	
	ii) Floor	Suitable for 20thick Granite	Suitable for 20thick Granite	Suitable for 20thick Granite	Suitable for 20thick Granite	
	iii) Ceiling	As per Architect's selection	As per Architect's selection	As per Architect's selection	As per Architect's selection	
	iv) illumination	CFL	CFL	CFL	CFL	
	v) ventilation	Sweep twin blower	Sweep twin blower	Sweep twin blower	Sweep twin blower	
6.2	Door					
	i) Car door	SS 304 Hairline Finish	SS 304 Hairline Finish	SS 304 Hairline Finish	SS 304 Hairline Finish	
	ii) Hoistway Door	SS 304 Hairline Finish	SS 304 Hairline Finish	SS 304 Hairline Finish	SS 304 Hairline Finish	
6.3	Hand rail	SS Hand rail	SS Hand rail	SS Hand rail	SS Hand rail	
6.4	Signal Fittings					
	i) Hallbuttons	Micro push – Self Illuminating with up/ down arrows / touch screen				
	ii) Car Position Indicator					
	a) Type	Digital with scrolling up/ down arrows				
	b) Arrival gong	Yes	Yes			
7.0	TRACTION & CONTROL					
7.1	Traction	Geared induction motor				
7.2	Speed Control	AC VV +VF				
7.3	Operation	Triplex				

7.4	Alarm Bell	Yes			
7.5	Buffers	Spring/ Hydraulic			
7.6	Automatic Rescue Device <input type="checkbox"/>	Yes			
7.7	Fire Man's Switch <input type="checkbox"/>	Yes			
7.8	Elevator Management System <input type="checkbox"/>	Yes			
7.9	Emergency Car Lighting <input type="checkbox"/>	Yes			
7.10	Overload Protective Device	Yes			
7.11	Pre-recorded voice	Yes			
	announcement				
	Notes				
		Battery operated automatic rescue device shall bring the elevator to the next landing and open the door			
		Fire Man's switch shall be at the home landing and shall be provided with each elevator.			
		All elevators shall be hard wired to the control room at ground floor and should be connected to the monitoring system proposed.			
		Emergency lighting shall be through a maintenance free battery complete with rectifier / charger.			

ELECTRIC POWER SUPPLY

All the equipments shall be suitable for operating within a range of $\pm 10\%$. Any equipment which cannot be operated with the above mentioned power supply shall be provided with necessary Transformer / Rectifier / Stabilizer at bidder's own cost. The power shall be provided at one point in each machine room at the location indicated by the contractor. Further power distribution shall be in the scope of the contractor.

3 RULES FOR SAFETY & LABOUR WELFARE

The CONTRACTOR shall comply with the safety and Labour Welfare Rules, as given hereunder & as per the Rules and Regulations framed by Local Authorities / Statutory Bodies / State / Central Govt. from time to time:-

FIRST AID POST:- The CONTRACTOR shall provide and maintain in a readily accessible place First Aid appliances including adequate supply of sterilised dressings, guage, cotton wool and requisite medicines, as prescribed in the Factory Rules of the place in which work is carried on. In case of a large work place the First Aid Post shall be run by a trained compounder. In case of accident, the CONTRACTOR shall provide suitable transport to facilitate removal of urgent cases to Hospitals etc **(One Omni / Van with driver shall be provided at**

site and maintained by the CONTRACTOR at his own cost for 24 Hrs. & shall work as ambulance in case of emergency).

SAFETY EQUIPMENT:- All necessary personal safety equipment such as Helmets (with approved colour scheme), Protective footwear, protective goggles / eye shields, Life Jacket, Gas masks etc. as considered adequate by the ENGINEER-IN-CHARGE shall be available for use of persons employed on the Site and maintained in a condition suitable for immediate use; and the CONTRACTOR shall take adequate steps to ensure proper use of equipment by those concerned.

- a) Workers employed on mixing asphaltic materials, cement and lime mortars / concrete shall be provided with protective footwear and protective goggles.
- b) Those engaged in handling any material which is injurious to eyes shall be provided with protective goggles.
- c) Those engaged in welding works shall be provided with welder's protective eye-shields.
- d) Stone-breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.
- e) When workers are employed in sewers and manholes, which are in use, the CONTRACTOR shall ensure that manhole covers are opened and manholes are ventilated at least for an hour before workers are allowed to get into them. Manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to public
- f) The CONTRACTOR shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting, the following precautions shall be taken:-
 - i) No paint containing lead or lead products shall be used except in the form of paste or ready made paint.
 - ii) Suitable face-masks shall be supplied for use by workers when paint is applied in the form of spray or a surface having lead paint dry rubbed and scrapped.
 - iii) Overalls shall be supplied by the CONTRACTOR to workmen and adequate facilities shall be provided to enable working painters to wash during and on cessation of work.

SAFETY PRECAUTIONS:- Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites shall be so stacked or placed as to cause danger or inconvenience to any person of the public. The CONTRACTOR shall provide all necessary fencing and lights to protect public from accidents and shall be bound to bear expenses of defence of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damage and costs which may be awarded in any such suit, action or proceedings to any such person or which may with the consent of the CONTRACTOR be paid to compromise any claim by any such person.

SCAFFOLDINGS:- Suitable scaffolds shall be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well, suitably footholds and hand-holes shall be provided on the ladder and the ladders shall be given an inclination not steeper than $\frac{1}{4}$ to 1 ($\frac{1}{4}$ horizontal and 1 vertical).

GUARD RAILS:- Scaffolding or staging more than 3.25 metres above the ground or floor, swung or suspended from an overhead support or erected with stationery support, shall have a guard rail properly attached, bolted, braced and otherwise secured at least 1 metre high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

RIGID DESIGN:- Working platform, gangways, and stairways shall be so constructed that they do not sag unduly or unequally, and if height of a platform or gangway or stairways is more than 3.25 metres above ground level or floor level, it shall be closely boarded, have adequate width and be suitably forced, as described in sub-para 4.05 above.

OPENINGS GUARDED:- Every openings in floor of a building or in a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or railing with a minimum height of 1 metre.

EXCAVATIONS SAFETY:- All excavations, 1.5 metres or more in depth, shall at all times be supplied with at least one ladder for each 30 metres in length or fraction thereof, Ladder shall be extended from bottom of trench to atleast 1 metre above surface of the ground. Sides of a trench which is 1.5 metres or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing. Excavated materials shall not be placed within 1.5 metres of edge of excavations or half of depth of excavations whichever is more. Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting be done.

DEMOLITION:- Before any demolition work is commenced and also during the process of the work.

- a) All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- b) No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by operator shall remain electrically charged.
- c) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion, or flooding. No floor, roof or other part of a building shall be so overloaded with debris or materials as to render it unsafe.

SAFETY AGAINST DROWNING:- When work is done near any place where there is risk of drowning, all necessary safety equipment shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

HOISTING MACHINES:- Use of hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following :-

- a)
 - i) These shall be of good mechanical construction, sound material and adequate, strength and free from patent defects and shall be kept in good repair and in good working order.
 - ii) Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength, and free from patent defects.
- b) Every crane driver of hoisting appliance / operator shall be properly qualified and no person under the age of 21 years shall be in-charge of any hoisting machine including any scaffold winch or to give signals to the operator.
- c) In case of every hoisting and of every chain ring hook, shackle swivel and pulley block used in hoisting or lowering or as means of suspension, safe working load shall be ascertained by adequate means. Every Hoisting machine and all gear referred to above shall be plainly marked with safe working load. In case of a hoisting machine having a variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond safe working load except for the purpose of testing.
- d) In case of usage of an OWNER supplied machine, safe working load shall be notified by the Engineer-In-Charge. As regards CONTRACTOR'S machines the CONTRACTOR shall notify safe working load of each machine to the ENGINEER-IN-CHARGE whenever he brings it to site of work and get it verified by the ENGINEER-IN-CHARGE.

SAFE-GUARDS FOR MOVING & DANGEROUS PARTS:- Motors gearing, transmission, electric wiring and other dangerous parts of hoisting appliance shall be provided with efficient safe guards; hoisting appliance shall be provided with such means as will reduce to the minimum risk of accidental descend of load. Adequate precautions shall be taken to reduce to the minimum risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energized, insulating mats, working apparel such as gloves, sleeves and boots, as may be necessary, shall be provided. Workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

NOTE:- All scaffolds, ladders, First Aid Equipments / Machines and other safety devices mentioned or described herein shall be maintained in a safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities shall be provided at or near places of work. **Necessary warning sign boards in Red / White paint, with proper lighting arrangements for nights are to be provided by CONTRACTOR at his costs, as approved by ENGINEER-IN-CHARGE at prominent locations.** The arrangements for providing and maintaining all such safety and labour welfare measures etc., shall be done at CONTRACTOR'S own cost and expenses.

4 LIST OF APPROVED MAKES FOR LIFT WORKS

Make indicated in the under mentioned list of Approved Makes is for general guidance of contractor. Final choice of make & model out of List of Approved Makes shall be of Architect/ Consultant/Owner.

- | | | |
|----|------|--|
| 1. | Lift | <ul style="list-style-type: none">- OTIS- MITSUBISHI- THOYSEN KRUP- SCHINDLER |
|----|------|--|

5 EXCLUDED ITEM FROM THE SCOPE OF LIFT CONTRACTOR

- a) Housing of equipments.
- b) Foundations of all equipments, supporting structure etc.
- c) Any kind of masonry work such as opening in wall / slab etc.
- d) Power for erection, testing and commissioning of the Lift System.

72 TECHNICAL SPECIFICATIONS FOR MODULAR O.T. WITH LED LIGHT:-

Operating Room

Walls made of 10mm High Pressure Laminate with anti bacterial cover HIPERCARE (back and front). (imported)

The complete supporting structure is made of anodized steel profiles.

Conductive floor made of antistatic resin, anti-bacterial, with self –leveling underground for smooth surface, easy cleaning (imported)

Corners made of round shaped aluminium profile, seamless integrated into the floor, inserted into the wall paneling.(imported)

False ceiling made of fiberglass enforced plaster panels, with double resin coating, dome shaped.

Door, automatic sliding door 1300x2135mm, made of High pressure Laminate with anti-bacterial HIPERCARE coating, with 2 opening controls. (imported)

Clean Air System with HEPA filters

Fabrication Supplying installing testing and commissioning of Surgeon O.T. control panel 6 tile. (a) Digital Time of Clock - 1 No. , (b) Digital Elapsed Timed of Clock - 1 No. , (c)Temperature Indicator only - 1set, (d) Humidity Indicator only -1 set, (e) Peripheral and Lighting Control with dimming arrangement with up and down touch push buttons. - 1 Set, (f) Low Gas alarm and Indication Consol - 1 Set, Remote telephone console with push buttons etc. complete - 1 Set

Twin Plate X-ray viewing Screen writing board with magnetic System, storage unit.

Ceiling Pendant for Anaesthesia with Spacer block and 6 Gas valves (imported)

Ceiling Pendant for Surgery with spacer block and 6 Gas valves (imported)

Clean Air System with HEPA filters

Surgical Scrub sink station made out of 304 stainless steel

Operating Light LED (imported)

Dirty Hatch

73 TECHNICAL SPECIFICATIONS FOR MEDICAL GAS PIPE LINE

S.No	DESCRIPTION	MAKE
	Supply Installaton Testing and Commissioning of Medical Gases Pipeline system.	
	Oxygen System.	
1	6+6 size Oxygen manifold extendable type complete with pig tail pipe, middle frame with chain and NRV's.	Indigenous
2	Fully Automatic Control Panel For Oxygen with inlet from Liquid Oxygen Tank as per HTM 02-01	Imported
3	2 Cylinders Emergency Oxygen Manifold with double stage pressure regulator and complete with pig tail pipe, middle frame with chain and NRV's	Indigenous
4	Oxygen Terminal Unit (Gas Outlets) with probes/Adaptors as per HTM 02-01	Imported
5	Oxygen Flowmeter with Humidifier Bottle	Indigenous
6	H.P Tubing Flexible having antistatic Core as per ISO with Proper colour coded	Imported
	Nitrous Oxide System	
7	1+1 size Nitrous Oxide manifold extendable type complete with pig tail pipe, middle frame with chain and NRV's.	Indigenous
8	Fully Automatic Gas Control Panel For Nitrous Oxide as per HTM 02-01	Imported
9	1 Cylinder Emergency Nitrous Oxide Manifold with double stage high pressure regulator and complete with pig tail pipe, middle frame with chain and NRV's	Indigenous

10	Nitrous Oxide Terminal Unit (Gas Outlets) with probes/Adaptors as per HTM 02-01	Imported
11	H.P Tubing Flexible having antistatic Core as per ISO with Proper colour coded as per Technical Specification enclosed.	Imported
	Vacuum System	
12	Vacuum System with Duplex V X 7 of Ingersoll-Rand Pump with 900 Ltrs capacity reservoir complete with bacteria filters	IR
		Domnic-hunter
13	Vacuum Terminal Unit (Outlets) with probes/Adaptors as per HTM 02-01	Imported
14	Ward Vacuum Unit with Regulator, Collection Jar of 600 ml with bracket.	Indigenous
15	Theater Suction Unit Trolley mounted with 2 nos. 2000ml collection jars jar selector unit and Suction Controller.	Indigenous
16	H.P Tubing Flexible having antistatic Core as per ISO with Proper colour coded as per Technical Specification enclosed.	Imported
	Compressed Air System	
17	Compressed Air System including Duplex 36.66 CFM, air cooled, oil free compressors and Air Drier, Moisture Separator and Air Receiver (900 ltrs) & Filtration system complete with 4 stage bacteria filters	Anist Iwata
		Ultra filter/Domnic hunter
18	M.Air Terminal Unit (Outlets) with probes/Adaptors as per HTM 02-01	Imported
19	H.P Tubing Flexible having antistatic Core as per ISO with Proper colour coded as per Technical Specification enclosed.	Imported
20	Electrical Control Panel for vacuum pump system and compressed air system	L&T/ Schematic
21	Medical Grade Copper pipe with fittings.	
	28mm OD X 0.9 mm thk	Mexflow
	22mm OD X 0.9 mm thk	Mexflow
	15mm OD X 0.9 mm thk	Mexflow
	12mm OD X 0.7 mm thk	Mexflow
22	Valve with Valve Box and pressure gauge	Indigenous
	4 Services	
	3 Services	
	2 Services	
23	Medical Gas Master Alarm	Indigenous
24	Medical Gas Area Alarm	Indigenous
	4 Services	
	3 Services	

**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM**

PACKAGE – 1

TENDER DOCUMENTS

(NIP NO. HRBC/PL. & DN./ 06 of 2013-2014, Dated: 31.08.2013)

BOOK – 1

VOLUME III

HOOGHLY RIVER BRIDGE COMMISSIONERS

(A Statutory Organisation under Government of West Bengal)

TRANSPORT DEPARTMENT

MUNSHI PREMCHAND SARANI

(ST. GEORGE'S GATE ROAD)

KOLKATA – 700 021

NOVEMBER 2013

**CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS
UNDER BRGF AT METIABURZ AND KAKDWIP IN SOUTH
24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM**

PACKAGE – 1

**Volume III
Contract Drawings**

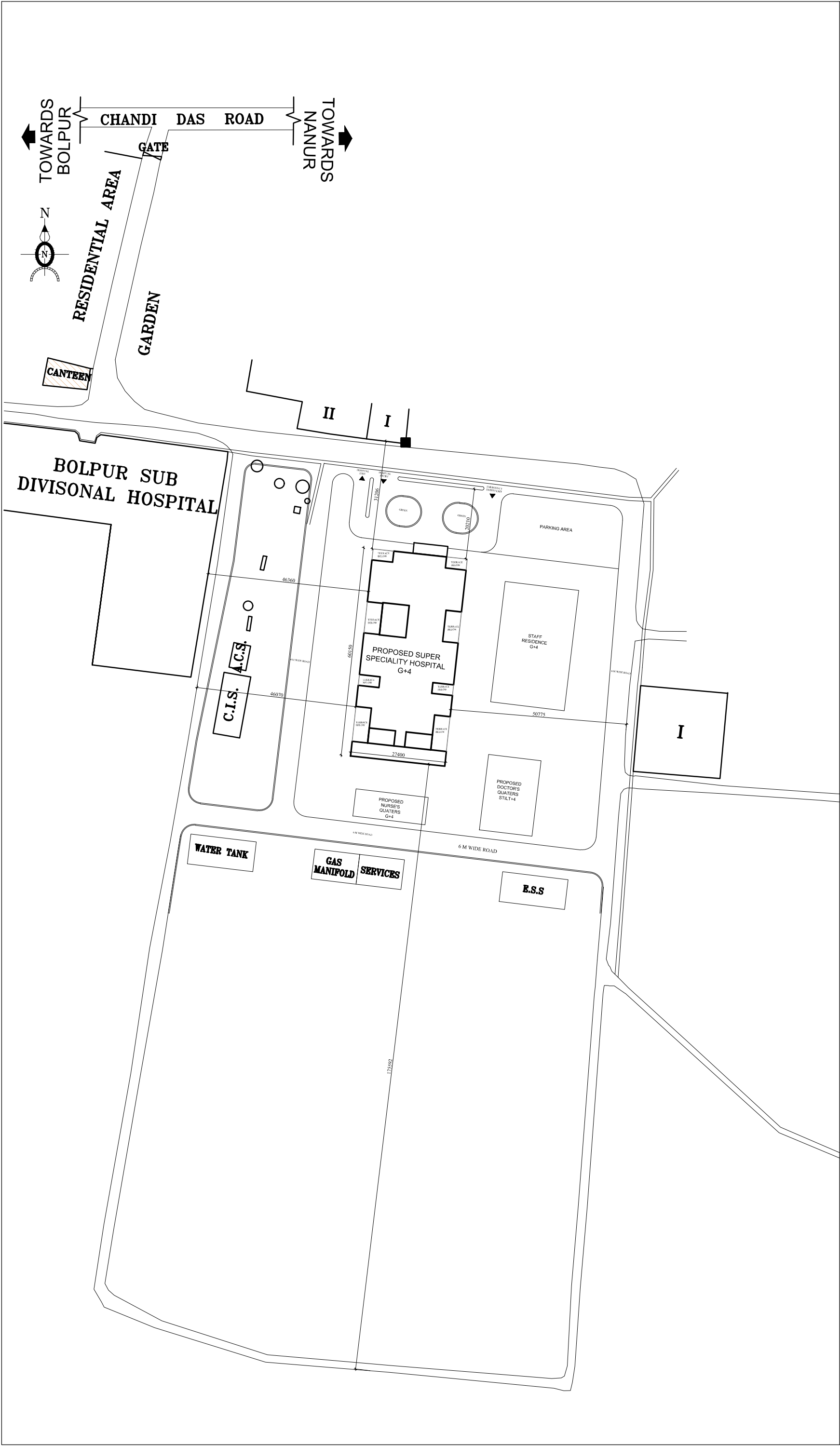
HOOGLY RIVER BRIDGE COMMISSIONERS
(A Statutory Organisation under Government of West Bengal)
TRANSPORT DEPARTMENT
MUNSHI PREMCHAND SARANI
(ST. GEORGE'S GATE ROAD)
KOLKATA – 700 021

NOVEMBER 2013

CONSTRUCTION OF 4(FOUR) SUPER SPECIALITY HOSPITALS UNDER BRGF
AT METIABURZ AND KAKDWIP IN SOUTH 24 PARGANAS, AT SAGARDIGHI IN MURSHIDABAD
AND AT BOLPUR IN BIRBHUM – (PACKAGE-1)

LIST OF TENDER DRAWINGS

Sl. No.	Drawing Title
	HOSPITAL
1	SITE PLAN- Bolpur
2	SITE PLAN- Sagardighi
3	SITE PLAN- Metiabruz
4	SITE PLAN- Kakdwip
5	GROUND FLOOR PLANS
6	TYPICAL FLOOR PLAN
7	TERRACE FLOOR PLAN
8	ELEVATIONS
9	SECTIONS
10	TYPICAL FRAMING PLAN
11	FOUNDATION PLAN
12	FOUNDATION RC DETAILS
13	DRAINAGE SYSTEM LAYOUT
14	ELECTRICAL LAYOUT
	DOCTOR'S RESIDENCE
15	TYPICAL FLOOR PLAN
16	ELEVATION
17	RESIDENTIAL FOUNDATION PLAN
18	RESIDENTIAL FOUNDATION PLAN & RC
	NURSE & STAFF RESIDENCE
19	TYPICAL FLOOR PLAN - STAFF & NURSE RESIDENCE
20	ELEVATION
21	RESIDENTIAL FOUNDATION PLAN
22	FOUNDATION PLAN & RC



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R1		
GFC		
AC		ADVANCE COPY
MARK	DATE	DESCRIPTION

CLIENT:
HOOGLY RIVER BRIDGE COMMISSIONERS

ELECTRICAL CONSULTANT:-

PLUMBING CONSULTANT:-

STRUCTURE CONSULTANT:-

ARCHITECTS:-
DESIGN ASSOCIATES INC.
ARCHITECTURE
2nd Floor, Star City Mall,
Mayur Vihar Phase-1, Extn.
New Delhi-110091.
PHONE NO.- 011-43077600-699
FAX NO.- 011-43077666

PROJECT:-
Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.

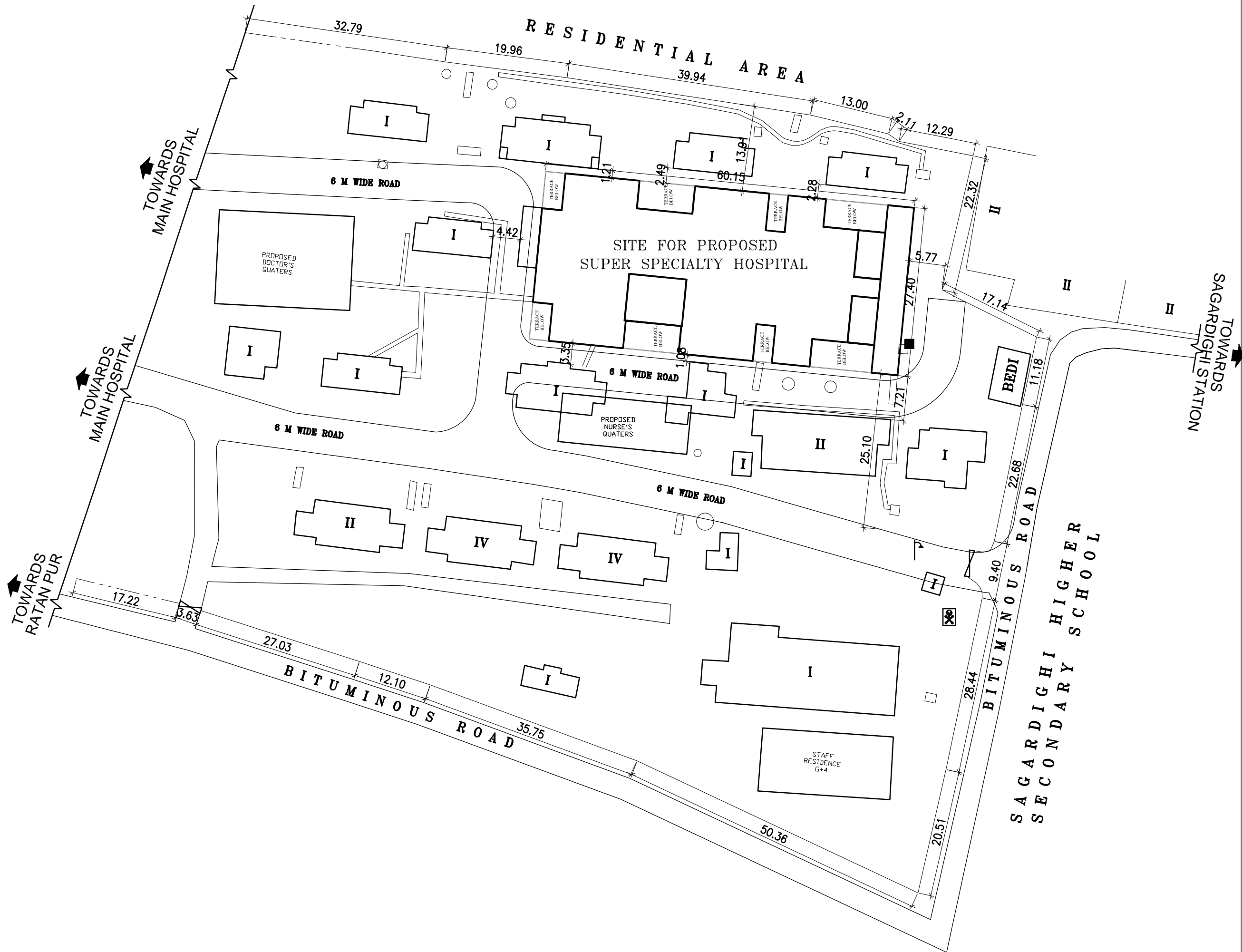
DRAWING TITLE-
SITE PLAN BOLPUR

DRAWING PURPOSE-
FOR TENDER ONLY

JOB NO. -	DWG. REF.NO.-	DATE- 23/09/2013
SCALE-	REVISION-	DATE OF ISSUE-

DWG. NO.-
555/SSH/BOL/AR/SITE/100

	SHEET SIZE-	SHEET NO-
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PROJECT:-

Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.

DRAWING TITLE:-

SITE PLAN SAGARDIGHI

DRAWING PURPOSE:-

FOR TENDER ONLY

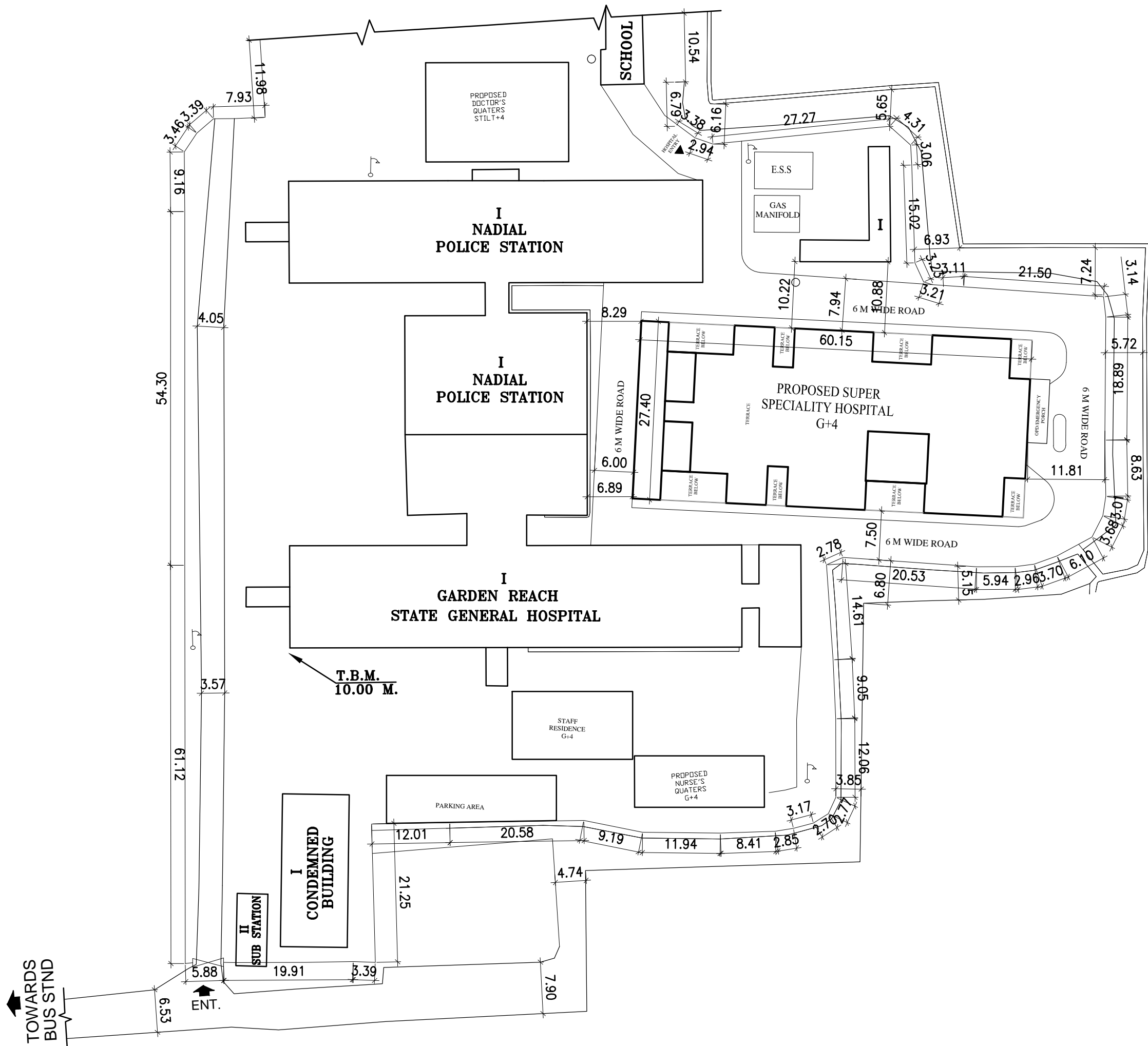
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		23/09/2013
SCALE-	REVISION-	DATE OF ISSUE-

DWG. NO.-

555/SSH/SAG/AR/SITE/100

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Page 600



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PROJECT:-
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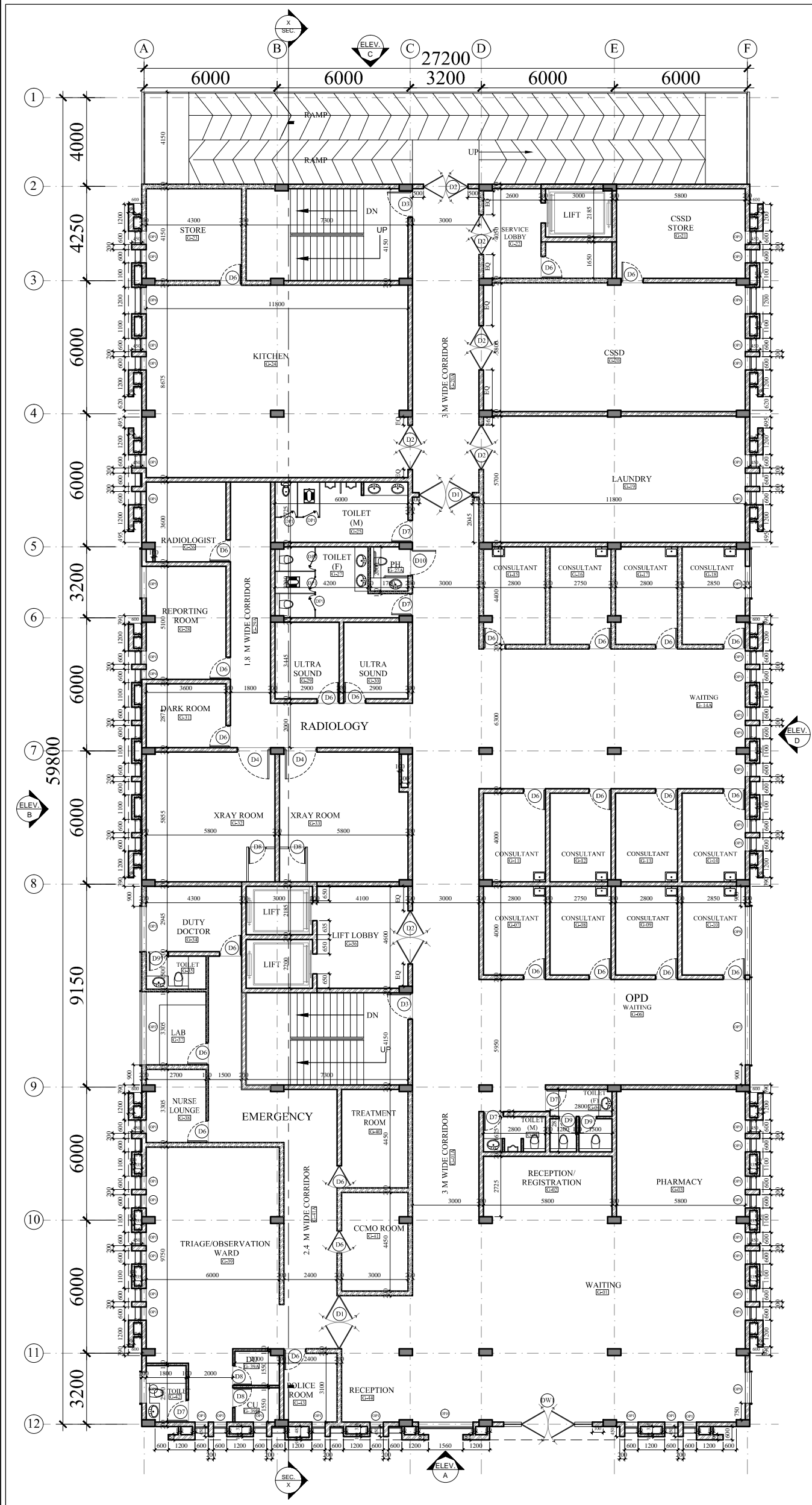
DRAWING TITLE:-
SITE PLAN METIABRUZ,

DRAWING PURPOSE:-
FOR TENDER ONLY

JOB NO. -	DWG. REF.NO.-	DATE-
		23/09/2013
SCALE-	REVISION-	DATE OF ISSUE-

DWG. NO.- 555/SSH/MET/AR/SITE/100

	SHEET SIZE-	SHEET NO-
	DRAWN BY-	CHECKED BY-
Page 601		



OPENING-SCHEDULE:-

S.NO.	TYPE	WIDTH	SILL	LINTEL
1.	OP1	600	1200	BOB
2.	OP2	3200	1200	BOB
3.	OP2'	3300	1200	BOB
4.	OP3	2050	1200	BOB
5.	OP3'	2500	1200	BOB
6.	OP4	455	1200	BOB
7.	OP5	1425	1200	BOB
8.	OP6	1200	1200	BOB
9.	OP7	3850	1200	BOB
10.	OP8	3100	1200	BOB
11.	OP9	1400	1200	BOB
12.	OP10	2460	1200	BOB
13.	OP11	4800	1200	BOB

DOOR-SCHEDULE:-

S.NO.	TYPE	WIDTH	SILL	LINTEL	DISCRPTION
1.	D1	2400	00	2100	DOUBLE PANEL DOUBLE SWING.
2.	D2	2000	00	2100	DOUBLE PANEL DOUBLE SWING.
3.	D2A	2000	00	2100	DOUBLE PANEL DOUBLE SWING.
4.	D3	1200	00	2100	FIRE DOOR / STAIRCASE DOOR
5.	D4	1500	00	2100	SINGLE PANEL SINGLE SWING XRAY ROOM
6.	D5	1000	00	2100	SINGLE LEAF (HINGED) TOILET DOOR WITH LOUVERS
7.	D6	1000	00	2100	SINGLE PANEL DOUBLE SWING
8.	D7	1000	00	2100	TOILET MAIN DOOR
9.	D8	900	00	2100	UTILITY ROOM FLUSH DOOR
10.	D9	800	00	2100	TOILET FLUSH DOOR
11.	D10	1200	00	2100	PH TOILET DOOR
12.	SD1	1500	00	2100	SLIDING DOOR
13.	SD2	1000	00	2100	SLIDING DOOR
14.	DP1	750	00	2100	INTERNAL PARTITION DOOR IN TOILETS
15.	DW1	4000	00	2100	DOUBLE PANEL DOUBLE SWING WITH WINDOW

PROJECT:-
Construction of 4(four) Super Speciality Hospital under BRGF at Metiabur and Kaddwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.

DRAWING TITLE:-
GROUND FLOOR PLAN

ARCHITECTS:-
DESIGN ASSOCIATES INC.
2nd Floor, Star City Mall,
Mayur Vihar Phase-1, Extn.
New Delhi-110091.
PHONE NO.- 011-43077600-699
FAX NO.- 011-43077666

STRUCTURE CONSULTANT:-
CECON ENGINEERS
NEW DELHI

DRAWING PURPOSE:-
FOR TENDER ONLY

DWG. NO.-
555/SSH/BOL/AR/BRK/101

JOB NO. -	DWG. REF. NO.-	DATE- 23/09/2013	SHEET SIZE-	SHEET NO.-
SCALE- 1:125	REVISION-	DATE OF ISSUE-	DRAWN BY-	CHECKED BY-

CLIENT:-
HOOGLY RIVER BRIDGE
COMMISSIONERS

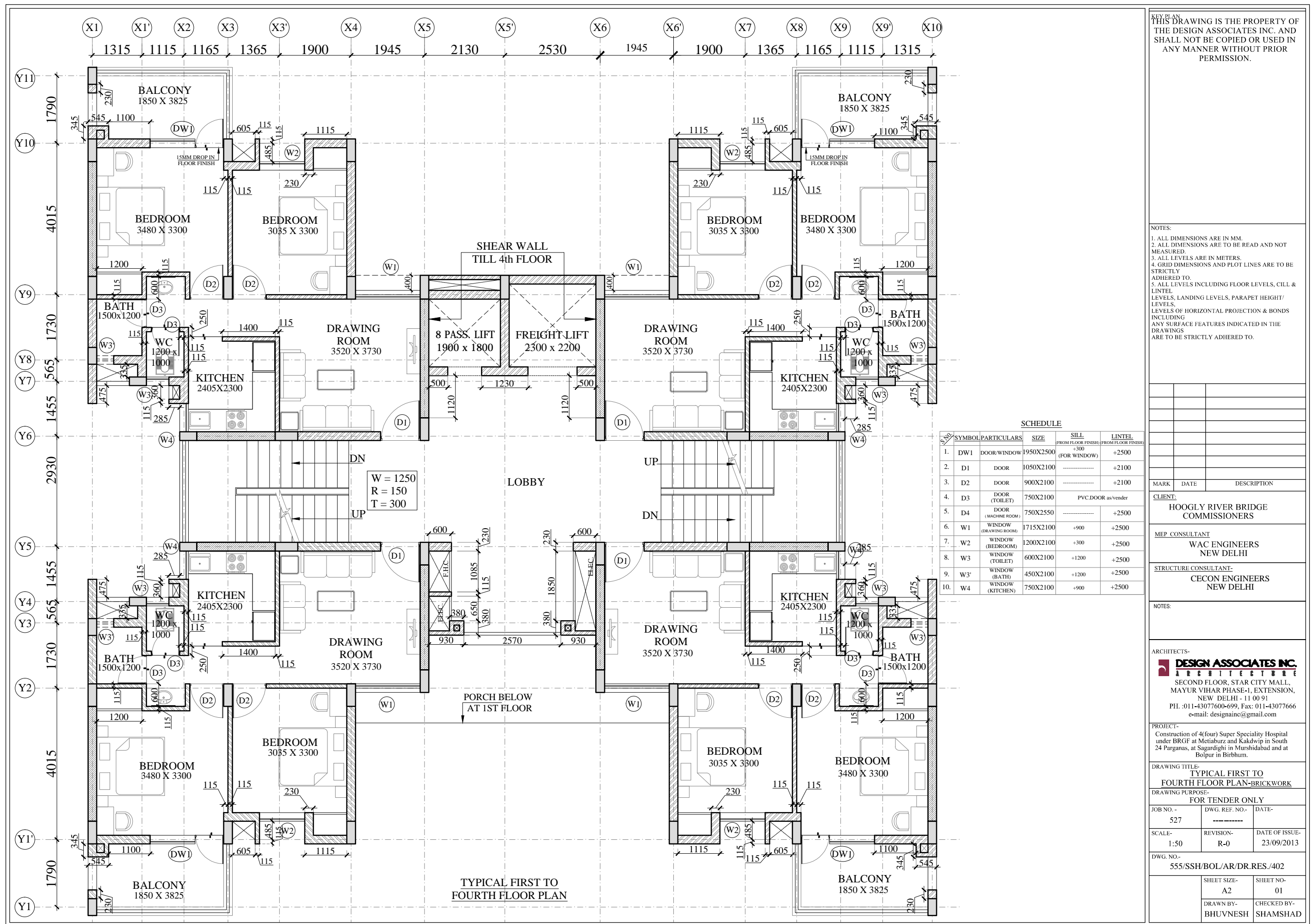
MEP CONSULTANT
WAC ENGINEERS
NEW DELHI

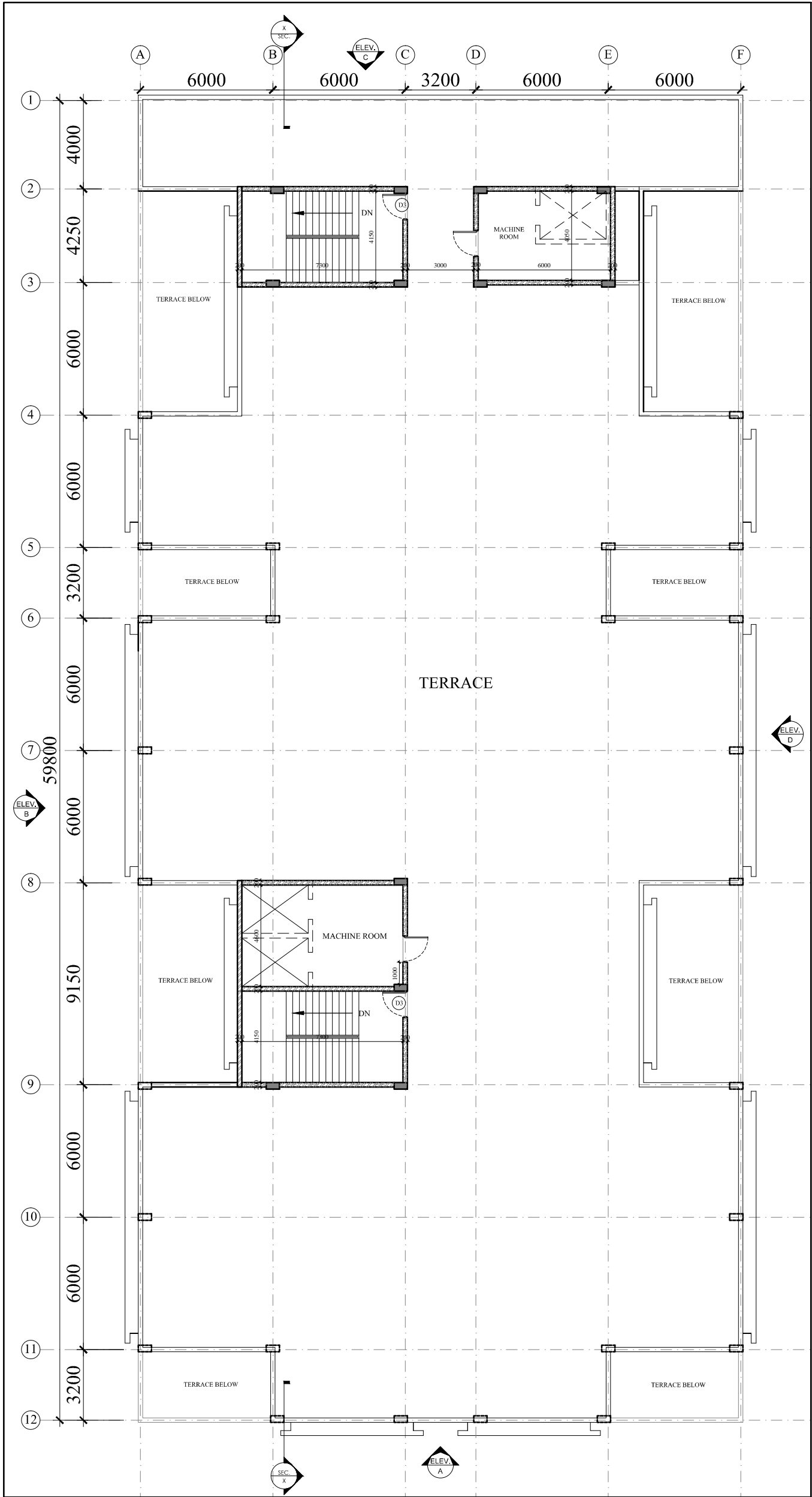
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KEY PLAN

R2		
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AC		ADVANCE COPY
MARK	DATE	DESCRIPTION





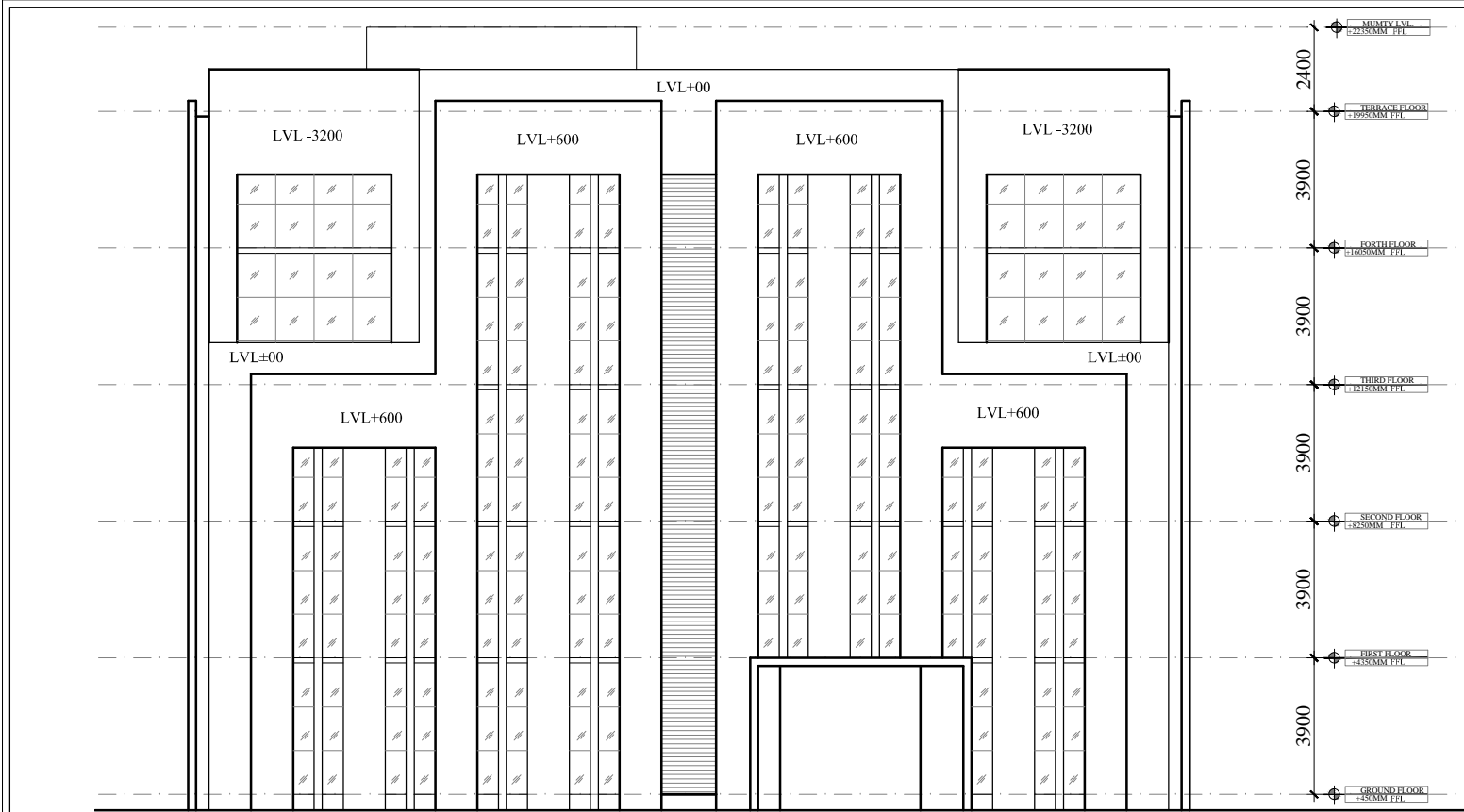
OPENING-SCHEDULE:-

S.NO.	TYPE	WIDTH	SILL	LINTEL
1.	OP1	600	1200	BOB
2.	OP2	3200	1200	BOB
3.	OP2'	3300	1200	BOB
4.	OP3	2050	1200	BOB
5.	OP3'	2500	1200	BOB
6.	OP4	455	1200	BOB
7.	OP5	1425	1200	BOB
8.	OP6	1200	1200	BOB
9.	OP7	3850	1200	BOB
10.	OP8	3100	1200	BOB
11.	OP9	1400	1200	BOB
12.	OP10	2460	1200	BOB
13.	OP11	4800	1200	BOB

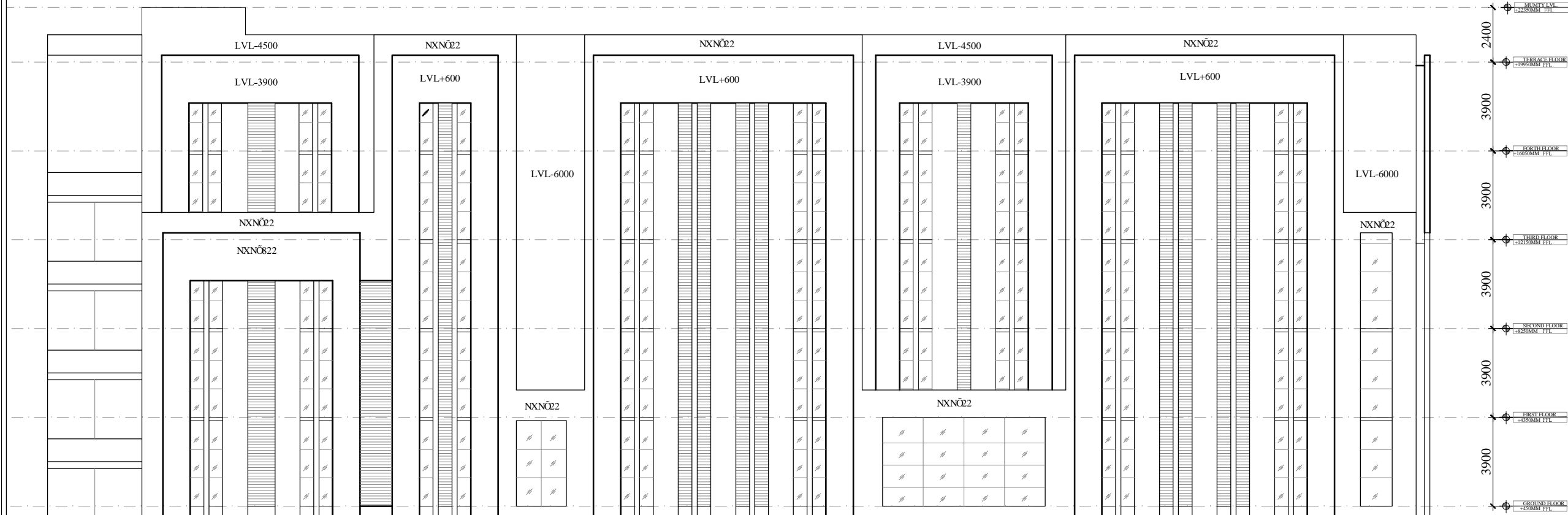
DOOR-SCHEDULE:-

S.NO.	TYPE	WIDTH	SILL	LINTEL	DISRIPTION
1.	D1	2400	00	2100	DOUBLE PANEL DOUBLE SWING
2.	D2	2000	00	2100	DOUBLE PANEL DOUBLE SWING
3.	D2A	2000	00	2100	DOUBLE PANEL DOUBLE SWING
4.	D3	1200	00	2100	FIRE DOOR / STAIRCASE DOOR
5.	D4	1500	00	2100	SINGLE PANEL SINGLE SWING XRAY ROOM
6.	D5	1000	00	2100	SINGLE LEAF (HINGED) TOILET DOOR WITH LOUVERS
7.	D6	1000	00	2100	SINGLE PANEL DOUBLE SWING
8.	D7	1000	00	2100	TOILET MAIN DOOR
9.	D8	900	00	2100	UTILITY ROOM FLUSH DOOR
10.	D9	800	00	2100	TOILET FLUSH DOOR
11.	D10	1200	00	2100	PH TOILET DOOR
12.	SD1	1500	00	2100	SLIDING DOOR
13.	SD2	1000	00	2100	SLIDING DOOR
14.	DP1	750	00	2100	INTERNAL PARTITION DOOR IN TOILETS
15.	DW1	4000	00	2100	DOUBLE PANEL DOUBLE SWING WITH WINDOW

PROJECT- Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kaddwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.		DRAWING TITLE- TERRACE FLOOR PLAN		ARCHITECTS- DESIGN ASSOCIATES INC. 2nd Floor, Star City Mall, Mayur Vihar Phase-1, Extn. New Delhi-110091 PHONE NO.- 011-43077600-699 FAX NO.- 011-43077666		STRUCTURE CONSULTANT- CECON ENGINEERS NEW DELHI		THIS DRAWING IS THE PROPERTY OF THE DESIGN ASSOCIATES INC. AND SHALL NOT BE COPIED OR USED IN ANY MANNER WITHOUT PRIOR PERMISSION.	
DRAWING PURPOSE- FOR TENDER ONLY		<div>N</div>		CLIENT- HOOGLY RIVER BRIDGE COMMISSIONERS		NOTES:			
DWG. NO.- 555/SSH/BOL/AR/BRK/105				MEP CONSULTANT WAC ENGINEERS NEW DELHI					
JOB NO. -	DWG. REF. NO.-			DATE- 23/09/2013	SHEET SIZE-	SHEET NO.-	MARK		
SCALE- 1:125	REVISION-	DATE OF ISSUE-	DRAWN BY-	CHECKED BY-					



ELEVATION-A



ELEVATION-B

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MARK	DATE	DESCRIPTION
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CLIENT:
HOOGLY RIVER BRIDGE
COMMISSIONERS

MEP CONSULTANT:
WAC ENGINEERS
NEW DELHI

STRUCTURE CONSULTANT:
CECON ENGINEERS
NEW DELHI

NOTES:

ARCHITECTS:
DESIGN ASSOCIATES INC.
SECOND FLOOR, STAR CITY MALL,
MAYUR VIHAR PHASE-1, EXTENSION,
NEW DELHI - 11 00 91
PH. :011-43077600-699, Fax: 011-43077666
e-mail: designainc@gmail.com

PROJECT:-
Construction of 4(four) Super Speciality Hospital
under BRGF at Metiaburz and Kakdwip in South
24 Parganas, at Sagardighi in Murshidabad and at
Bolpur in Birbhum.

DRAWING TITLE:-
ELEVATION A & B

DRAWING PURPOSE:-
FOR TENDER ONLY

JOB NO. -	DWG. REF. NO. -	DATE-
527	-----	

SCALE-	REVISION-	DATE OF ISSUE-
1:125	R-0	23/09/2013

DWG. NO.-
555/SSH/BOL/AR/ELE/201

SHEET SIZE- A2	SHEET NO- 01
DRAWN BY- SIMRAN	CHECKED BY- SHAMSHAD

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MARK	DATE	DESCRIPTION
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CLIENT:

HOOGLY RIVER BRIDGE
COMMISSIONERS

MEP CONSULTANT

WAC ENGINEERS
NEW DELHI

STRUCTURE CONSULTANT
CECON ENGINEERING
NEW DELHI

NOTES:

ARCHITECTS-



PROJECT-	Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.
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DRAWING TITLE-

SECTION X-X

DRAWING PURPOSE-
FOR TENDER ONLY

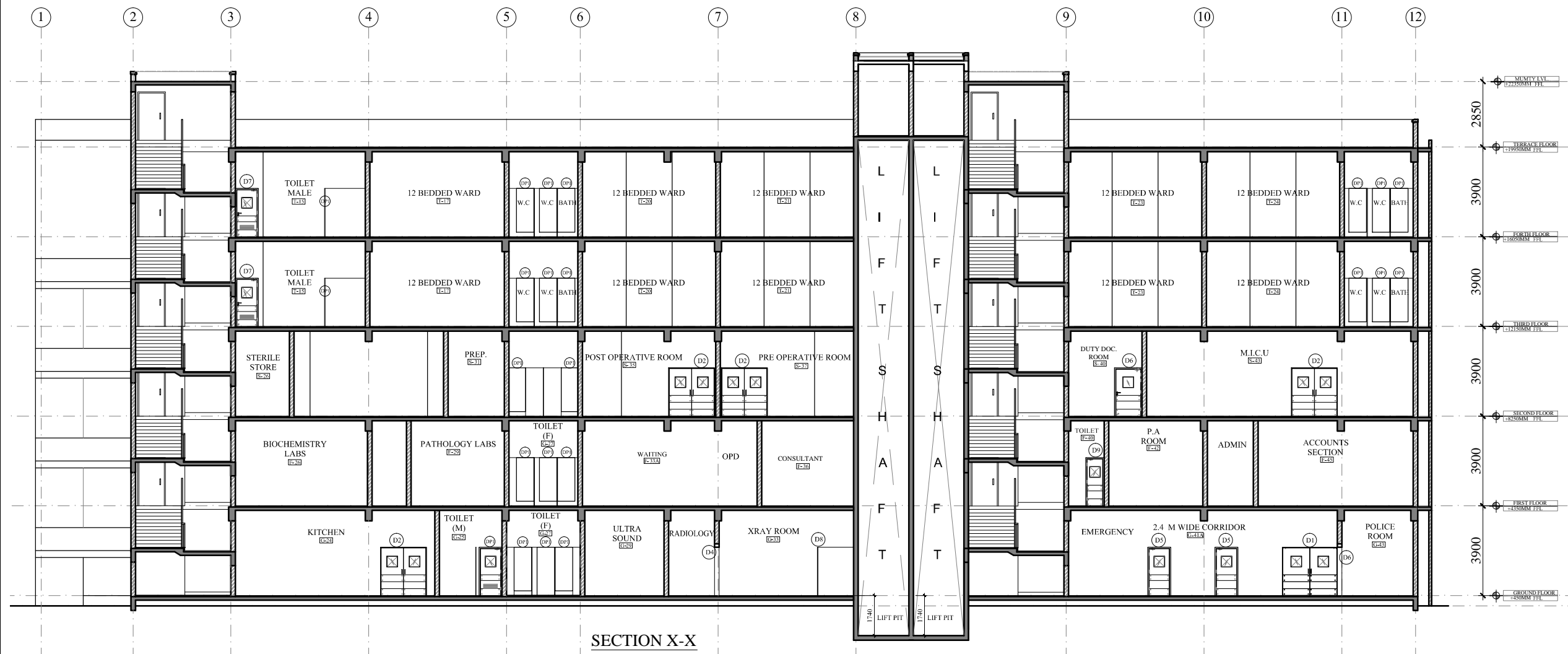
JOB NO. -	DWG. REF. NO.-	DATE-
527	-----	

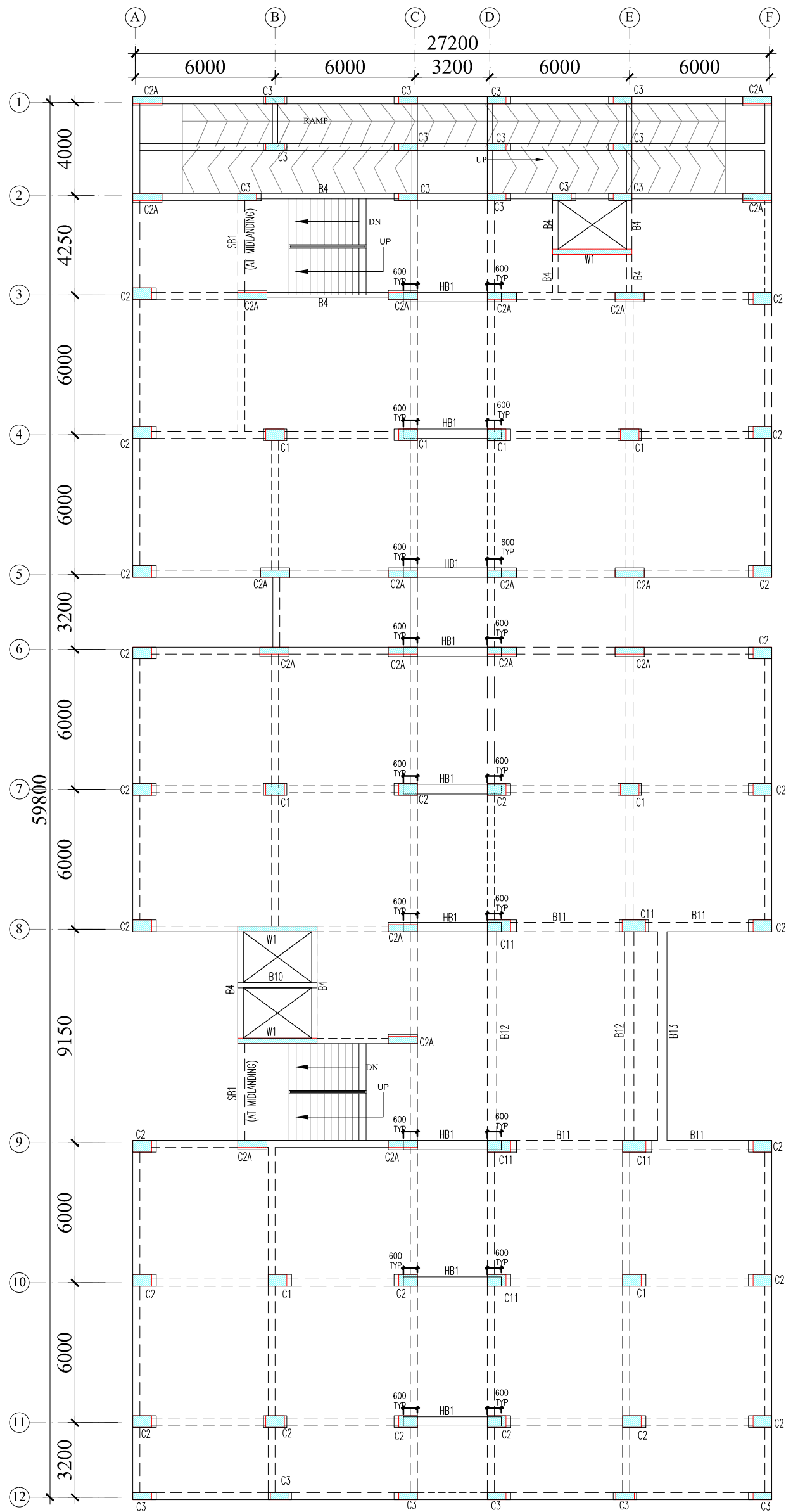
SCALE- 1:125	REVISION- R-0	DATE OF ISSUE- 23/09/2013
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DWG. NO.-

555/SSH/BOL/AR/SEC/203



	SHEET SIZE- A2	SHEET NO- 01
	DRAWN BY- SIMRAN	CHECKED BY- SHAMSHAD





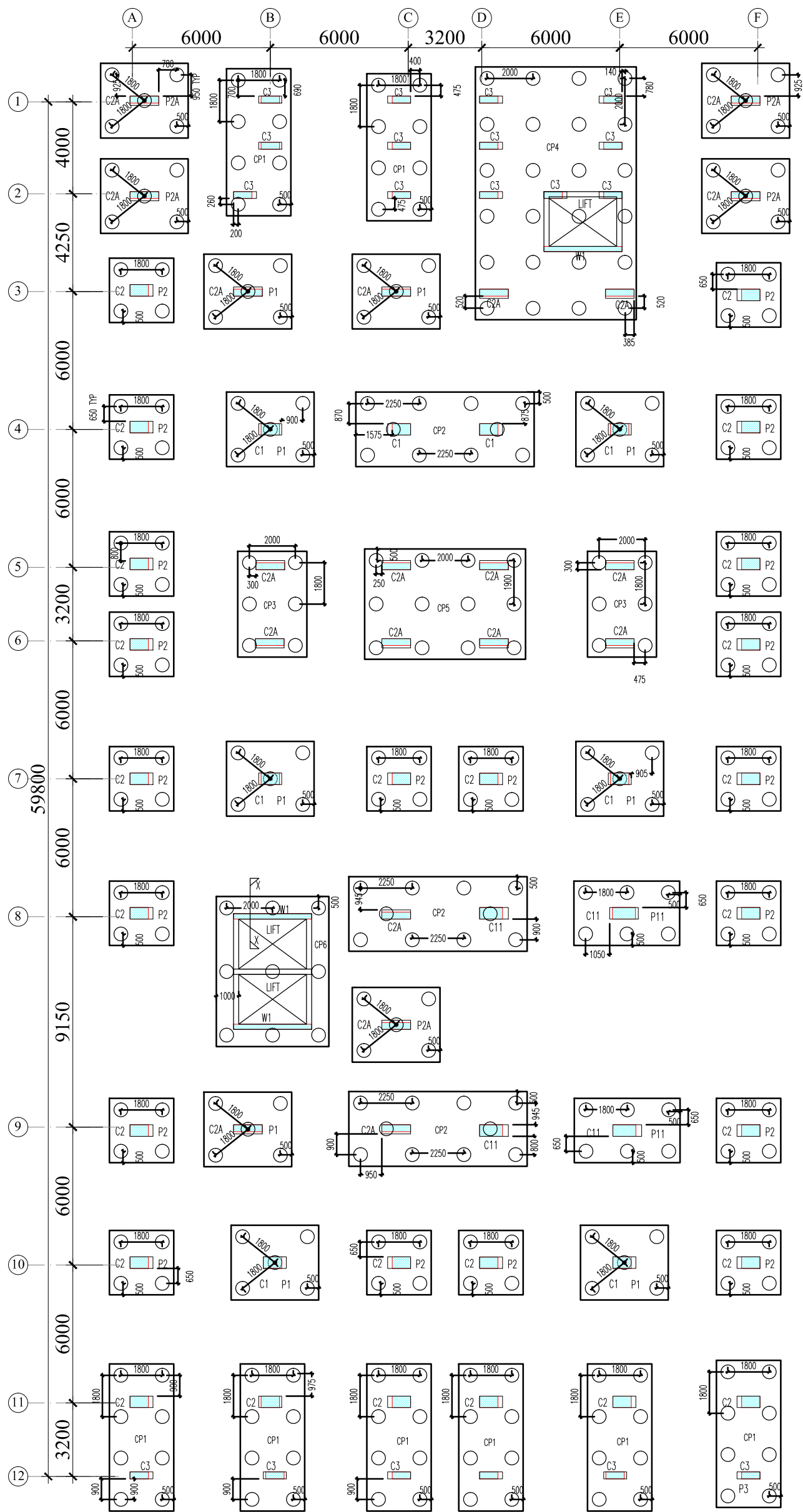
FIRST & SECOND FLOOR ROOF FRAMING PLAN



SLAB 175 THK (TYPICAL UNLESS NOTED OTHERWISE)
BEAMS 300X550 (TYPICAL UNLESS NOTED OTHERWISE)
B4/B10-230X550
B11/B12 & B13-400X650
HB1-400 WIDE (HIDDEN BEAM)

PROJECT- Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburuz and Kakkdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.				DRAWING TITLE- TYPICAL FLOOR ROOF ROOF FRAMING PLAN				ARCHITECTS-  DESIGN ASSOCIATES INC. 2nd Floor, Star City Mall, Mayur Vihar Phase-1, Extn. New Delhi-110091. PHONE NO.- 011-43077600-699 FAX NO.- 011-43077666				STRUCTURE CONSULTANT- CECON ENGINEERS NEW DELHI				NOTES: <table><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td>R2</td><td></td><td></td></tr><tr><td>R1</td><td></td><td></td></tr><tr><td>GFC</td><td></td><td></td></tr><tr><td>AC</td><td></td><td>ADVANCE COPY</td></tr><tr><td>MARK</td><td>DATE</td><td>DESCRIPTION</td></tr></table>										R2			R1			GFC			AC		ADVANCE COPY	MARK	DATE	DESCRIPTION
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DWG. NO.- 555/SSH/BOL/STR-05																																								
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KEY PLAN



PROJECT- Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakkdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.			DRAWING TITLE- FOUNDATION PLAN			ARCHITECTS- <div> DESIGN ASSOCIATES INC. 2nd Floor, Star City Mall, Mayur Vihar Phase-I, Extn. New Delhi-110091, PHONE NO.- 011-43077600-699 FAX NO.- 011-43077666</div>			STRUCTURE CONSULTANT- CECON ENGINEERS NEW DELHI			THIS DRAWING IS THE PROPERTY OF THE DESIGN ASSOCIATES INC. AND SHALL NOT BE COPIED OR USED IN ANY MANNER WITHOUT PRIOR PERMISSION.											
DRAWING PURPOSE- FOR TENDER ONLY					<div></div>			NOTES:															
DWG. NO.- 555/SSH/BOL/STR-03								CLIENT: HOOGLY RIVER BRIDGE COMMISSIONERS															
JOB NO. -					DWG. REF. NO.-			DATE- 23/09/2013			SHEET SIZE-				SHEET NO-			MEP CONSULTANT					
SCALE- 1:125					REVISION-			DATE OF ISSUE-			DRAWN BY-			CHECKED BY-			WAC ENGINEERS NEW DELHI						
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MARK	DATE	DESCRIPTION

CLIENT:

HOOGLY RIVER BRIDGE COMMISSIONERS

MEP CONSULTANT

WAC ENGINEERS
NEW DELHI

STRUCTURE CONSULTANT-

CECON ENGINEERS
NEW DELHI

NOTES:

ARCHITECTS-

DESIGN ASSOCIATES INC.
ARCHITECTS

2nd Floor, Star City Mall,
Mayur Vihar Phase-1, Extn.
New Delhi-110091.
PHONE NO.- 011-43077600-699
: 5L'BC'1A5%('S++***

PROJECT-

Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.

DRAWING TITLE-

FOUNDATION RC DETAILS

DRAWING PURPOSE-

FOR TENDER ONLY

JOB NO. -	DWG. REF. NO.-	DATE-
SCALE-	REVISION-	DATE OF ISSUE-
1:200	R0	23.09.2013

DWG. NO.-

555/SSH/BOL/STR-01

SHEET SIZE-	SHEET NO.-
A2	01
DRAWN BY-	CHECKED BY-

PILE CAP SCHEDULE

MARK	SIZE	D	BOTTOM RENF BOTH EXTRA	TOP RENF BOTH WAYS	REMARK
P1	AS/PLAN	1500	Y20-150	Y16-200	
P2	AS/PLAN	1250	Y20-150	Y16-200	
P11	AS/PLAN	1500	Y20-150	Y16-200	
CP1	AS/PLAN	1750	Y25-125	Y20-200	
CP2	AS/PLAN	1500	Y25-125	Y20-200	
CP3	AS/PLAN	1750	Y25-125	Y20-200	
CP4	AS/PLAN	1750	Y25-125	Y20-200	
CP5	AS/PLAN	1750	Y25-125	Y20-200	
CP6	AS/PLAN	1750	Y25-125	Y25-200	

COLUMN SECTION

CONC. GRADE-M30
RINGS AT CLOSER SPACING AS/SEISMIC DETAILING FOR LO : LO IS LONGER COLUMN DIMENSION

TILL THIRD ROOF

ABOVE

1xY10(OUTER)+6xY8-100C/C(FOR LO)
7xY8-200C/C(FOR MID SPAN)

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5xY8-200C/C(FOR MID SPAN)

1xY10(OUTER)+4xY8-100C/C(FOR LO)
5xY8-200C/C(FOR MID SPAN)

1xY10(OUTER)+4xY8-100C/C(FOR LO)
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1xY10(OUTER)+4xY8-100C/C(FOR LO)
5xY8-200C/C(FOR MID SPAN)

1xY10(OUTER)+4xY8-100C/C(FOR LO)
5xY8-200C/C(FOR MID SPAN)

10 d (> 75mm)

3-bar dia

RING DETAIL

SHOWING TYPICAL HOOK DETAIL FOR COLUMNS

COL RING CONTD WHERE BEAMS NOT FRAMING ON ALL FOUR SIDE

CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)

CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)

CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)

CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)

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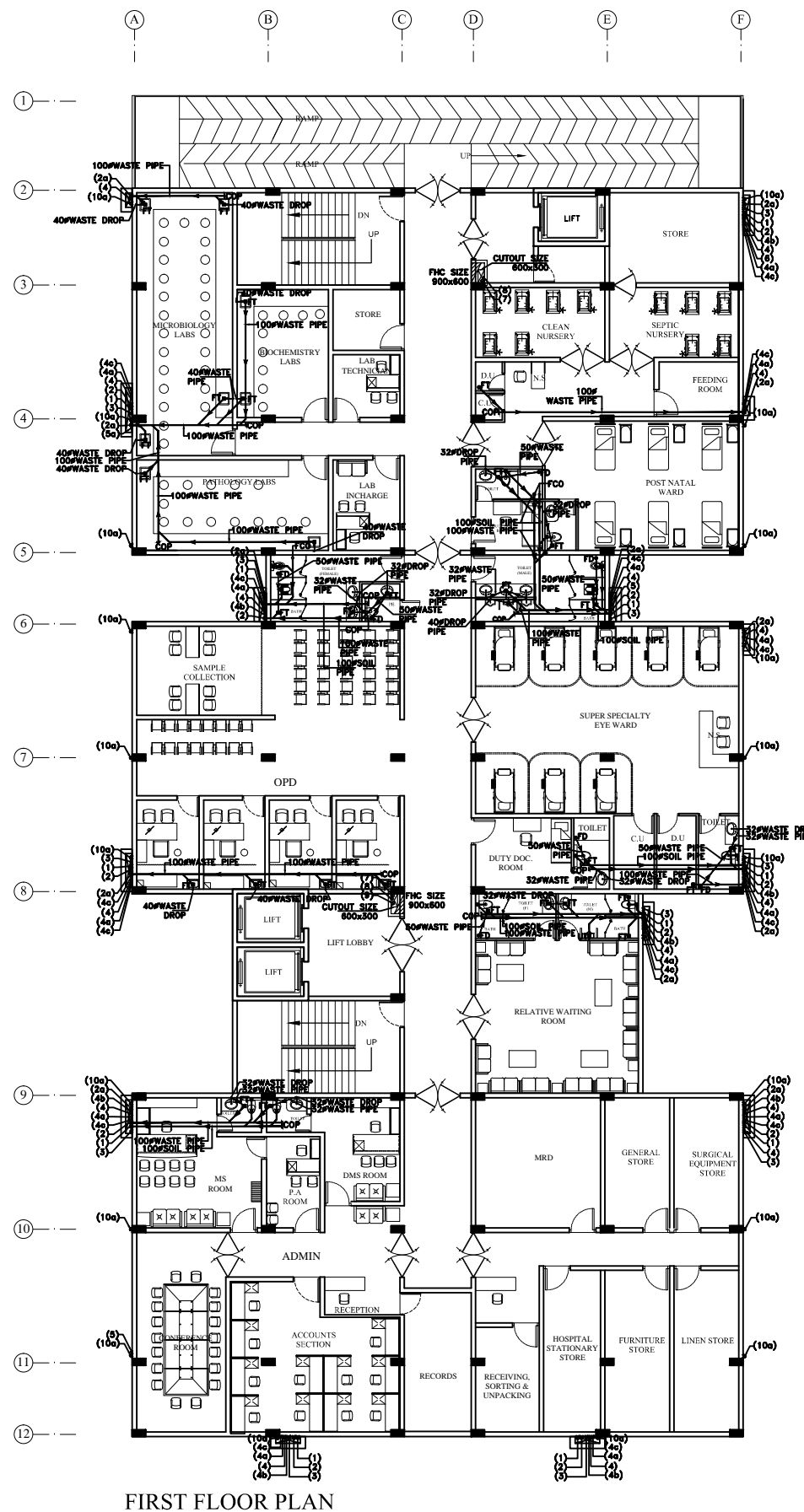
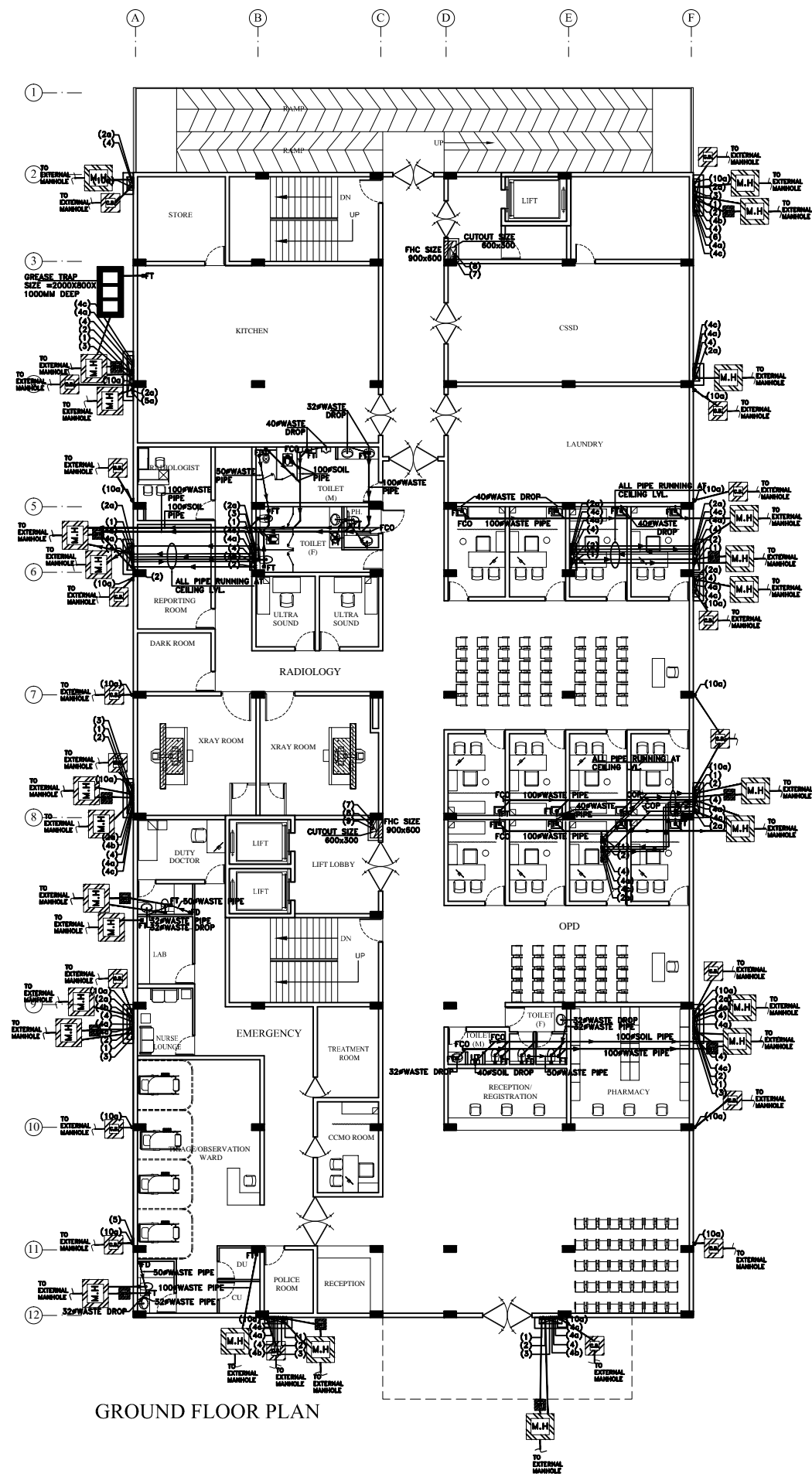
CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)

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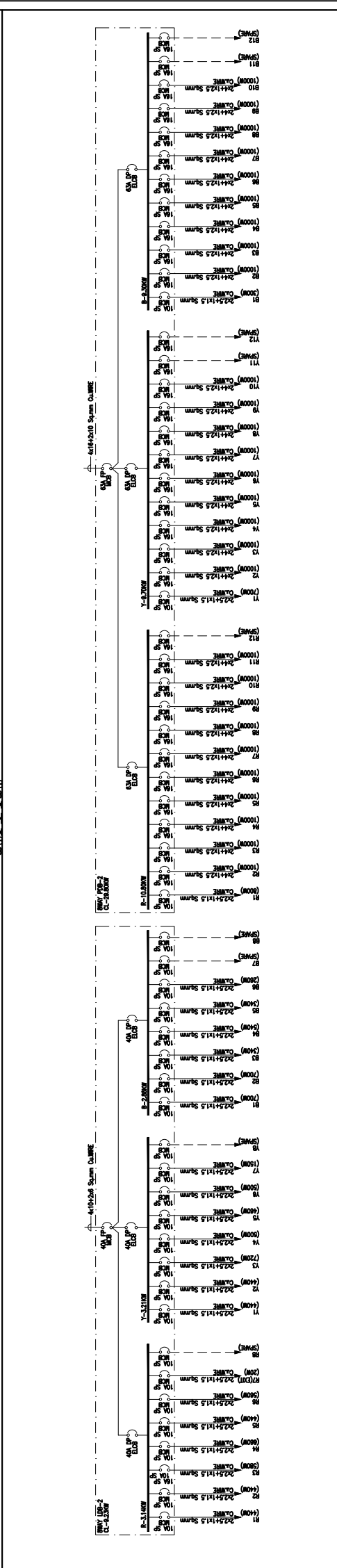
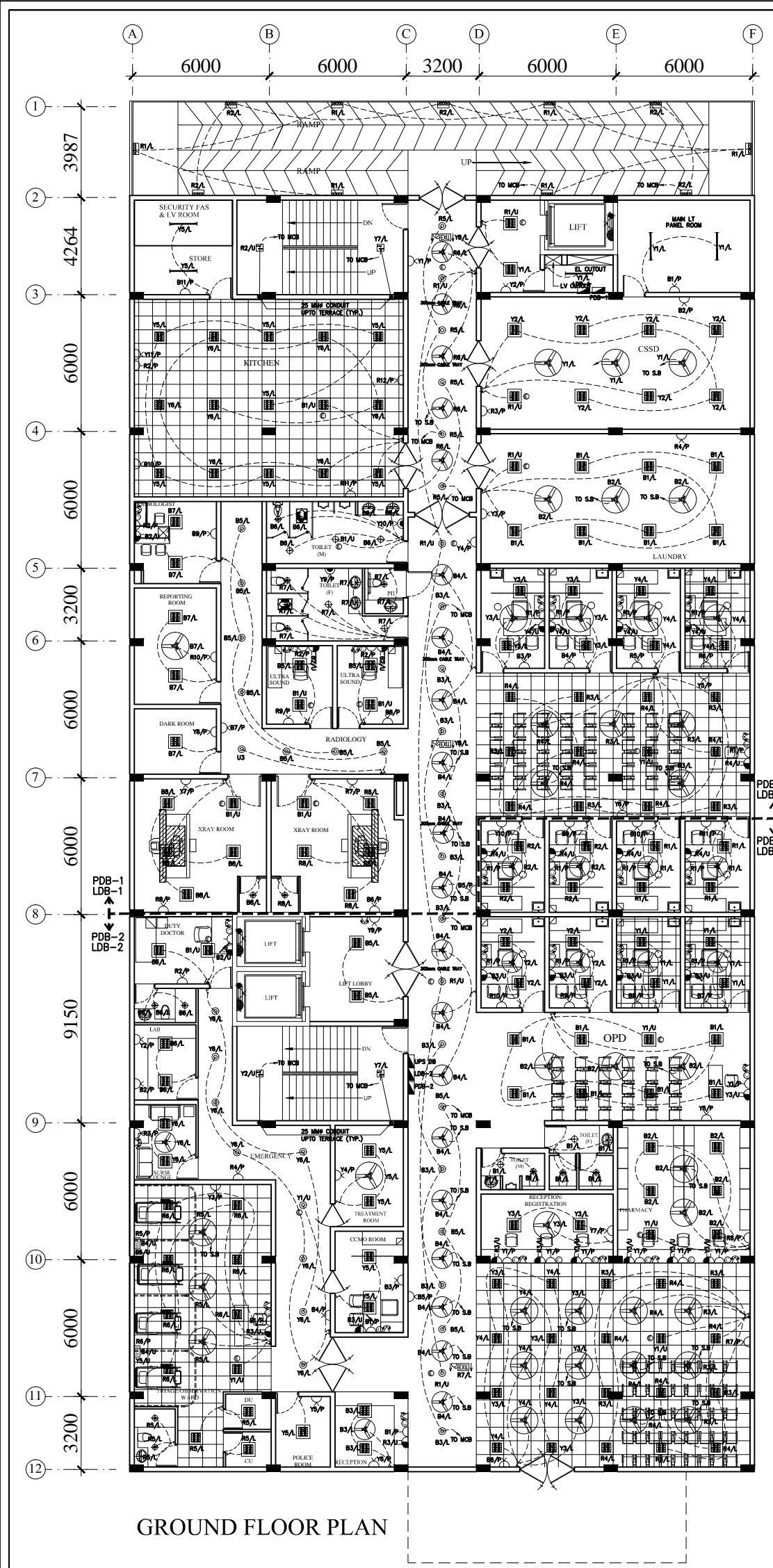
CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)



CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)

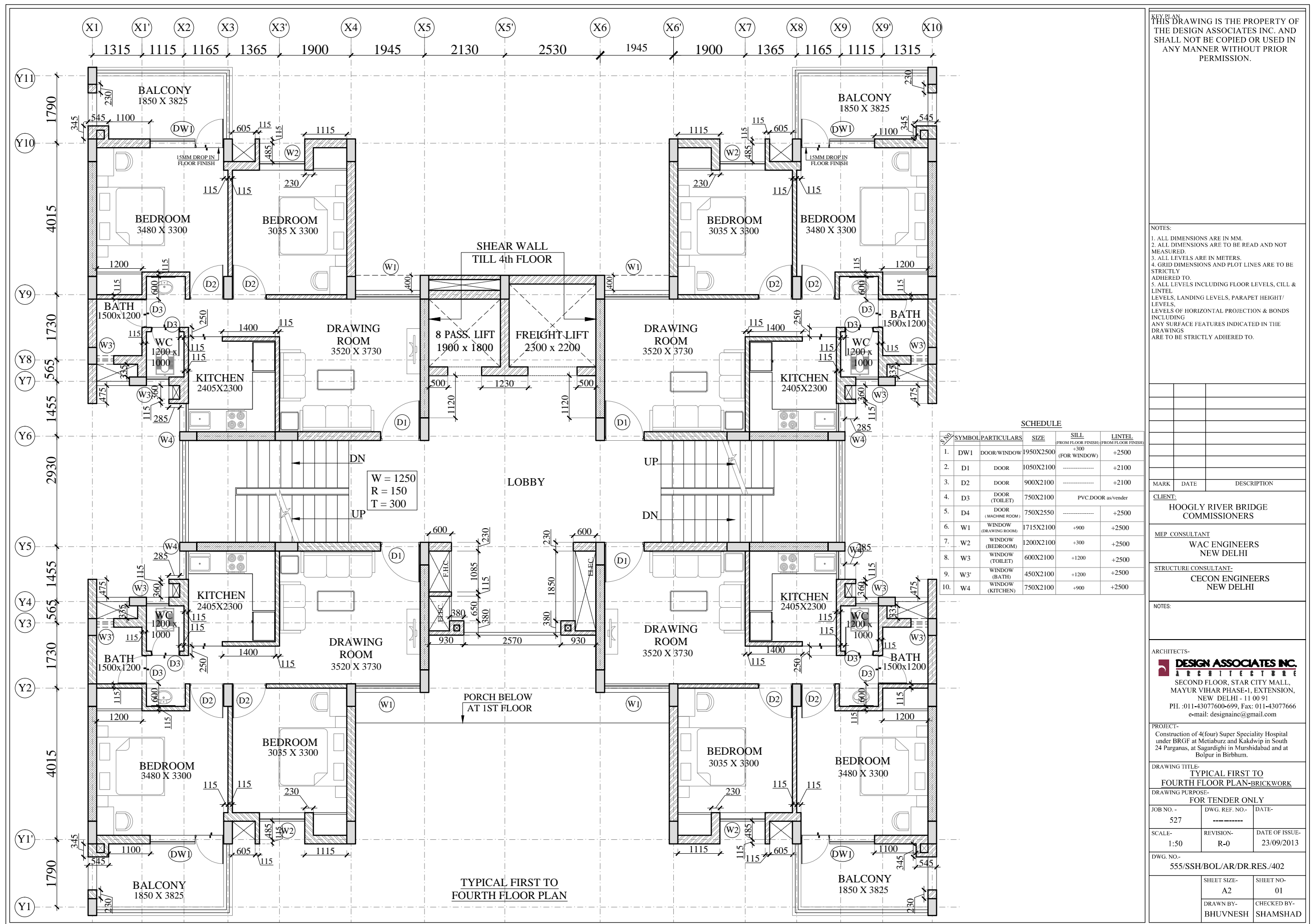
CONFIRMED JOINT WITH BEAM FRAMING INTO ALL FOUR SIDES (SINGLE RING)



LEGEND FOR PLUMBING PIPE			
(1)	100Ø SOIL & VENT PIPE		
(2)	100Ø WASTE & VENT PIPE		
(2a)	100Ø E.T.P. WASTE & VENT PIPE		
(3)	75Ø ANTI SYPHONEAGE PIPE		
(4)	COLD WATER SUPPLY		
(4a)	HOT WATER SUPPLY		
(4b)	FLUSHING WATER SUPPLY		
(4c)	HOT WATER RETURN		
(5)	COLD WATER RISER		
(5a)	FLUSHING WATER RISER		
(6)	HOT WATER SUPPLY SOLAR TO BOILER		
(7)	150Ø FIRE PIPE		
(8)	80Ø DRAIN PIPE		
(9)	150Ø SPRINKLER PIPE		
(10)	75Ø RAIN WATER PIPE		
(10a)	100Ø RAIN WATER PIPE		
(10b)	150Ø RAIN WATER PIPE		
(10c)	200Ø RAIN WATER PIPE		
FD	FLOOR DRAIN		
FT	FLOOR TRAP		
FT	CUTOUT SIZE 150mmX150mm		
W.C	CUTOUT SIZE 150mmX150mm		
CWS	COLD WATER SUPPLY		
HWS	HOT WATER SUPPLY		
HWR	HOT WATER RETURN		
FWS	FLUSHING WATER SUPPLY		
∇	VALVE		
NOTE:- 1. FD TO FT 50Ø WASTE PIPE			
2. WASHBASIN TO FT 32Ø WASTE PIPE			
3. KITCHEN SINK/URINAL TO FT 40Ø WASTE PIPE			
REV.NO.	DATE	DESCRIPTION	REV.BY
CONSULTANTS:-			
WAC engineers MEP Consultants & Project Managers 610, Suneja Tower-II, Janak Puri District Center, Janak Puri, New Delhi-58, Ph.: +91 11 40565325 Mob.: +91 9811128282 E-mail: wac@wacmep.com			
ARCHITECTS:-			
DESIGN ASSOCIATES INC. ARCHITECTS 2nd Floor, Star City Mall, Mayur Vihar Phase-1, Extn. New Delhi-110091. PHONE NO.- 011-43077600-699 FAX NO.- 011-43077666			
CLIENT:-			
HOOGLY RIVER BRIDGE COMMISSIONERS			
PROJECT:-			
Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakkdip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.			
DRG. TITLE:-PLUMBING LAYOUT			
DRAINAGE SYSTEM			
GROUND FLOOR & FIRST FLOOR (TYPICAL)			
Dwg No	Rev.	No	NORTH
PL-01	0		
Drawn By:- PAWAN			
Checked By:- SANJEEV THAKUR			
Approved BY:- SANJEEV THAKUR			
Date:- 09.09.2013			
Scale:- 1 : 125(A1)			
DRAWING PURPOSE			
FOR TENDER ONLY			



LEGEND:-			
SYM.	DESCRIPTION	M. UNIT ABOVE FFL	CATALOG NO. WIPRO OR EQUIV.
6	6AMP ONE WAY SWITCH BOARD	1200	
6	6AMP ONE WAY UPS SWITCH BOARD	1200	
6	6AMP 2WAY SWITCH BOARD	1200	
6A	6A SOCKET WITH SWITCH	ABOVE F/C	
6A	6A SOCKET WITH F.C.U	ABOVE F/C	
16A	16A 3PIN SOCKET WITH SWITCH FOR UPS	230/150 A/DESK	
16A	16A 3PIN SOCKET WITH SWITCH	230	
2Nos. 6A	2Nos. 6A SWITCH SOCKET CONTROLLED BY 1No. 16A SWITCH FOR UPS	300	
16A	16A 3PIN SOCKET WITH SWITCH FOR HANDDRYER	1200	
OVERHEAD PROJECTOR	OVERHEAD PROJECTOR	CEILING MOUNTED	
TELEPHONE OUTLET	TELEPHONE OUTLET	300	
CEILING FAN 1200mm	CEILING FAN 1200mm	CEILING MOUNTED	
1NOS. COMPUTER/DATA OUTLET	1NOS. COMPUTER/DATA OUTLET	CEILING MOUNTED	
1x28W FLOURESCENT FIXTURE	1x28W FLOURESCENT FIXTURE	CEILING MOUNTED	WDF-9128
1x18W MIRROR LIGHT	1x18W MIRROR LIGHT	WALL MOUNTED	WVF-30118
2x36W CFL RECESSED MOUNTED FIXTURE	2x36W CFL RECESSED MOUNTED FIXTURE	CEILING MOUNTED	WCP-84236
2x11W CFL SURFACE MOUNTED FIXTURE	2x11W CFL SURFACE MOUNTED FIXTURE	CEILING MOUNTED	WVP-41211
2x18W CFL RECESSED MOUNTED FIXTURE	2x18W CFL RECESSED MOUNTED FIXTURE	CEILING MOUNTED	WCP-27218
BRICK LIGHT	BRICK LIGHT	600	
1x18W CFL RECESSED MOUNTED FIXTURE	1x18W CFL RECESSED MOUNTED FIXTURE	CEILING MOUNTED	WCP-27118
9W CFL BATTEN HOLDER	9W CFL BATTEN HOLDER	CEILING MOUNTED	BATTEN HOLDER
1x36W WALL MOUNTED FIXTURE	1x36W WALL MOUNTED FIXTURE	2100	WRF-21136
1x9W CFL BULK HEAD LIGHT	1x9W CFL BULK HEAD LIGHT	2100	WKG-13
EXIT SIGNAGE	EXIT SIGNAGE	CEILING SUSPENDED	
LIGHT/POWER DISTRIBUTION BOARD	LIGHT/POWER DISTRIBUTION BOARD		
1No. 16A 6PIN UPS SOCKET & 1No. 16A 6PIN RAW POWER SOCKET 1set, 2No. 6A 3PIN SOCKET CONTROLLED BY PUSH BUTTON FOR NURSE CALL SYSTEM			
REV.NO.	DATE	DESCRIPTION	REV.BY
CONSULTANTS:-			
<div> WAC engineers MEP Consultants & Project Managers 610, Suneja Tower-II, Janak Puri District Center, Janak Puri, New Delhi-58, Ph.: +91 11 40565325 Mob.:+91 9811128282 E-mail: wac@wacmep.com</div>			
ARCHITECTS:-			
<div> DESIGN ASSOCIATES INC. ■■</div>			



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- NOTES:
1. ALL DIMENSIONS ARE IN MM.
 2. ALL DIMENSIONS ARE TO BE READ AND NOT MEASURED.
 3. ALL LEVELS ARE IN METERS.
 4. GRID DIMENSIONS AND PLOT LINES ARE TO BE STRICTLY ADHERED TO.
 5. ALL LEVELS INCLUDING FLOOR LEVELS, CILL & LINTEL LEVELS, LANDING LEVELS, PARAPET HEIGHT/ LEVELS, LEVELS OF HORIZONTAL PROJECTION & BONDS INCLUDING ANY SURFACE FEATURES INDICATED IN THE DRAWINGS ARE TO BE STRICTLY ADHERED TO.

MARK	DATE	DESCRIPTION
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CLIENT:
HOOGLY RIVER BRIDGE COMMISSIONERS

MEP CONSULTANT:
WAC ENGINEERS
NEW DELHI

STRUCTURE CONSULTANT:
CECON ENGINEERS
NEW DELHI

NOTES:

ARCHITECTS-
DESIGN ASSOCIATES INC.
ARCHITECTURE
SECOND FLOOR, STAR CITY MALL,
MAYUR VIHAR PHASE-1, EXTENSION,
NEW DELHI - 11 00 91
PH. :011-43077600-699, Fax: 011-43077666
e-mail: designainc@gmail.com

PROJECT-
Construction of 4(four) Super Speciality Hospital
under BRGF at Metiaburuz and Kakkdwip in South
24 Parganas, at Sigardighi in Murshidabad and at
Bolpur in Birbhum.

DRAWING TITLE-
ELEVATION - A & B

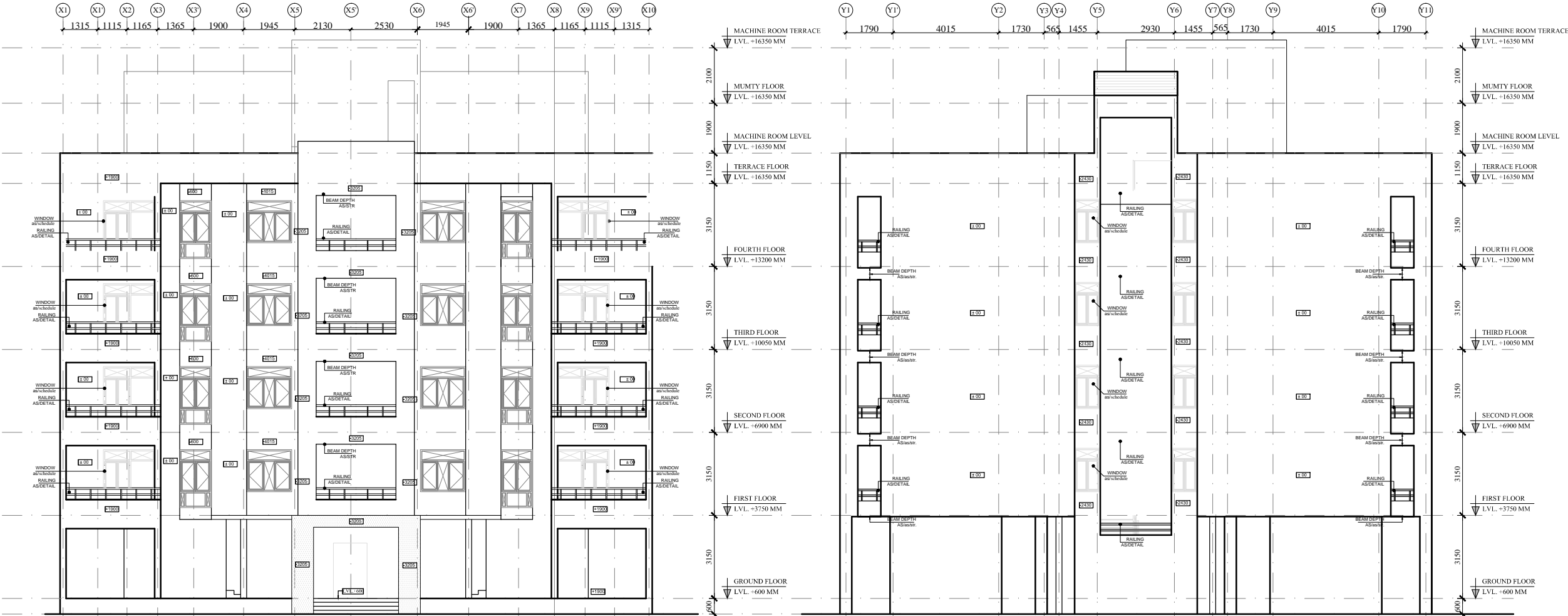
DRAWING PURPOSE-
FOR TENDER ONLY

JOB NO. - 527	DWG. REF. NO. - -----	DATE -
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SCALE - 1:100	REVISION - R-0	DATE OF ISSUE - 23/09/2013
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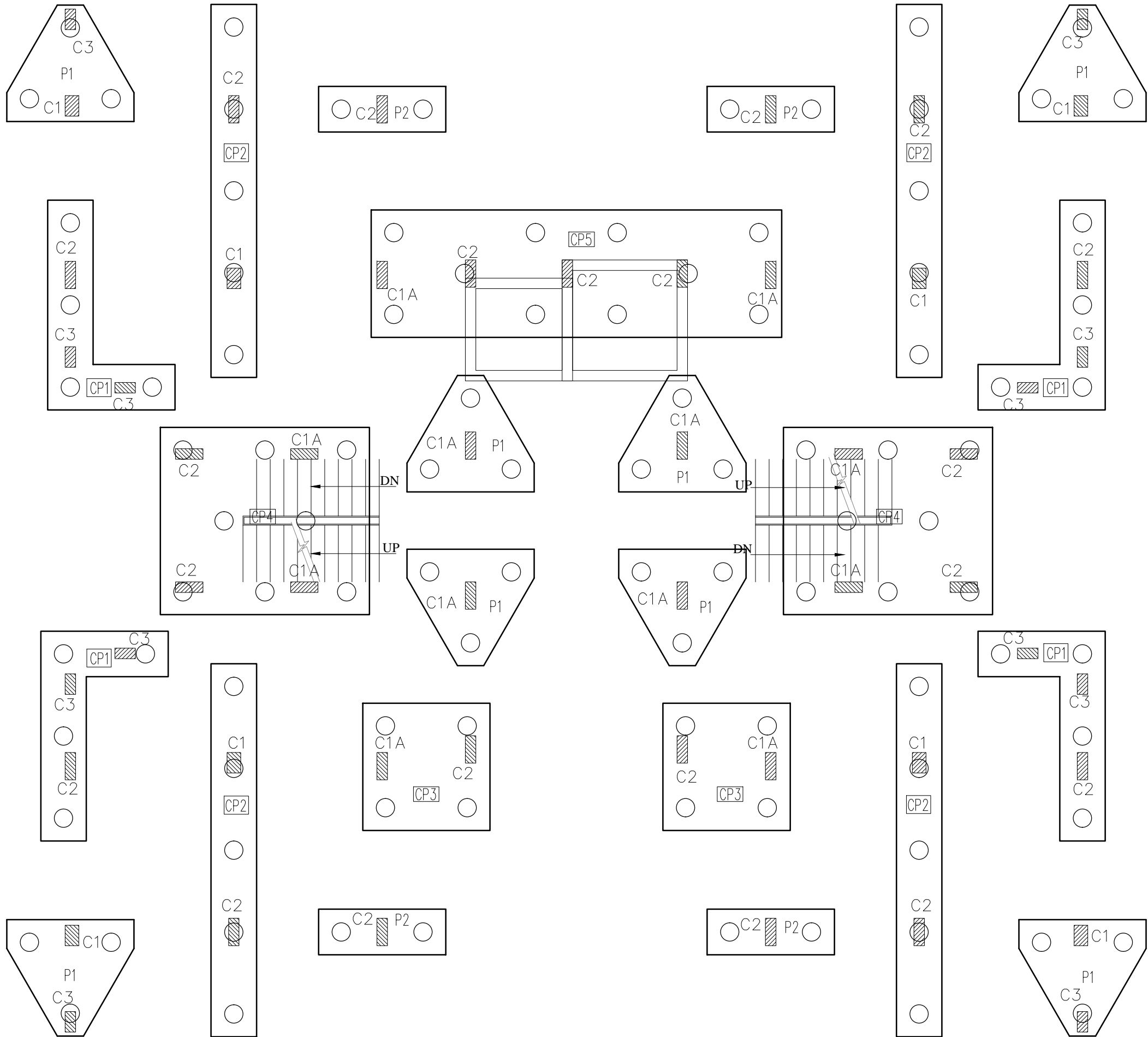
DWG. NO. -
555/SSH/BOL/AR/DR.RES./404

SHEET SIZE - A2	SHEET NO. - 01
DRAWN BY - BHUVNESH	CHECKED BY - SHAMSHAD



ELEVATION - A

ELEVATION - B



FOUNDATION PLAN

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MARK	DATE	DESCRIPTION
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CLIENT:
HOOGLY RIVER BRIDGE COMMISSIONERS

MEP CONSULTANT:
WAC ENGINEERS NEW DELHI

STRUCTURE CONSULTANT:
CECON ENGINEERS NEW DELHI

NOTES:

ARCHITECTS-
DESIGN ASSOCIATES INC.
SECOND FLOOR, STAR CITY MALL,
MAYUR VIHAR PHASE-I, EXTENSION,
NEW DELHI - 11 00 91
PH. :011-43077600-699, Fax: 011-43077666
e-mail: designainc@gmail.com

PROJECT:
Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.

DRAWING TITLE-
FOUNDATION PLAN

DRAWING PURPOSE-
FOR TENDER ONLY

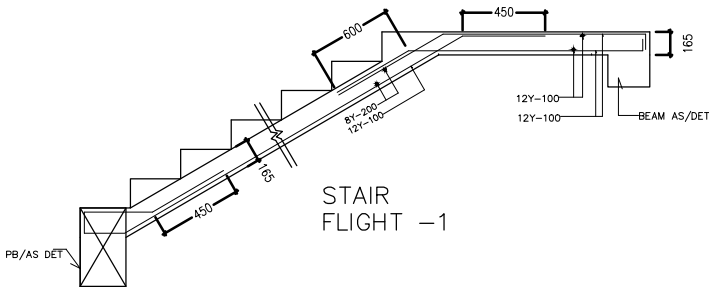
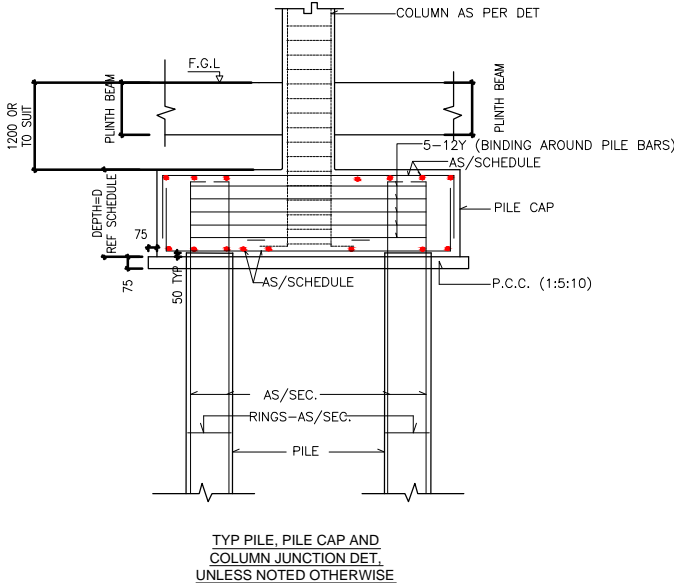
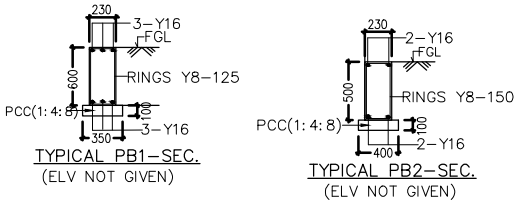
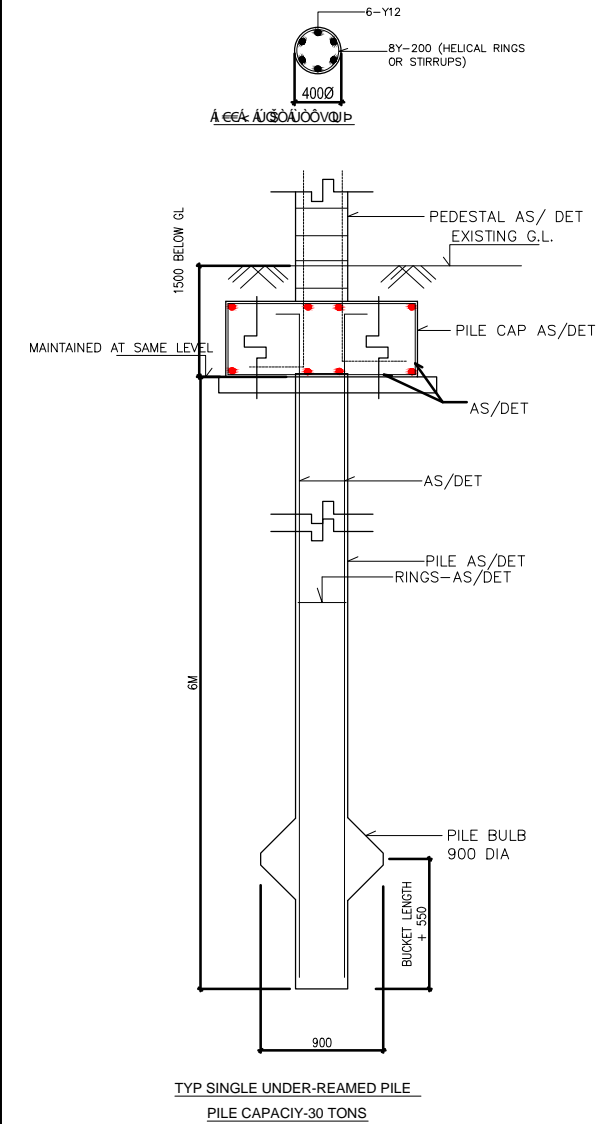
JOB NO. -	DWG. REF. NO.-	DATE-
555	-----	

SCALE-	REVISION-	DATE OF ISSUE-
NTS	R-0	23/09/2013

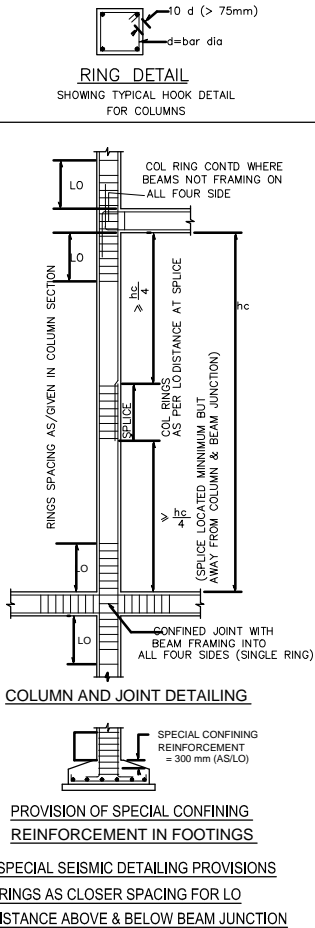
DWG. NO.-
555/SSH/BOL/DR.RES./STR-01

SHEET SIZE-	SHEET NO-
A3	01
DRAWN BY-	CHECKED BY-

PILE CAP SCHEDULE					
MARK	SIZE	DEPTH	BOTTOM RENF BOTH EXTRA	TOP RENF BOTH WAYS	REMARK
P1/P3	AS/PLAN	900	Y16-150	Y12-200	
CP1/CP2	AS/PLAN	900	Y16-150	Y16-200	



NO	COLUMN SECTION CONC. GRADE- M30 RINGS AT CLOSER SPACING AS/SEISMIC DETAILING FOR LONGER COLUMN DIMENSION	
	FIRST FLOOR	ABOVE
C1		
C1A		
C2		
C3		



- NOTES:-
- ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
 - READ THIS DRG ALONG WITH RELEVANT ARCH. DRG.
 - CONCRETE GRADE M25 FOR ALL STRUCTURES. STONE AGGREGATE TO BE 20 MM DOWN.EXCEPT COL & PILES AS NOTED.
 - DONOT SCALE THE DRG, FOLLOW WRITTEN DIMENSIONS. ANY MISMATCH IN ARCH OR SERVICES DRGS TO BE CLARIFIED FROM ENGINEER.
 - 'Y' DESIGNATES STEEL REINFORCEMENT DIA, AND SHALL CONFORM TO IS-1786 WITH MINIMUM YIELD STRENGTH OF 415 N/SQ.MM.
 - DO NOT PROVIDE MORE THAN 50% LAPPING AT ANY SECTION, AND AVOID LAPS AT LOCATIONS OF MAXIMUM BENDING MOMENTS. LAP LENGTH/DEVELOPMENT LENGTH SHALL BE AS FOLLOWS: 42xBAR DIA FOR M25 CONCRETE; 37xBAR DIA FOR M30 CONCRETE
 - NOMINAL COVER SHALL BE AS FOLLOWS: BEAMS-25MM, SLABS-15MM, COLUMNS-40MM, FOUNDATION-50MM. WALLS-25MM, BASE SLAB TOP FACE-25MM
 - WATER CEMENT RATIO FOR CONCRETE MIX SHALL NOT BE MORE THAN 0.45. IF REQUIRED USE PLASTICISER TO CONTROL SAME.
 - INDICATES TOP BAR INDICATES BOTTOM BAR
 - DISTRIBUTION STEEL WHEREVER NOT SHOWN SHALL BE 8Y-200 C/C
 - FOR DETAILS TO THIS DRG REFER OTHER STR DRGS.
 - EXTRA EXCAVATION OR LOOSE EARTH POCKETS AT FOUNDING LEVEL SHALL BE REPLACED BY PCC 1:4:8.
 - THE FDN IS DESIGNED CONSIDERING PILES, PILE LOAD TESTING TO BE DONE FOR CONFIRMATION OF PILE CAPACITY.
 - ALL LAYOUT DIMNS TO MATCH ARCHT DRGS AND ALL MEMBER SIZES AND REINF TO MATCH STRUCTURAL DRGS.

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MARK	DATE	DESCRIPTION
------	------	-------------

CLIENT:
HOOGLY RIVER BRIDGE COMMISSIONERS

MEP CONSULTANT
WAC ENGINEERS NEW DELHI

STRUCTURE CONSULTANT:
CECON ENGINEERS NEW DELHI

NOTES:

ARCHITECTS-
DESIGN ASSOCIATES INC.
SECOND FLOOR, STAR CITY MALL,
MAYUR VIHAR PHASE-I, EXTENSION,
NEW DELHI- 11 00 91
PH. :011-43077600-699, Fax: 011-43077666
e-mail: designainc@gmail.com

PROJECT:
Construction of 4(four) Super Speciality Hospital under BRGF at Metiaburz and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Bolpur in Birbhum.

DRAWING TITLE-
FOUNDATION & RC DETS

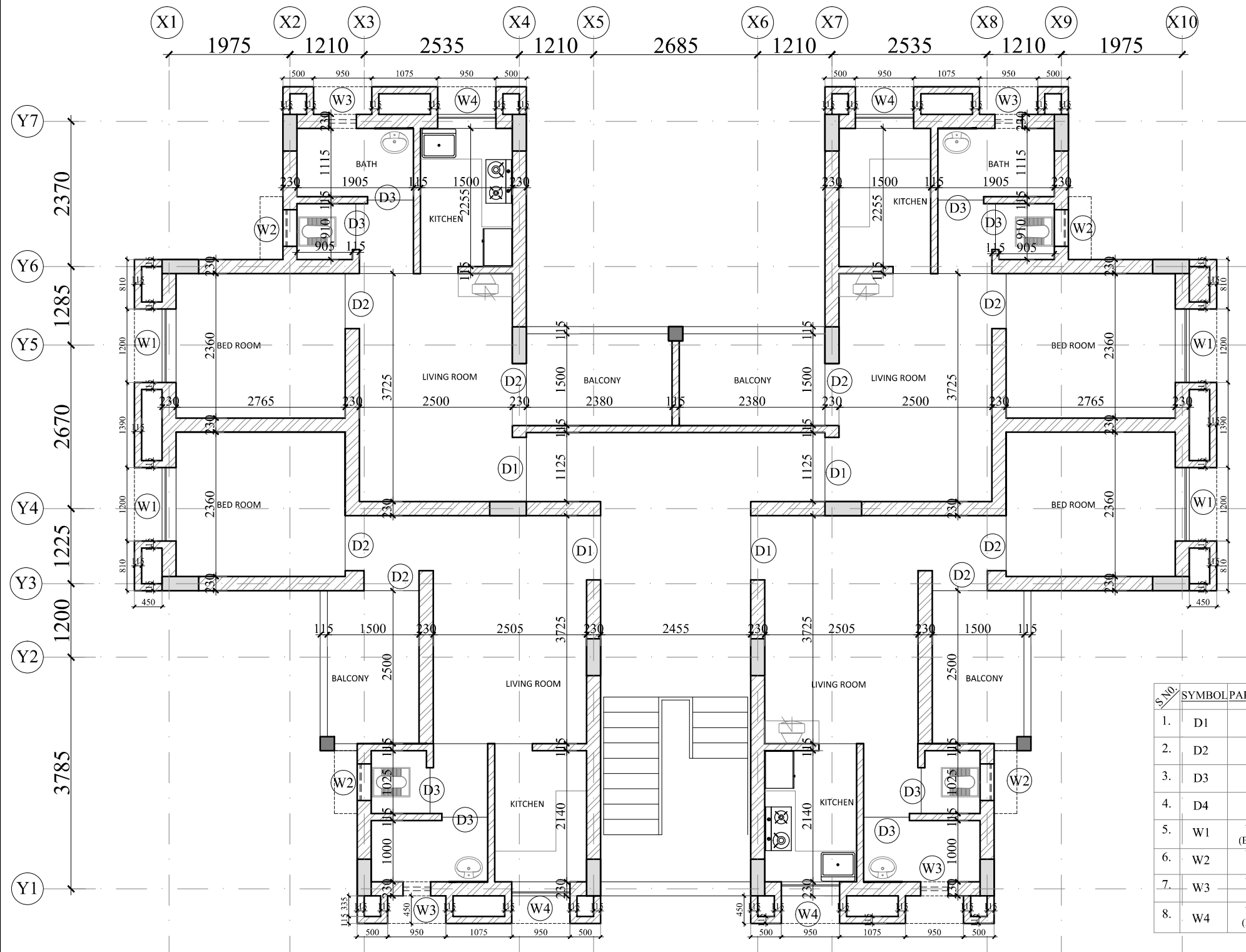
DRAWING PURPOSE-
FOR TENDER ONLY

JOB NO. -	DWG. REF. NO.-	DATE-
555	-----	

SCALE-	REVISION- R-0	DATE OF ISSUE- 23/09/2013
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DWG. NO.-
555/SSH/BOL/DR.RES/STR-01A

SHEET SIZE- A3	SHEET NO- 01
DRAWN BY-	CHECKED BY-



SCHEDULE

S.NO.	SYMBOL	PARTICULARS	SIZE	SILL	LINTEL
				(FROM FLOOR FINISH)	(FROM FLOOR FINISH)
1.	D1	DOOR	1050X2100	-----	+2100
2.	D2	DOOR	900X2100	-----	+2100
3.	D3	DOOR (TOILET)	750X2100	PVC.DOOR as/vender	
4.	D4	DOOR (TERRACE)	950X2100	-----	+2100
5.	W1	WINDOW (BEDROOM)	1200X2100	+300	+2500
6.	W2	WINDOW (TOILET)	600X2100	+1200	+2500
7.	W3	WINDOW (BATH)	450X2100	+1200	+2500
8.	W4	WINDOW (KITCHEN)	950X2100	+900	+2500

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MARK	DATE	DESCRIPTION
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MEP CONSULTANT:
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STRUCTURE CONSULTANT:
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PROJECT:-
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DRAWING TITLE:-
FIRST TO FOURTH FLOOR PLAN-
BRICKWORK

DRAWING PURPOSE:-
FOR TENDER ONLY

JOB NO. - 555	DWG. REF. NO.- -----	DATE-
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SCALE:- 1:50	REVISION- R-0	DATE OF ISSUE- 23/09/2013
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DWG. NO.-
555/SSH/BOL/AR/NURSE & STAFF RES./502

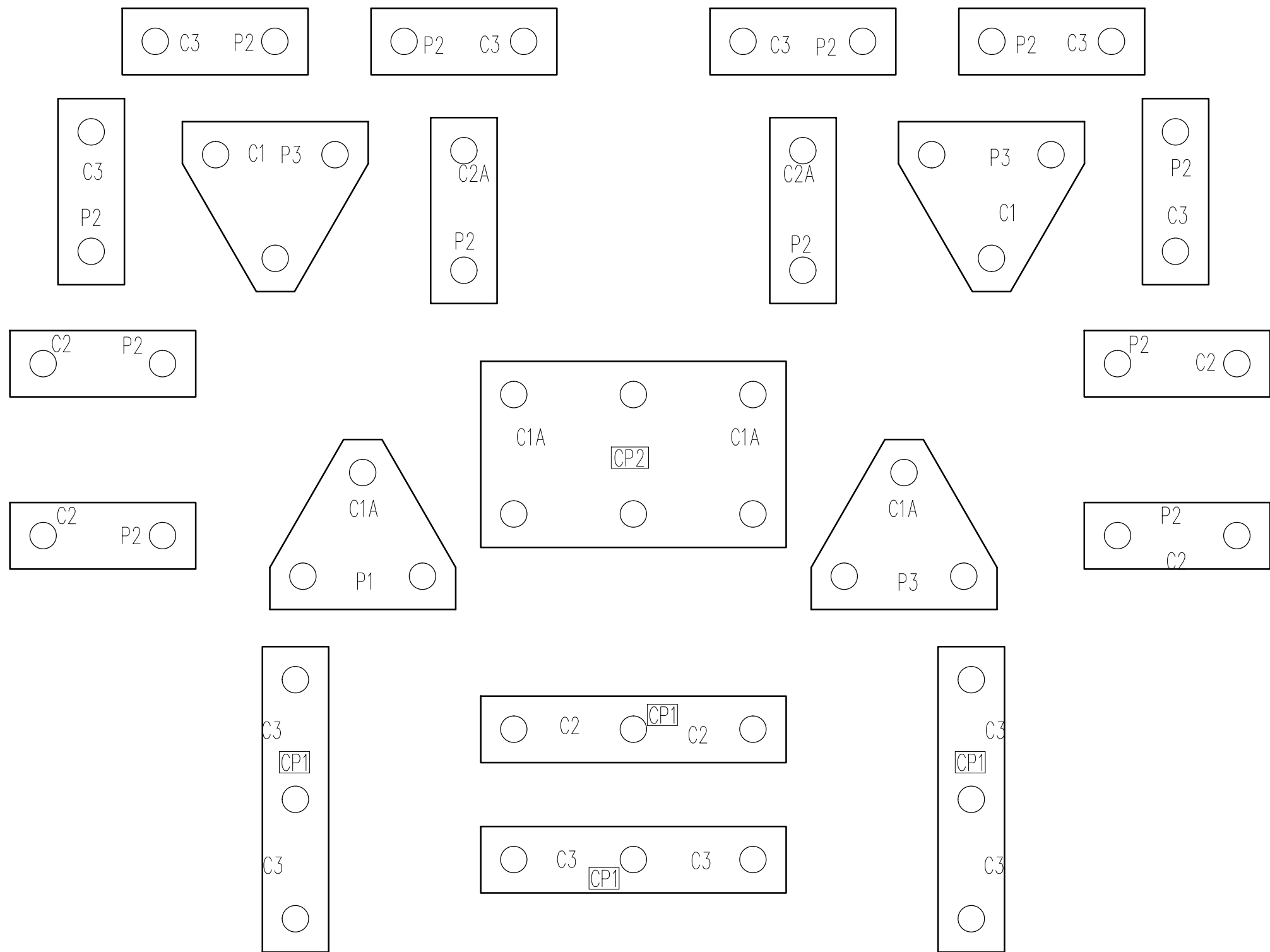
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KEY PLAN
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 3. ALL LEVELS ARE IN METERS.
 4. GRID DIMENSIONS AND PLOT LINES ARE TO BE STRICTLY ADHERED TO.
 5. ALL LEVELS INCLUDING FLOOR LEVELS, CILL & LINTEL LEVELS, LANDING LEVELS, PARAPET HEIGHT/ LEVELS, LEVELS OF HORIZONTAL PROJECTION & BONDS INCLUDING ANY SURFACE FEATURES INDICATED IN THE DRAWINGS ARE TO BE STRICTLY ADHERED TO.

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HOOGLY RIVER BRIDGE COMMISSIONERS		
MEP CONSULTANT:		
WAC ENGINEERS NEW DELHI		
STRUCTURE CONSULTANT:		
CECON ENGINEERS NEW DELHI		
NOTES:		
ARCHITECTS-		
 SECOND FLOOR, STAR CITY MALL, MAYUR VIHAR PHASE-1, EXTENSION, NEW DELHI - 11 00 91 PH. :011-43077600-699, Fax: 011-43077666 e-mail: designainc@gmail.com		
PROJECT:		
Construction of 4(four) Super Speciality Hospital under BRGF at Metiabury and Kakdwip in South 24 Parganas, at Sagardighi in Murshidabad and at Boipur in Birbhum.		
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SCALE-	REVISION-	DATE OF ISSUE-
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FOUNDATION PLAN

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MEP CONSULTANT:
WAC ENGINEERS
NEW DELHI

STRUCTURE CONSULTANT:
CECON ENGINEERS
NEW DELHI

NOTES:

ARCHITECTS:-
DESIGN ASSOCIATES INC.
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PROJECT:-
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DRAWING TITLE:-
FOUNDATION PLAN

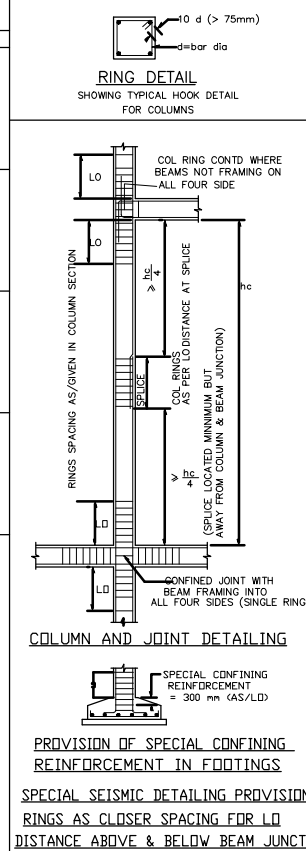
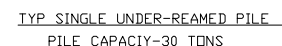
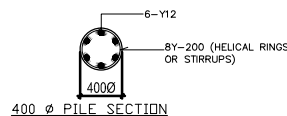
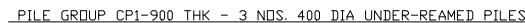
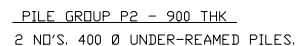
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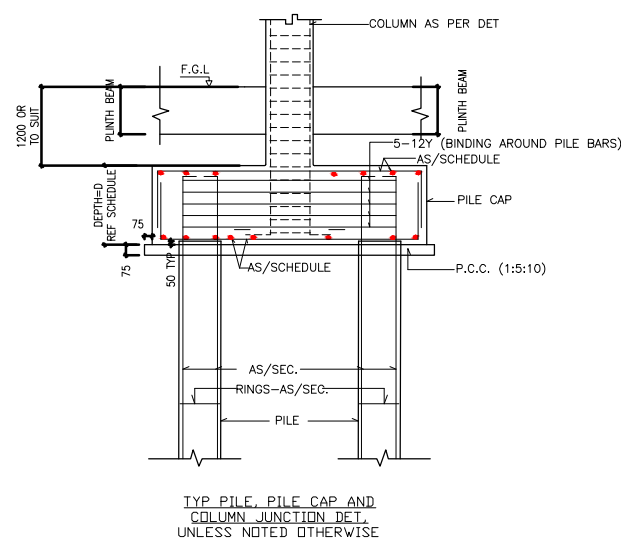
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A3	01
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TYPICAL PB1-SEC.
(ELV NOT GIVEN)

TYPICAL PB2-SEC.
(ELV NOT GIVEN)



NOTES:-

1. ALL DIMENSIONS ARE IN MM UNLESS NOTED OTHERWISE.
2. READ THIS DRG ALONG WITH RELEVANT ARCH. DRG.
3. STONE CEMENT GRADE M25 FOR ALL STRUCTURES.
4. STONE AGGREGATE TO BE 20 MM DOWN INCEPT COL & PILES AS NOTED.
5. DONOT SCALE THE DRG, FOLLOW WRITTEN DIMENSIONS. ANY MISMATCH IN ARCH OR SERVICES DRGS TO BE CLARIFIED FROM ENGINEER.
6. 'Y' DESIGNATES STEEL REINFORCEMENT DIA, AND SHALL CONFORM TO IS-1786 WITH MINIMUM YIELD STRENGTH OF 415 N/SQ.MM.
7. DO NOT PROVIDE MORE THAN 50% LAPPING AT ANY SECTION, AND AVOID LAPS AT LOCATIONS OF MAXIMUM BENDING MOMENTS.
LAP LENGTH/DEVELOPMENT LENGTH SHALL BE AS FOLLOWS:
42xBAR DIA FOR M25 CONCRETE; 37xBAR DIA FOR M30 CONCRETE
8. NOMINAL COVER SHALL BE AS FOLLOWS:
BEAMS-25MM, SLABS-15MM, COLUMNS-40MM, FOUNDATION-50MM.
WALLS-25MM, BASE SLAB TOP FACE-25MM
9. WATER CEMENT RATIO FOR CONCRETE MIX SHALL NOT BE MORE THAN 0.45. IF REQUIRED USE PLASTICISER TO CONTROL SAME.
9. ----- INDICATES TOP BAR
----- INDICATES BOTTOM BAR
10. DISTRIBUTION STEEL WHEREVER NOT SHOWN SHALL BE 8Y-200 C/C
11. FOR DETAILS TO THIS DRG REFER OTHER STR DRGS.
12. EXTRA EXCAVATION OR LOOSE EARTH POCKETS AT FOUNDING LEVEL SHALL BE REPLACED BY FILL
13. THE FDN IS DESIGNED CONSIDERING PILES. PILE LOAD TESTING TO BE DONE FOR CONFIRMATION OF PILE CAPACITY.
14. ALL LAYOUT DIMS TO MATCH ARCH DRGS AND ALL MEMBER SIZES, AND REINFT TO MATCH STRUCTURAL DRGS.

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[illegible]

CLIENT:
HOOGLY RIVER BRIDGE
COMMISSIONERS

MEP CONSULTANT
WAC ENGINEERS
NEW DELHI

STRUCTURE CONSULTANT-
CECON ENGINEERS
NEW DELHI

NOTES:

ARCHITECTS-

 **DESIGN ASSOCIATES INC.**
ARCHITECTURE

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MAYUR VIHAR PHASE-1, EXTENSION,
NEW DELHI - 11 00 91

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DRAWING TITLE-

FOUNDATION & RC DETS

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