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Name of Work: "Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"

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Certified that Bid document contains pages 01 to 649

PART-A

GENERAL INFORMATION

INFORMATION AND INSTRUCTIONS FOR BIDDERS FOR E-TENDERING

The Superintending Engineer, IWD, IIT Kanpur invites on behalf of Board of Governors of IIT Kanpur invites online percentage rate open bids from eligible/ contractors of repute in two bid system (Eligibility cum Technical bid & Financial Bid) for the following work: -

NIT No.	28/Composite/CO/2025-26
Name of work	"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"
Location	IIT Campus, Kanpur
Estimated cost put to bid	Rs. 119,75,10,345/- (i/c of Civil works: - Rs. 99,10,51,949.00 Electrical & Lift works: - Rs. 15,01,04,195.00 & HVAC works: - Rs. 5,63,54,201.00)
Earnest Money	Rs. 129.75 lacs
Period of Completion	18 Months
Last date & time of online submission of 'Eligibility and Financial Bids'	01.07.2025 & 17:00 Hours
EMD Submission hard copies	03.07.2025 upto 14:30 Hours
Time and date of opening of eligibility documents	03.07.2025 upto 15:00 Hours
Pre-Bid Conference	18.06.2025 at 12:00 Noon

INDIAN INSTITUTE OF TECHNOLOGY KANPUR
INSTITUTE WORKS DEPARTMENT
CENTRAL OFFICE
Notice Inviting e-Tender 28/Composite/CO/2025-26

The Superintending Engineer, IWD, IIT Kanpur invites on behalf of Board of Governors of IIT Kanpur invites online percentage rate open bids from eligible/contractors of repute in two bid system (Eligibility cum Technical bid & Financial Bid) for the following work: -

Sl No.	Name of work	Estimated Cost	Earnest money	Period of completion
1.	"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"	Rs. 119,75,10,345/-	Rs. 129.75 lacs	18 Months

Last date & time of submission of bid on 01.07.2025 Up to 17.00 PM. All details are available on website, <http://eprocure.gov.in/eprocure/app> & www.iitkac.in/iwd/tenderhall.htm. The bids can only be submitted online at <http://eprocure.gov.in/eprocure/app>. Any corrigendum regarding this tender will be published only on above mentioned websites.

No. IWD/CO/2025-26/84

Dated: 9.06.2025

Superintending Engineer
Phone No. 0512-259-7604

Initial criteria for eligibility:

Contractors who fulfill the following requirements shall be eligible to apply Joint ventures and Special Purpose Vehicles are not accepted.

- a) Should have satisfactorily completed the works as mentioned below during the last Seven years ending month previous the month in which tenders are invited.

Three similar works each costing not less than Rs. 4790.0 lacs

Or

Two similar works each costing not less than Rs. 7185.0 lacs

Or

One similar works each costing not less than Rs. 9580.0 lacs

Similar work shall mean works of **Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"**

Note:

1. Mumty and machine room will not be counted as storeys for this purpose.
2. For this purpose, each basement, stilt constructed in the building shall be considered as a storey.
3. Complete set of TDS certificate (Form 16A) shall be uploaded in case the similar work is executed for a private body, which shall form basis for establishing the completion cost of work executed.
4. **One completed work costing not less than 20% of the estimated cost executed with the Modular Aluminium Formwork Shuttering System (MAFSS) as proposed by the bidder. This work can be part of eligible work or as a separate work. The details have to be submitted by the**

bidder as per Form 'I' during the last seven years ending the last day of month previous to the one in which the tender is invited.

If the bidder does not have adequate experience of opted technology, then the bidder can associate the contractor having requisite experience of the executed work in the in structural system with the opted technology. The bidder has to submit MOU and form 'I' with such associate contractor, along with his tender, for Modular Aluminium Formwork Shuttering System (MAFSS) only. The associated contractor must satisfy the eligibility criteria of having successfully completed one work of opted technology having the cost of structural system not less than 20% of the estimated cost put to tender during the last seven years ending the last day of month previous to the one in which the tender is invited.

The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of tenders.

Associated contractor should not have been debarred from any ministry or any Government organization in the last five years.

The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of tenders.

If private works shown in support of eligibility, certified copy of the Tax deducted at source TDS Certificate (Form 16 A & 26 AS) shall be submitted along with the Experience Certificate and the TDS amount shall tally with the actual amount of work done. Otherwise, the amount that tally with TDS shall only be considered for eligibility.

- b) The Bidder should have had Average Annual Financial Turnover of Rs **3592.50** lacs on Civil & Electrical construction works during the last three years ending 31st March 2024 (Scanned copy of Certificate from CA with Unique Document Identification Number (UDIN) to be uploaded). The value of annual turnover figures shall be brought to the current value by enhancing the actual turnover figures at simple rate of 7% per annum.
- c) The Bidder should not have incurred any loss (profit after tax should be positive) in more than two years during available last 05 (five) consecutive balance sheets (Standalone financial statement) duly audited and certified by the Chartered Accountant.
- d) The Bidder should have a Banker's Certificate from a commercial Bank for Rs. **4790.00** Lacs or Net Worth certificate of minimum Rs. **1197.50** Lacs

from CA with Unique Document Identification Number (UDIN) Scanned copy of original to be uploaded).

- e) The Bidder should have bidding capacity equal to or more than the estimated cost of the work put to tender. The bidding capacity shall be worked out by the following formula:

$$\text{Bidding Capacity} = \{[A \times N \times 1.5] - B\}$$

Where,

A = Maximum turnover in construction works executed in any one year during the last seven years taking into account the completed as well as works in progress. The value of completed works shall be brought to current costing level by enhancing at a simple rate of 7% per annum.

N = Number of years prescribed for completion of work for which bids have been invited.

B = Value of existing commitments and outgoing works to be completed during the period of completion of work for which bids have been invited.

2. The intending bidder must read the terms and conditions of CPWD-6 carefully. He should submit his bid only if he considers himself eligible and he is in possession of all the documents required.

3. Information and Instructions for bidders posted on website shall form part of bid document.

4. But the bid can only be submitted after deposition of original EMD either in the office of Superintending Engineer inviting bids or division office of any Executive Engineer, IWD within the period of bid submission and uploading the mandatory scanned documents such as Insurance Surety Bonds. Account Payee Demand draft or Banker's Cheque or Fixed Deposit Receipts or/ and Bank Guarantee including e-Bank Guarantee (for balance amount as prescribed) from any of the Commercial Bank towards EMD in favour of The Director, IIT Kanpur receipt for deposition of original EMD to Central office.

5. The bid document consisting of Technical (eligibility) & the financial bid i/c plans specifications, and the set of terms and conditions of the contract to be complied with and other necessary documents can be seen and downloaded from the website <http://eprocure.gov.in/eprocure/app> or www.iitk.ac.in.

6. Applicant has to deposit Earnest Money in the form of Insurance Surety Bonds, Account Payee Demand Draft, Fixed Deposit Receipt, Banker's Cheque or Bank Guarantee (for balance amount as prescribed) from any of the Commercial Banks (Drawn in favour of The Director, IIT Kanpur) shall be scanned and uploaded to the e-Tendering website within the period of bid submission.

7. Earnest Money in the form of Insurance Surety Bonds, Account Payee Demand Draft, Fixed Deposit Receipt, Banker's Cheque or Bank Guarantee (drawn in favour of The Director, IIT Kanpur) shall be scanned and uploaded to the e-Tendering website within the period of bid submission. The original EMD should be deposited either in the office of Executive Engineer inviting bids or division office of any Executive Engineer, IWD within the period of bid submission. The EMD receiving Executive Engineer (including NIT issuing EE/AE) shall issue a receipt of deposition of earnest money deposit to the bidder in prescribed format (enclosed) uploaded by tender inviting EE in the NIT.

This receipt shall also be uploaded to the e-tendering website by the intending bidder upto the specified bid submission date and time.

Online technical bid documents submitted by intending bidders shall be opened only of those bidders whose original EMD deposited in the O/o SE, IWD and other documents scanned and uploaded are found in order.

Online financial bid document submitted by the bidders shall be opened only of those bidders who on the basis of pre-qualification documents uploaded by them within the period of bid submission, qualify in accordance with the provision of technical bid. The financial bid shall be opened at the notified time, date & place in presence of qualified bidders or their representative.

8. The intending bidder must have valid class-III **digital signature** to submit the bid.

9. On opening date, the contractor can login and see the bid opening process. After opening of bids, he will receive the competitor bid sheets.

10. Contractor can upload documents in the form of **JPG** format and **PDF** format.

11. **Certificate of Financial Turn Over:** At the time of submission of bid, contractor has to upload Affidavit/Certificate from **CA** mentioning Financial Turnover on construction work of last 5 years or for the period as specified in the bid document and further details if required may be asked from the contractor after opening of technical bids containing pre-qualification documents. The balance sheet in case of private public limited company shall include its standalone finance statement and consolidated financial statement both. There is no need to upload entire voluminous balance sheet.

12. The **Technical bid** shall be **opened first** on due date and time as mentioned above. The time and date of opening of financial bid of contractors qualifying the technical bid shall be communicated to them at a later date.

13. **Pre-Bid Meeting** shall be held in the office of Superintending Engineer IWD, IIT Kanpur **at 12 Noon on 18.06.25** to clear the doubt of intending bidders/ associates, if any. For physical attendance in pre bid meeting only one representative of firm shall be allowed to maintain the physical distance. Bidders are advised to send their queries/ doubts by email to the Superintending Engineer on email id seiwd@iitk.ac.in at least one day prior to the pre-bid meeting. A bidder can send multiple mails with different queries/doubts in each mail. The bidder may also raise query on the date of pre-bid meeting. If found necessary, an addendum/corrigendum to the tender document and /or minutes of meeting shall be issued and same shall be uploaded on the CPP portal and no further queries after pre-bid meeting shall be entertained. Such addendum/corrigendum shall become part of tender.

14. The department reserves the right to reject any prospective application without assigning any reason and to restrict the list of qualified contractors to any number deemed suitable by it, if too many bids are received satisfying the laid down criterion.

15. After submission of the bid the contractor can re-submit revised bid any number of times but before last time and date of submission of bid as notified.

16. The rates for all items of work, shall unless clearly specified otherwise, include cost of all operations and all inputs of labor, material, T&P, scaffolding at all heights irrespective of any location, wastages, watch and ward, other inputs, all incidental charges, all taxes, cess, duties, levies, excluding GST etc. required for execution of the work.

17. Copy of certificate of work experience and other documents as specified in the technical bid/eligibility bid document shall be scanned and uploaded to the e-Tendering website within the period of bid submission.

18. The bid submitted shall become invalid if:

- (i) The bidder is found ineligible.
- (ii) The bidder does not deposit original EMD to the office of the Superintending Engineer, IWD IIT Kanpur.
- (iii) The bidder does not upload scanned copies of all the documents stipulated in the bid document.
- (iv) If a tenderer quotes nil rates against each item in scheduled of quote of tender or does not quote any rate in any section/sub head in rate tender, the tender shall be treated as invalid and will not be considered as lowest tenderer.

19. List of Documents to be filled in by the bidders in various forms as indicated in Section III and other documents, to be scanned & uploaded within the period of bid submission and deposited in hard copy.

1	Treasury challan /Demand draft/Pay order or Banker's Cheque/ Deposit at Call Receipt/Fixed Deposit Receipt of a Scheduled Bank/ Bank Guarantee of any Scheduled Bank against EMD (scan copy of the EMD is to be uploaded and original copy of EMD shall be deposited to the office of SE, IWD before the last date & time of opening of technical bid as specified in the bid document)
2	The scanned copy of duly signed Integrity Pact with date and seal
3	Letter of transmittal
4	Certificate of Financial Turnover for the last five years from Chartered Accountant (Form 'A') .
5	Banker's certificate from a Commercial Bank (Form 'B') or Certificate of Net worth from Chartered Accountant (Form 'B-1')
6	Details of eligible similar nature of works completed during the last seven years ending previous day of last date of submission of tenders (Form 'C')
7	Details of Projects under execution (Form 'C-1') .
8	Calculation sheet of Bidding capacity of Bidder in (Form 'C-3')
9	Performance report of works referred to in (Form 'D')
10	Assessment of Quality for Completed as well as ongoing works in (Form 'D-1') .
11	Structure & Organization (Form 'E') .
12	Receipt of deposition of Original EMD (Form 'F') .
13	Affidavit as per provision of CPWD-6 (Form 'G') .
14	GST Registration Certificate of the State in which the work is to be taken up, if already obtained by the bidder. If the bidder has not obtained GST registration in the State in which the work is to be taken up, Or as required by GST authorities then in such a case bidder shall furnish undertaking as given in Form-'H'
15	Enlistment order for CPWD enlisted contractors.
16	A self-certificate/declaration that Bidder have not been blacklisted or penalized any Central Government/State Government Offices/PSUs up to the last date of submission of bid.

Superintending Engineer

CPWD-6 FOR e-Tendering

The Superintending Engineer, IWD IIT Kanpur invites on behalf of Board of Governors, online percentage rate open bids from eligible firms/contractors of repute in two bid system (Eligibility cum Technical bid & Financial Bid) for the work of -

"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"

1. The work is estimated to cost **Rs. 119,75,10,345.00**. This estimate, however, is given merely as a rough guide.
2. The time allowed for carrying out of the work will be 18 Months from the date of start as defined in schedule 'F' or from the first date of handing over of the site, whichever is later, in accordance with the phasing, if any, indicated in the bid documents.
3. Intending bidders are eligible to submit the bid subjected to fulfilment of eligibility criteria as stipulated in this bid document.
4. Agreement shall be drawn with the successful bidders on prescribed Form No. **CPWD 7** which is available as a Govt. of India Publication and also available on website: www.iitk.ac.in/iwd/tenderhall.htm, <https://eprocure.gov.in/eprocure/app> his rates including all applicable taxes but **excluding GST** as per various terms and conditions of the said modified form which will form part of the agreement.
5. The time allowed for carrying out the work will be 18 months from the date of start as defined in schedule 'F' or from the first date of handing over of the site, whichever is later, in accordance with the phasing, if any, indicated in the bid documents.
6.
 - i) The site for the work is available.
 - ii) All the GFC (Architectural, structural & Electrical drawings work) drawings and details are available. Further details if any shall be made available in phased manner as per requirement of the same as per approved programme of completion submitted by the contractor after award of work.
7. The bid document consisting of Good of construction (Architectural, structural & Electrical, HVAC drawings work) drawing and details ,

specifications , the schedule of finishes of various items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents except Standard General Conditions of Contract -2023 for projects can be seen on website www.iitk.ac.in/iwd/tenderhall.htm, <https://eprocure.gov.in/eprocure/app> free of cost.

8. After submission of the bid the contractor can re-submit revised bid any number of times but before last time and date of submission of bid as notified.
9. While submitting the revised bid, contractor can revise the rate of one or more item(s) any number of times (he need not re-enter rate of all the items) but before last time and date of submission of bid as notified.
10. This bid is invited in two stage system.
1. a) Applicant has to deposit earnest money of **Rs. 129.75 Lacs** in the form of receipt/ Treasury Challan or Demand Draft or Pay order or Banker's Cheque or Deposit at Call Receipt or Fixed Deposit Receipt (drawn in favour of Director IIT Kanpur) along with tender document.
 - i. Earnest Money in the form of Treasury Challan or Demand Draft or Pay order or Banker's Cheque or Deposit at Call Receipt or Fixed Deposit Receipt (drawn in favour of the Director, IIT Kanpur) shall be scanned and uploaded to the e-Tendering website within the period of bid submission.
 - ii. **The original EMD shall be submitted in the hard copy to the office of the Superintending Engineer upto 14:30 on 03.07.2025.**
 - iii. **A part of earnest money (EM)** is acceptable in the form of bank guarantee also. In such case, **minimum** 50% of earnest money or Rs. 20 lac, whichever is less, **shall** have to be deposited in shape prescribed above, and balance **may be deposited in** shape of Bank Guarantee of any scheduled bank **having validity for six months or more from the last date of receipt of bids** which also is to be scanned and uploaded by the intending bidders

b) Copy of certificate of work experience and other documents as specified in the technical bid/eligibility bid document shall be scanned and uploaded to the e- Tendering website within the period of bid submission. Online qualification bid documents submitted by intending bidders shall be opened only of those bidders who have deposited Earnest Money & Integrity pact.

Online financial bid document submitted by the bidders shall be opened only of those bidders who on the basis of pre-qualification documents

uploaded by them within the period of bid submission, qualify in accordance with the provision of technical bid. The financial bid shall be opened at the notified time, date & place in presence of qualified bidders or their representative.

The technical (eligibility) bid submitted shall be opened at 15:00 PM on 03.07.2025

11. The bid submitted shall become invalid if:
 - a) The bidder is found ineligible.
 - b) The bidder does not deposit original EMD within due date and time in the office of the Superintending Engineer, IWD IIT Kanpur.
 - c) The bidder does not upload scanned copies of all the documents stipulated in the bid document.
 - d) If any discrepancy is noticed between the documents as uploaded at the time of submission of bid and hard copies as submitted physically by the lowest bidder in the office of bid opening authority.
 - e) If a bidder quotes NIL rates against each item in scheduled of quote of tender or does not quote any rate in any section/sub head in rate tender, the tender shall be treated as invalid and will not be considered as lowest tenderer.
12. The contractor whose bid is accepted will be required to furnish **performance guarantee of 5% (Five Percent)** of the bid amount within the period specified in Schedule F. This guarantee shall be in the form of Insurance Surety Bonds, Account payee Demand draft, Fixed deposit receipt or Bank Guarantee from any of the Commercial banks in accordance with the prescribed form. In case the contractor fails to deposit the said performance guarantee within the period as indicated in Schedule 'F', including the extended period if any, the Earnest Money deposited by the contractor shall be forfeited automatically without any notice to the contractor. **The earnest money deposited along with bid shall be returned after receiving the aforesaid performance guarantee.** The contractor whose bid is accepted will be also be required to furnish either copy of applicable licenses/registrations or proof of applying for obtaining labor licenses, registration with EPFO, ESIC and BOCW Welfare Board including provident fund code no. if applicable and also ensure the compliance of aforesaid provisions by the sub-contractors, if any engaged by the contractor for the said work and Programme Chart (Time and Progress) within the period specified in Schedule F.

13. Description of the work is as follows:

"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"

14. The competent authority on behalf of the Board of Governors, IIT Kanpur does not bind itself to accept the lowest or any other bid and reserves to itself the authority to reject any or all the bids received without the assignment of any reason. All bids in which any of the prescribed condition is not fulfilled or any condition including that of conditional rebate is put forth by the bidders shall be summarily rejected.
15. Canvassing whether directly or indirectly, in connection with bidders is strictly prohibited and the bids submitted by the contractors who resort to canvassing will be liable for rejection.
16. The competent authority on behalf of Board of Governors, IIT Kanpur reserves to himself the right of accepting the whole or any part of the bid and the bidders shall be bound to perform the same at the rate quoted.
17. **The bid for the works shall remain open for acceptance for a period of Ninety (90) days from the date of opening of technical bid.**

This notice inviting Bid shall form a part of the contract document. The successful bidders/contractor, on acceptance of his bid by the Accepting Authority shall **within 15 days from the stipulated date of start of the work, sign the contract** consisting of: -

- a) The Notice Inviting Bid, all the documents including additional conditions, specifications and drawings, if any, forming part of the bid as uploaded at the time of invitation of bid and the rates quoted online at the time of submission of bid and acceptance thereof together with any correspondence leading thereto.
- b) Standard C.P.W.D. Form 8 and GCC for Projects as amendment up to last date of submission of bid and or other Standard C.P.W.D. Form as applicable.
18. Temporary electrical connection at single point shall be provided by the Engineer-in-charge. The contractor has to provide the power cable, Electricity meter etc for release of power connection of the required load. The Electricity charges shall be recovered on the prevailing rates of the Institute.
19. The arrangement of water suitable to construction works as well as other

usage i/c testing of equipment will be arranged by the contractor at site at his own cost. The necessary approval for boring shall be taken by the contractor.

20. The contractor shall barricade the site confirming to CPCB and NGT guidelines to avoid any pollution at site and the surroundings to the subject building. The contractor's rate shall be deemed to be inclusive of the barricading of the site as per requirement of these bodies of Central Govt. Apart from this the contractor has to comply with the guidelines issued from time to time by UP State Govt. to ensure pollution control measures at site and surroundings at their own cost.

21. For Composite Bids

21.1.1 The Executive Engineer in charge of the major component will call bids for the composite work. The cost of bid document and Earnest money will be fixed with respect to the combined estimated cost put to tender for the composite bid.

21.1.2 The bid document includes following components:

PART A:- General Information.

- (i) Information And Instructions For Bidders For E-Tendering
- (ii) CPWD-6 for e-tendering.
- (iii) Section-I: Brief Particulars of work.
- (iv) Section-II: Information & Instructions for Bidders.
- (v) Section-III: Eligibility Documents and Evaluation Criteria consisting Form A to H for the major component of the work.
- (vi) CPWD-7 and General Conditions of Contract 2023 for construction projects as amended/modified up to previous day of last date of submission of bid.

PART B1: - General requirement/ Additional Conditions, General Terms & Conditions etc. and specific conditions, specifications and list of drawings applicable to major component of the work.

PART B2: -General Guidelines, Particular specifications and schedule of Finishes of the work.

PART B3:- Proforma of Guarantee Bonds.

PART B4: - List of Good for Construction (GFC) Drawings.

PART C:- Schedule A to F for minor component of the work. General/ specific conditions, and list of drawings applicable to minor component(s) of the Electrical works.

Schedule A to F for HVAC component of the work. General/ specific conditions, and list of drawings applicable to minor component(s) of the HVAC work.

PART D:- Schedule of financial quote

21.1.3 The bidders must associate himself, with agencies of the appropriate class eligible to bid for each of the minor component individually as per details given in respective minor component.

- 21.1.4 The eligible bidders shall quote rates for all items of major component as well as for all items of minor components of work.
- 21.1.5 After acceptance of the bid by competent authority, the SE shall issue letter of award on behalf of the Board of Governors. After the work is awarded, the main contractor will have to enter into one agreement with EE in charge of major component and has also to sign two or more copies of agreement depending upon number of EE's in charge of minor components. One such signed set of agreement shall be handed over to EE in charge of minor component (s), EE of major component will operate **Part A, Part B** and **Part D** of the agreement. EEs in charge of minor component(s) shall operate **Part C** along with **Part A** of the agreement.
- 21.1.6 Entire work under the scope of composite bid including major and all minor components shall be executed under one agreement.
- 21.1.7 Security Deposit will be worked out separately for each component corresponding to the estimated cost of the respective component of works.
- 21.1.8 The main contractor has to associate agency(s) for minor component (s) conforming to eligibility criteria as defined in the bid document and has to submit details of such agency (s) to Engineer-in-charge of minor component (s) within prescribed time. Name of the agency (s) to be associated shall be approved by Engineer-in-charge of minor component(s).
- 21.1.9 In case of main contractor intends to change any of the above agency/agencies during the operation of contract, he shall obtain prior approval of Engineer-in-charge of relevant specialized component (s). The new agency/agencies shall also have to satisfy the laid down eligibility criteria. In case Engineer-in-charge is not satisfied with the performance of any agency, he can direct the contractor to change the agency executing such items of work and this shall be binding on the contractor.
- 21.1.10 The main contractor has to enter into MOU with contractor(s) associated by him for execution of minor component(s). Copy of such MOU shall be submitted to EE/DDH in charge of each relevant component as well as to EE in charge of major component. In case of change of associate contractor, the main agency has to enter into MoU/agreement with the new contractor associated by him.
- 21.1.11 The requirement of technical staff given in various specialize works in Part-C (Electrical works) is in addition to the requirement given in clause 32 in Part-A of NIT. The actual deployment of these technical staff will be as per execution of work and direction of Executive Engineer, IWD, IIT Kanpur (U.P).
- 21.1.12 Running payment for the major component shall be made by EE of major discipline to the main contractor. Running payment for

minor components shall be made by the Engineer-in-charge of the discipline of minor component directly to the main contractor.

21.1.13 (a) **The composite work shall be treated as complete when all the components of the work are complete. The completion certificate of the composite work shall be recorded by Engineer-in-charge of major component after record of completion certificate of all other components.**

21.1.13 (b) Final bill of whole work shall be finalized and paid by the EE of major component. Engineer (s) in charge of minor component (s) will prepare and pass the final bill for their component of work and pass on the same to the EE of major component for including in the final bill for composite contract.

22. The intending bidders are required to upload their bids well in advance of last date of submission of tender. Any issue related to uploading tender can be resolved through the Executive Engineer, IWD, IIT Kanpur (U.P). website: www.iitk.ac.in/iwd/tenderhall.htm, <https://eprocure.gov.in/eprocure/app>. The e-tendering bidders are also advised not to wait to raise any issues till the last date of submission of bid in their own interest.

Superintending Engineer

SECTION- I
BRIEF PARTICULARS OF THE WORK

- 1. Salient details of the work for which bids are invited are as under:**

Sl. No.	Name of work	Estimated Cost	Period of completion
1.	"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"	Rs.119,75,10,345/-	18 Months
	Total	Rs.119,75,10,345/-	

- 2. The work is situated inside IIT campus Kanpur, (UP) Pin: 208016.**
- 3.** The scope of works includes complete execution of work with Modular Aluminium Formwork Shuttering System (MAFSS) by using Aluminium Formwork including foundation, superstructure, Finishing, Internal & External Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) and etc. complete in all respects to big the building habitable and handing over the assets to the Institute.
The work is to be executed on percentage rate as per tender drawings attached with the tender documents. The cost of labour, material, tools & plants, machinery, taxes, incidentals etc. required for execution of the whole project as per approved layout plan and detailed drawings, specifications, schedule of finishes and terms and conditions mentioned in the bid document are within the scope of this work. The brief scope of work is as follows: -
- 4. General features and major components of the work are as under:**
- (i) The proposed work includes **"Construction of Hall of Residence**

No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)" on percentage basis. having total Plinth Area 32733 sq. mtr including stilt floor area as per GFC drawings approximately. The scope of work also includes related Civil, Electrical & Mechanical work and External Development work including all incidental works as shown in the GFC drawings.

- (ii) The project site is located within the campus of **IIT Kanpur (U.P.)**.
- (iii) The work is to be executed on percentage rate basis.
- (iv) Modular Aluminium Formwork Shuttering System (MAFSS) by using Aluminium Formwork shall be adopted.
- (v) The architectural and engineering design and drawings for the work have been prepared and attached with bid document.
- (vi) All the buildings are to be constructed by adopting Modular Aluminium Formwork Shuttering System (MAFSS) by using Aluminium Formwork. Contractor shall be required to execute the work as per tender drawings and specification and schedule of finishes mentioned in bid documents for all Civil, Electrical and External development works and services i.e Internal Roads, paths, construction of Underground water tank, water supply system, sewer lines, storm water drains, Rain water harvesting system, street lighting, firefighting and fire alarm system, Lifts, HT/LT Panels, cable and cable laying in underground pipe/conduits/ ducts including feeder pillars & related items, CCTV and EPBAX System, Laying and Installation of Telephone cable, optical fire cable, all other Civil, MEP and incidental works as per tender drawings and also detailed working drawings, if any as per requirement of work, issued by Engineer-in-charge during execution of work and also as per detailed items, specifications and other details elaborated in this bid document complete in all respect within the area specified in the layout drawing.
- (vii) Contractor has to complete the buildings in all respects and make them habitable and hand over to Engineer-in-charge.
- (viii) The working drawings/GFC drawings i.e. Architectural, Structural, Services, E & M development drawings and details are attached with bid documents. The execution shall be done by the contractor based on these working drawings which are part of tender document.
- (ix) CPWD specifications, relevant IS codes, National building code 2016, CPWD green rating manual 2021, Griha Rating standards specifications shall be followed in general except otherwise mentioned in bid document. Manufacturer's specification shall be followed in case of item for which provision is not available in above said documents.
- (x) **Electrical & Mechanical works:** Details of E & M works are given in

part C of the tender document.

- (xi) Samples of the materials of approved make or otherwise shall be got approved from the Engineer-in-charge before use in the work.
- (xii) Shifting / Removal of services and statutory Approvals: Contractor shall take all necessary measures required to be taken to remove any dead service lines running through the plot area, cutting/ shifting of trees etc, without any extra cost. After completion of the work and commissioning of building(s) along with services, he shall assist as required for all statutory inspections and approvals, The Contractor shall seek and provide help in obtaining statutory approvals for all Electrical and Lift Installations. The Contractor shall be bound to abide by all the clauses of all statutory and other approvals.
- (xiii) Provisional Fire NOC will be applied & obtained by the IIT Kanpur and final Fire NOC shall be obtained by the contractor before completion & handing over the work to the Engineer-in-charge.
- (xiv) Other Works: Apart from above mentioned works following works are also
under the scope of tender:
 1. Contractor shall prepare and submit shop drawings for approval, wherever required as per the detail/ typical detail provided and layout drawings for all related civil & electrical services, duly supported with design as required by Engineer-in-charge.
 2. Contractor shall submit item wise detailed measurements of all items, for record and other purpose following CPWD specifications and method of measurement.
 3. After completion of the work contractor shall submit as built drawings in hard and soft copies along with final Bills of all Civil, Electrical and Mechanical services in Auto CAD including five sets of coloured drawings on A0/A1 size. AUTOCAD Drawings will be provided to contractor for preparation of as built drawing. These drawing will solely be used for the purpose of preparation of as built drawings.
- (xv) Scope of work as mentioned above is indicative and not exhaustive. Execution of all the items, sub items of work as shown on the GFC drawings/ mentioned in the tender documents are within the scope of work, unless specifically excluded.
- (xvi) **Tender Drawings:** The Good for construction (GFC) drawings and their list attached with this NIT are part of this bid document. Contractor shall execute and complete all works as per these drawings and details given elsewhere in this bid document.

SECTION- II

INFORMATION & INSTRUCTIONS FOR BIDDERS

1.0 General:

The Indian Institute of Technology, Kanpur, is an institution of premier National importance situated at Kanpur **"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"** It is a very prestigious and time-bound project being monitored by the highest authority.

Important Note: The construction conditions and milestones have been specifically drafted to complete the project in time.

- 1.1** Letter of transmittal and forms for deciding eligibility are given in Section III.
- 1.2** All information called for in the enclosed forms should be furnished against the relevant columns in the forms. If for any reason, information is furnished on a separate sheet, this fact should be mentioned against the relevant column. Even if no information is to be provided in a column, a **"nil" or "no such case"** entry should be made in that column. If any particulars/query is not applicable in case of the bidder, it should be stated as **"not applicable"**. The bidders are cautioned that not giving complete information called for in the application forms or not giving it in clear terms or making any change in the prescribed forms or deliberately suppressing the information may result in the bid being summarily disqualified. Bids made by telegram or telex and those received late will not be entertained.
- 1.3** The bid should be type- written. The bidder should sign with seal each page of the application.
Overwriting should be avoided. Correction, if any, should be made by neatly crossing out, initiating, dating and rewriting. Pages of the eligibility criteria document are numbered. Additional sheets, if any added by the contractor, should also be numbered by him. They should be submitted as a package with signed letter of transmittal.
- 1.4** References, information and certificates from the respective clients certifying suitability, technical knowledge or capability of the bidder should be signed by an officer not below the rank of Executive Engineer or equivalent.
- 1.5** The bidder may furnish any relevant additional information which he thinks is necessary to establish his capabilities to successfully complete the envisaged work. He is, however, advised not to furnish superfluous

information. No information shall be entertained after submission of eligibility criteria document unless it is called for by the Employer.

- 1.6** If private works are shown in support of eligibility, certified copy of the tax deducted at source certificate (TDS) shall be submitted along with the experience certificate and the TDS amount shall tally with the actual amount of work done.

2.0 Definitions:

- 2.1** In this document the following words and expressions have the meaning hereby assigned to them.

- 2.2 Employer:** Means the Board of Governors, IIT Kanpur, acting through the **Superintending Engineer, IWD IIT Kanpur.**

- 2.3 Bidder and/or contractor:** Means the individual, proprietary firm, firm in partnership, limited company private or public or corporation.

- 2.4 "Year"** means "Financial Year" unless stated otherwise.

3.0 Method of application:

- 3.1** If the bidder is an individual, the application shall be signed by him above his full type written name and current address.

- 3.2** If the bidder is a proprietary firm, the application shall be signed by the proprietor above his full type written name and the full name of his firm with its current address.

- 3.3** If the bidder is a firm in partnership, the application shall be signed by all the partners of the firm above their full type written names and current addresses, or, alternatively, by a partner holding power of attorney for the firm. In the latter case a certified copy of the power of attorney should accompany the application. In both cases a certified copy of the partnership deed and current address of all the partners of the firm should accompany the application.

- 3.4** If the bidder is a limited company or a corporation, the application shall be signed by a duly authorized person holding power of attorney for signing the application accompanied by a copy of the power of attorney. The bidder should also furnish a copy of the Memorandum of Articles of Association duly attested by a Public Notary.

4.0 Final decision-making authority.

The employer reserves the right to accept or reject any bid and to annul the process and reject all bids at any time, without assigning any reason or incurring any liability to the bidders.

5.0 Particulars provisional

The particulars of the work given in Section I are provisional. They are

liable to change and must be considered only as advance information to assist the bidder.

6.0 Site visit

The bidder is advised to visit the site of work, at his own cost, and examine it and its surroundings to himself collect all information that he considers necessary for proper assessment of the prospective assignment.

7.0 Initial criteria for eligibility

7.1 The contractors to fulfill the following requirements shall be eligible to apply.
Joint ventures and special Purpose Vehicles are not accepted.

A) Bidder should have satisfactory completed works as mentioned below, during the last seven years ending previous day of last date of submission of tenders. For this purpose cost of work shall mean gross value of the completed work. This should be certified by an officer not below the rank of Executive Engineer / Project Manager or equivalent. In case of works executed for private organizations, the certificate shall be signed by the chief consultant and countersigned by the owner of the Project.

(i) Three similar works each costing not less than Rs **4790.0** lacs

OR

(ii) Two similar works each costing not less than Rs **7185.0** lacs

OR

(iii) One similar work costing not less than Rs **9580.0** lacs.

AND

One complete work costing not less than Rs **4790.0** lacs with some Central Government department / Central autonomous body / central public sector undertaking.

Similar work shall mean Construction of building in RCC framed structure having minimum one building of eight storied or completing balance construction work of one building (including structural work) minimum upto eight storey including internal water supply, sanitary installation, Internal Electrical Installations all executed under one agreement. The eight storied building should have Firefighting System or lift or Fire alarm system or HVAC (Low side) executed under the said agreement.

Note:

1. Mumty and machine room will not be counted as storeys for this purpose.

2. For this purpose, each basement, stilt constructed in the building shall be considered as a storey.
 3. Complete set of TDS certificate (Form 16A) shall be uploaded in case the similar work is executed for a private body, which shall form basis for establishing the completion cost of work executed.
 - a) The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of tenders.
- If private works shown in support of eligibility, certified copy of the Tax deducted at source TDS Certificate (Form 16 A & 26 AS) shall be submitted along with the Experience Certificate and the TDS amount shall tally with the actual amount of work done. Otherwise, the amount that tally with TDS shall only be considered for eligibility.

One completed work costing not less than 20% of the estimated cost executed with the Modular Aluminium Formwork Shuttering System (MAFSS) as proposed by the bidder. This work can be part of eligible work or as a separate work. The details have to be submitted by the bidder as per Form 'I' during the last seven years ending the last day of month previous to the one in which the tender is invited.

If the bidder does not have adequate experience of opted technology, then the bidder can associate the contractor having requisite experience of the executed work in the in structural system with the opted technology. The bidder has to submit MOU and form 'I' with such associate contractor, along with his tender, for Modular Aluminium Formwork Shuttering System (MAFSS) only. The associated contractor must satisfy the eligibility criteria of having successfully completed one work of opted technology having the cost of structural system not less than 20% of the estimated cost put to tender during the last seven years ending the last day of month previous to the one in which the tender is invited.

The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of tenders.

(b). The Bidder should have had Average Annual Financial Turnover of **Rs 3592.53 lacs** on Civil & Electrical construction works during the last three years ending 31st March 2024 (Scanned copy of Certificate from CA with Unique Document Identification Number (UDIN) to be uploaded). The value of annual turnover figures shall be brought to the current value by enhancing the actual turnover figures at simple rate of 7% per annum.

(c). The Bidder should not have incurred any loss (profit after tax should be positive) in more than two years during available last 05 (five) consecutive balance sheets (Standalone financial statement) duly audited and certified by the Chartered Accountant.

(d). The Bidder should have a Banker's Certificate from a commercial Bank for **Rs. 4790.00** lacs or Net Worth Certificate of minimum Rs. **1197.50** Lacs from CA with Unique Document Identification Number (UDIN) (Scanned copy of original to be uploaded).

(e). The Bidder should have bidding capacity equal to or more than the estimated cost of the work put to tender. The bidding capacity shall be worked out by the following formula:

$$\text{Bidding Capacity} = \{[A \times N \times 1.5] - B\}$$

Where,

A = Maximum turnover in construction works executed in any one year during the last seven years taking into account the completed as well as works in progress. The value of completed works shall be brought to current costing level by enhancing at a simple rate of 7% per annum.

N = Number of years prescribed for completion of work for which bids have been invited.

B = Value of existing commitments and outgoing works to be completed during the period of completion of work for which bids have been invited.

7.2 The bidder should have sufficient number of Technical and Administrative employees for the proper execution of the contract. The bidder shall have to submit a list of these employees stating clearly how these would be involved in this wo within **15 days of award of work**.

7.3 The bidder's performance for each work completed in the last seven years should be certified by an officer not below the rank of Executive Engineer or equivalent.

8.0 Evaluation criteria

8.1 The detailed submitted by the bidders will be evaluated in the following manner:

- 8.1.1 The initial criteria prescribed in para **7.0** above in respect of experience of eligible similar works completed, loss (Profit after tax), solvency, financial turn over, bidding capacity, etc. will first be scrutinized and the bidder's eligibility for the work be determined.
- 8.1.2 The bidders qualifying the initial criteria as set out in para 7.0 above will be evaluated for following criteria by scoring method on the basis of details furnished by them and on the basis of inspection of ongoing and completed work carried out by the scrutiny committee duly constituted by the Director, IIT Kanpur.

(a)	Financial strength (Form 'A' & 'B')	Maximum 20 marks
(b)	Experience in eligible similar nature of work during last seven years (Form 'C')	Maximum 20 marks
(c)	Performance on works (Form 'D') – Time over run	Maximum 20 marks
(d)	Performance on works (Form 'D-1') – Quality	Maximum 40 marks
		Total 100 marks

To become eligible for short listing the bidder must **secure at least fifty percent marks in each (section a, b, c & d) and sixty percent marks in aggregate.**

The department, however, reserves the right to restrict the list of such qualified contractors to any number deemed suitable by it.

Note- The average value of performance of works for time over run and quality for completed works shall be taken on the basis of performance report and on the basis of inspection of ongoing and completed work carried out by the scrutiny committee duly constituted by the Director, IIT Kanpur of the eligible similar works.

Evaluation of performance

Evaluation of the performance of contractors for the eligibility shall be done by the scrutiny committee. All the eligible Similar Works executed and submitted by the bidders may be got inspected by the committee. The marks for the quality shall be given based on this inspection, if inspection is carried out.

Scoring method of evaluation:

The scoring for evaluation mentioned in these columns shall be done as given in Annexure-1.

9.0 Financial information

Bidder should furnish the following financial information:

1. Annual financial statement for the last five year in (**Form "A"**) and
2. Banker's certificate in (**Form "B"**)

or

Net worth certificate in (**Form- "B-1"**)

10.0 Experience in works highlighting experience in similar works.

10.1 Bidder should furnish the following:

- (a) List of eligible similar nature of work successfully completed during the last seven years in (**Form "C"**) and ongoing works as well in (**Form-C-1**).
- (b) Performance reports (corresponding to work mentioned in Form – C1) in Form-D1 (information in FORM-D should be complete & no completed work of more than Rs 4000 lacs (as mentioned in FORM-C) should be left out).

For eligible private works of similar nature, form 16A and form 26AS (i.e work done for private client) needs to be necessarily uploaded by the bidder as a proof of actual amount of work done by the bidder and paid by the private client.

The eligible Private/Government/PSU works as given under letter of Transmittal and form C may be got inspected by committee constituted by NIT approving authority for verification of completion of work and quality of work. The grading recorded by the committee shall be considered final for evaluation of the performance of the contractor.

11.0 Organisation information

Bidder is required to submit the information in respect of his organization in Form "E".

12.0 Letter of transmittal

The bidder should submit the letter of transmittal attached with the document.

13.0 Opening of Price bid

After evaluation of Pre-Qualification Documents, a list of short listed agencies will be prepared. Thereafter the financial bids of only the qualified and technically acceptable bidders shall be opened at the notified time, date and place in the presence of the qualified bidders or their representatives.

14.0 Award criteria

- 14.1** The employer reserves the right, without being liable for any damages or obligation to inform the bidder, to:
- (a) Amend the scope and value of contract to the bidder.
 - (b) Reject any or all the applications without assigning any reason.
- 14.2 Any effort on the part of the bidder or his agent to exercise influence or to pressurize the employer would result in rejection of his bid. Canvassing of any kind is prohibited.

SECTION- III

**Eligibility Documents and Evaluation
Criteria**

ANNEXURE- 1

CRITERIA FOR EVALUATION OF THE PERFORMANCE OF CONTRACTORS FOR PRE-ELIGIBILITY

Attribut es	Sub attributes	Marks	Evaluation Criteria			
(a)	Financial Strength	20 marks	60% marks for minimum eligibility criteria. 100% marks for twice the minimum eligibility criteria or more Pro-rata basis in between (i) & (ii)			
	Average Annual Turnover	16 Marks				
	Banker’s Certificate OR Net worth certificate	4 Marks				
(b)	Experience in Similar class of Works	20 Marks	60% marks for minimum eligibility criteria. 100% marks for twice the minimum eligibility criteria or more Pro-rata basis in between (i) & (ii)			
(c)	Performance on Works					
	Parameter calculation for points	Score	Maximum Marks			
	If TOR=	1.0	2.0	3.0	>3.50	20
	(i) Without levy of compensation	20	15	10	10	
	(ii) With Levy of compensation	20	5	0	-5	
	(iii) Levy of compensation not decided	20	10	0	0	
	TOR = AT/ST, where AT=Actual Time; ST=Stipulated Time (+) Justified Period of Extension of Time.					
(d)	Performance of works (quality) as per assessment in Form- 'D-1' (40 Marks)					
	Completed works (Maximum 25 Marks)	Ongoing works (Maximum 15 Marks)	Total marks Assessed			

**INFORMATION REGARDING ELIGIBILITY
LETTER OF TRANSMITTAL**

From

To,

**The Superintending Engineer
IWD, IIT, Kanpur**

Name of work: "Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"

Sir,

Having examined the details given in press notice and bid document for the above work, I/we hereby submit the relevant information.

1. I/we hereby certify that all the statement made and information supplied in the **enclosed forms A to H** and accompanying statement are true and correct.
2. I/we have furnished all information and details necessary for eligibility and have no further pertinent information to supply.
3. I/we submit the requisite certified Bankers certificate and authorize the **Superintending Engineer, IWD IIT Kanpur** to approach the Bank /Chartered Accountant issuing the Bankers certificate/ correctness thereof. I/we also authorize **Superintending Engineer, IWD IIT Kanpur** to approach individuals, employers, firms and corporation to verify our competence and general reputation.
4. I/we submit the following certificates in support of our suitability, technical knowledge and capability for having successfully completed the following **eligible similar** works:

<i>Sl. No.</i>	<i>Name of work</i>	<i>Certificate from</i>
<i>1</i>		
<i>2</i>		

Certificate:

It is certified that the information given in the enclosed eligibility bid of are correct. It is also certified that I/we shall be liable to be debarred, disqualified / cancellation of enlistment in case any information furnished by me/us found to be incorrect.

Enclosures:

Seal of bidder

Date of submission:

Signature(s) of Bidder(s).

FORM 'A'

FINANCIAL INFORMATION

1. Financial Analysis – Details to be furnished duly supported by figures in balance sheet/ profit & loss account for the last five years duly certified by the Chartered Accountant, as submitted by the applicant to the Income Tax Department. (Copies to be attached).

Financial Year

Year	2019-20	2020-21	2021-22	2022-23	2023-24
Gross Annual turnover on construction works					
Profit / Loss. (Standalone Financial Turnover)					

2. Financial arrangements for carrying out for proposed work.

Signature of Chartered Accountant with Seal

Signature of Bidder(s).

*** The bidder should give information strictly in above format.**

FORM "B"

BANKER'S CERTIFICATE FROM A COMMERCIAL BANK

This is to certify that to the best of our knowledge and information that
M/s./Sh..... having marginally noted
address,.....
.....as a customer of our bank are/is respectable and can be treated as good
for any engagement up to a limit of Rs (Rupees
.....) This certificate is issued
without any guarantee or responsibility on the bank or any of the officers.

(Signature)
for the Bank

NOTE:

1. Banker's certificates should be on letter head of the Bank, addressed to tendering authority.
2. In case of partnership firm, certificate should include names of all partners as recorded with the Bank.
3. Banker's certificate should not be more than **6 months old**.

FORM "B-1"

CERTIFICATE OF NET WORTH FROM CHARTERED ACCOUNTANT

"It is to certify that as per the audited Balance Sheet and Profit & Loss account during the financial year, the net worth of M/s./Sh.....(Name & Registered Address of individual/firm/company) as on.....(the relevant date) is Rs.....after considering all liabilities.. It is further certified that the net worth of the company has not eroded by more than 30% in the last three years ending on (the relevant date)"

Unique Document Identification Number (UDIN).....

Signature of Chartered Accountant.....

Name of the Chartered Accountant.....

Membership No. of ICAI

Date & Seal

FORM 'C'
DETAILS OF ELIGIBLE SIMILAR NATURE OF WORKS COMPLETED
DURING THE
LAST SEVEN YEARS ENDING LAST DAY OF THE MONTH PREVIOUS
TO THE MONTH IN WHICH TENDERS ARE INVITED.

Sl. No	Name of work/project and location	Owner of sponsoring organization	Cost of work In Cr. of Rupees	Date of commencement as per contract	Stipulated date of completion	Actual date of completion	Litigation/arbitration cases pending /in progress with	Name and address /telephone number of officer	Whether the work was done on back to back basis Yes/No
1	2	3	4	5	6	7	8	9	10

* Indicate gross amount claimed and amount awarded by the Arbitration Tribunal.

Signature of Bidder(s)

Note: The agency should give list of only those eligible works which are of 'SIMILAR NATURE'.

FORM 'C-1'
PROJECTS UNDER EXECUTION

Sl. No	Name of work / project and Location	Owner or sponsoring organization	Cost of work in crore of Rupees	Date of commencement as per contract	Stipulated date of completion	Up to date percentage progress of work	Slow progress if any and reasons thereof	Name and address (Postal address & E-mail) / Mobile number of officer to whom reference may be made.	Remark
1	2	3	4	5	6	7	8	9	10

Signature of Bidder(s)

FORM 'C-3'**CALCULATION OF BIDDING CAPACITY****Details of existing commitments and ongoing works.**

Sl.No.	Name of work / project and Location	Owner or sponsoring organization	Contract value in crore of Rupees	Date of commencement as per contract	Stipulated date of completion	Up to date percentage progress of work	Remaining work in percentage (100- column7)	Existing commitment Column 4x Column 8/100 to be made	Name and address / Telephone Number of officer to whom reference may be made.	Remarks
1	2	3	4	5	6	7	8	9	10	11
Total (B) = Maximum turnover in last seven years Updated value of turnover (A) No. of years (N) Bidding Capacity = $\{[AxNx1.5]-B\}$ = Certificate: I certify that all the awarded and ongoing works have been included in the above list. (Signature of Bidder(s))										

FORM 'D'

PERFORMANCE REPORT OF WORKS REFERRED TO IN FORMS "C"

1. Name of work/project & location:.....
2. Agreement no.....
3. Estimated cost:.....
4. Tendered cost:.....
5. Value of work done.....
6. Date of start:.....
7. Date of completion:.....
8. Stipulated date of completion:.....
9. Actual date of completion:.....
 - (a) Whether case of levy of compensation for delay has been decided or not Yes/No compensation levied for delayed completion, if any:
 - (b) If decided, amount of compensation levied for delayed completion, if any:
10. Performance Report:
 - (a) Quality of work: Outstanding / Very Good / Good /Poor
 - (b) Financial soundness: Outstanding / Very Good / Good /Poor
 - (c) Technical Proficiency: Outstanding / Very Good / Good /Poor
 - (d) Resourcefulness: Outstanding / Very Good / Good /Poor
 - (e) General Behavior: Outstanding / Very Good / Good /Poor

Dated:

Executive Engineer or Equivalent

Note: If Name of Work is not clearly defining scope of work as specified in the definition of similar work, bidders are advised to upload copy of Agreement/ final bill or any other relevant document in support of their proposed completed work conforming to the definition of similar work.

FORM 'D-1'

Assessment of Quality for Completed as well as Ongoing Works:

Name of work :
 Date of Inspection :
 Date of submission of report :

A. General observations & Operational Aspects			Yes/No
1.	Availability of approval from local bodies in case of Construction of Private Buildings.		
2.	Availability of approved structural drawings.		
3.	Observation on seepage/leakage in the building.		
4.	Whether Line & level maintained.		
5.	In case of basement, observation on seepage, if any.		
6.	Any Structural defects/ distress observed, if yes give details.		
7.	Whether safety measures adopted at site as per CPWD safety code of Govt. guidelines are adequate or not.		
8.	Whether the welfare facilities provided to labor as per Clause-19H of GCC for CPWD works / and or Govt. guidelines are adequate or not		
9.	Whether AHU getting automatically switched off and fire dampers closed in case of fire signal		
10.	Whether thimbles used for termination of wires in DBs, EBDs and panels		
B. Quality of work		Maximum Marks	Marks Assessed
1.	Quality of plaster / finishing	10	
2.	Quality of RCC / CC work	10	
3.	Quality of Flooring	10	
4.	Quality of Wood Work	10	
5.	Quality of Steel work / Aluminum Work	10	
6.	Quality of Plumbing and Sanitary Installation	10	
7.	Quality of Workmanship	10	
8.	Quality of Water Proofing	10	
9.	If cladding done, observation on efficiency / quality of cladding / brick work	10	
10.	Quality of internal electrification work	10	
11.	Quality of DBs, EBDs & Panels	10	
12.	Quality of E&M equipment's, panels & feeder pillar	10	
13.	Quality of Fire alarm system / firefighting system	10	
14.	Quality of Air Conditioning work	10	
15.	Quality of Substation based on complete live diagram, capacitor panel, power factor, insulating mat, cleanliness, cable termination earthing pits, earthing of transformer/DG sets	10	
16.	Any other aspect (To be elaborated)	10	

Average marks (to be awarded out of 100 marks based on average of marks assessed on each attribute mentioned at B above). Note:- 1. All the above parameters may be considered for assessing the overall quality of work executed by the contractor. Each attribute shall be assessed on maximum marks of 10 under B above. 2. In case, any attribute is not applicable, the same may not be included in assessment and mentioned as not applicable (N/A) 3. The works as assessed above shall be converted on a scale of 25/15 marks for completed/ ongoing works respectively. 4. In case of eligible completed works being more than one the average marks assigned for eligible completed works shall be considered for marking purpose. Only one ongoing work to be assessed.	

FORM "E"

STRUCTURE & ORGANISATION

1. Name & address of the bidder
2. Telephone no. /Telex no. /Fax no.
3. Legal status of the bidder (attach copies of original document defining the legal status)
 - (a) An Individual
 - (b) A proprietary firm
 - (c) A firm in partnership
 - (d) A limited company or Corporation
4. Particulars of registration with various Government Bodies (attach attested photocopy)

**Organisation/Place of registration
No.**

Registration

- 1.
- 2.
- 3.
5. Names and titles of Directors & Officers with designation to be concerned with this work.
6. Designation of individuals authorized to act for the organization.
7. Has the bidder, or any constituent partner in case of partnership firm Limited **Company/Joint Venture**, ever been convicted by the court of law? If so, give details.
8. In which field of Civil Engineering construction, the bidder has specialization and interest?
9. Any other information considered necessary but not included above.

Signature of Bidder(s)

FORM 'F'

RECEIPT OF DEPOSITION OF ORIGINAL EMD

(Receipt

No.....#...../date.....#.....)

- 1. Name of work: "Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"NIT No.:_28/Composite/CO/2025-26**
- 2. Estimated cost:**
- 3. Amount of Earnest money Deposit:**
- 4. Last date of submission of Bid:**

Name of Contractor:#.....

1. Form of EMD.....#.....

2. Amount of Earnest Money Deposit.....#.....

3. Date of submission of EMD.....#.....

.....

.....

Signature, Name and Designation of EMD
receiving officer (EE/AE(P)/AE/AAO) alongwith Officer stamp

To be filled by EE receiving EMD.

FORM "G"

Affidavit as per provision of CPWD-6

I/We undertake and confirm that eligible similar works(s) has/have not been got executed through another contractor on back to back basis. Further that, if such a violation comes to the notice of the Department, then I/we shall be debarred for bidding in IIT Kanpur in future forever. Also, if such information comes to the notice of department on any day before date of start of work, the Engineer-in-charge shall be free to cancel the agreement and to forfeit the entire amount of Earnest Money Deposit/Performance Guarantee.

NOTE: *Affidavit to be furnished on a 'non-judicial' stamp paper worth Rs.100/-*

Signature of Bidder(s) or
an authorized Officer of
the firm with stamp

Signature of Notary with seal

FORM 'H'

Declaration about Site Inspection

(By Bidder)

To

The Executive Engineer,

IWD, IIT,

Kanpur

Subject: "Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"

Dear Sir/Madam,

It is hereby declared that as per terms and conditions of this tender document, I/ We the bidder inspected and examined the subject site and its surrounding and satisfy myself / ourselves as to the nature of the ground and sub-soil (so far as is practicable), the forms and nature of the site./ ourselves before submitting the bid, the accommodation which may require and all necessary information as to risks, contingencies and other circumstances which may influence or affect our bid have been obtained. I/We the bidder shall have full knowledge of the site and no extra charge consequent upon any misunderstanding or otherwise shall be claimed in later date. I /We bidder shall be responsible for arranging and maintaining at own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by me/us implies that I / We have read this notice and all other contract documents and has made myself /ourselves aware of the scope and specifications of the work to be done and local conditions and other factors having a bearing on the execution of the work.

Sincerely

(Duly authorized signatory of the Bidder)

FORM 'I'

CERTIFICATE OF EXPERIENCE IN SUPPORT OF HAVING SUCCESSFULLY COMPLETED ONE WORK WITH THE MODULAR ALUMINIUM FORMWORK SHUTTERING SYSTEM (MAFSS) PROPOSED TO BE USED IN THE WORK

1. Name of work/project and location:
2. Owner or sponsoring organization :
3. Cost of work in crore of rupees :
4. Date of commencement as per contract:
5. Stipulated date of completion :
6. Actual date of completion :
7. Type of structural system Technology used :
8. Litigation/ arbitration cases pending/ in progress with details :
9. Name and address/ telephone number of officer to whom reference may be made:
10. Whether the work was done on back to back basis (yes/no) :

Certified that M/s..... has completed the above work with the structural system technology as per details mentioned above.

To be signed with date and seal of the owner/
Sponsoring organization

SECTION-B

PART-A

FINANCIAL BID

INDIAN INSTITUTE OF TECHNOLOGY, KANPUR
INSTITUTE WORKS DEPARTMENT
CENTRAL OFFICE

Percentage Rate Tender

Tender for the work of: **"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"**

- (i) Last date and time of technical and financial bid for online submission of e-tenders is up to 15:00 PM on 01.07.2025.
- (ii) Time and Date of opening of technical bid in presence of tenders who may be present on 15:00 PM on 03.07.2025 in the office of the Superintending Engineer, IWD, IIT Kanpur.
- (iii) The pre-qualification bids shall be opened first on due date and time as mentioned above. The time and date of opening of financial bid of contractors qualifying the technical bid shall be communicated to them at later date.

TENDER

I/We have read and examined the notice inviting tender, schedule, A, B, C, D, E & F Specifications applicable, Drawings & Designs, General Rules and Directions, Conditions of Contract, clauses of contract, Special conditions, Schedule of Rate & other documents and Rules referred to in the conditions of contract and all other contents in the tender document for the work.

I/We hereby tender for the execution of the work specified for the Board of Governor, IIT Kanpur within the time specified in Schedule 'F' viz., schedule of quantities and in accordance in all respect with the specifications, designs, drawing and instructions in writing referred to in Rule-1 of General Rules and Directions and in Clause 11 of the Conditions of contract and with such materials as are provided for, by, and in respect of accordance with, such conditions so far as applicable.

We agree to keep the tender open for **ninety (90) days** from the due date of its opening and not to make any modification in its terms and conditions.

A sum of **Rs 129.75 Lacs** is hereby forwarded in cash/receipt treasury challan/ deposit at call receipt of a scheduled bank/fixed deposit receipt of scheduled bank/demand draft of a scheduled bank/bank guarantee issued by a scheduled bank as earnest money. If I/We, fail to furnish the prescribed performance guarantee within prescribed period. I/We agree that the said President of India or his successors, in office shall without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money absolutely. Further, if I/We fail to commence work as specified, I/We agree that Board of Governor, IIT Kanpur or the successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and the performance guarantee absolutely, otherwise the said earnest money shall be retained by him towards security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to those in excess of that limit at the rates to be determined in accordance with the provision contained in Clause 12.2 and 12.3 of the tender form. Further, I/We agree that in case of forfeiture of Earnest Money & Performance Guarantee as aforesaid. I/We shall be debarred for participation in the re-tendering process of the work.

I/We undertake and confirm that eligible similar work(s) has/have not been got executed through another contractor on back to back basis. Further that, if such a violation comes to the notice of Department, then I/We shall be debarred for tendering in IWD, IIT Kanpur in future forever. Also, if such a violation comes to the notice of Department before date of start of work, the Engineer-in-Charge shall be free to forfeit the entire amount of Earnest Money Deposit/Performance Guarantee.

I/We hereby declare that I/We shall treat the tender documents drawings and other records connected with the work as secret/confidential documents and shall not communicate information/derived therefrom to any person other than a person to whom I/We am/are authorized to communicate the same or use the information in any manner prejudicial to the safety of the State.

Dated :

Signature of Contractor

Witness

Postal Address

Address:

Occupation:

ACCEPTANCE

The above tender (as modified by you as provided in the letters mentioned hereunder) is accepted by me for an on behalf of the Board of Governors, IIT Kanpur for a sum of Rs..... (Rupees

.....
.....).

The letters referred to below shall form part of this contract agreement:

- (a)
- (b)
- (c)

For & on behalf of Board of Governors, IIT Kanpur

Signature.....
.....

Dated:
.....

Designation

Pre-Contract Integrity Pact
(Applicable for all tenders of the value above Rs.1 Crore)

General

This pre-bid pre-contract Agreement (hereinafter called the Integrity Pact) is made on _____ day of the month of _____ 202__.

BY AND BETWEEN

The Indian Institute of Technology Kanpur represented through "The Registrar", having its office located at G.T. Road, Kalyanpur, Kanpur, Uttar Pradesh – 208016 (hereinafter called the "BUYER", which expression shall mean and include, unless **the** context otherwise requires, his successors in office and assigns) of the **First Party**;

AND

M/s _____ a
company incorporated under the Companies Act, 2013 through its representative/authorized signatory (insert name and designation of the officer) vide resolution dated _____ passed by the Board of Directors, having its registered office at _____

(hereinafter referred to as "The Bidder(s)/Contractor(s)" which terms or expression shall, unless excluded by or repugnant to the subject or context, mean and include its successor-in-office, administrators or permitted assignees) of the **Second Party**;

WHEREAS, the Institute/Buyer has floated the Tender bearing No. 28/composite/co/2025-26 (hereinafter referred to as "**Tender/Bid**") and intends to award, under laid down organization procedures, contract(s) for Construction of Hall of Residence No-15 for girls (U+12) at IIT Kanpur (Name of the work/goods/ services). The Institution values full compliance with all relevant laws of the land, rules, regulations, economic use of resources and of fairness/transparency in its relations with its Bidder(s) and/or Contractor(s).

AND WHEREAS, the BIDDER is a private company/public company/Government undertaking/partnership/registered export agency, constituted in accordance with the relevant law in the matter and the BUYER is a body corporate and has been established under the provisions of the Institutes of Technology Act, 1961.

AND WHEREAS, in order to achieve these goals, in consultation with the CVC, the Govt. of India, Ministry of Education has appointed Independent External Monitors (IEMs), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

NOW, THEREFORE, to avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:-

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Enabling the BUYER to obtain the desired said stores/equipment at a competitive price in conformity with the defined specifications by avoiding the high cost and the distortionary impact of corruption on public procurement, and

Enabling BIDDERS to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that their competitors will also abstain from bribing and other corrupt practices and the BUYER will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows:

Section 1: Commitments of the BUYER

1. The BUYER commits itself to take all measures necessary to prevent corruption and to observe the following principles: -
 - (a) No employee of the BUYER, personally or through family members, shall in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.
 - (b) The BUYER shall treat all Bidder(s) with equity and reason during the tender process. The BUYER shall, in particular, before and during the tender process, provide to all Bidder(s) the same information and shall not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in the tender process or the contract execution.
 - (c) The BUYER shall exclude from the process all known persons having conflict of interest.
2. If the BUYER obtains information on the conduct of any of its employees which is a criminal offence under the IPC/PC Act, or if there be a substantive suspicion in this regard, the BUYER shall inform the Chief Vigilance Officer, IIT Kanpur and in addition shall initiate disciplinary proceedings.

Section 2: Commitments of BIDDERS

1. The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract or in furtherance to secure it and in particular commit itself to the following:-
 - (a) The BIDDER will not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the BUYER, connected directly or indirectly with the bidding process, or to any person, organisation or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.

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- (b) The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the BUYER or otherwise in procuring the Contract or forbearing to do or having done any act in relation to the obtaining or execution of the contract or any other contract with the Government for showing or forbearing to show favour or disfavour to any person in relation to the contract or any other contract with the Government.
- (c) The Bidder(s)/Contractor(s) of foreign origin shall disclose the name and address of the Agents/representatives in India, if any. Similarly, the Bidder(s)/Contractor(s) of Indian Nationality shall furnish the name and address of the foreign entity or associates, if any. Further details as mentioned in the "Guidelines of Indian Agents of Foreign suppliers" shall be disclosed by the Bidders(s)/Contractor(s). Further, as mentioned in the Guidelines all payments made to the Indian Agent/representative have to be in Indian Rupees only.
- (d) BIDDERS shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid/contract.
- (e) The BIDDER further confirms and declares to the BUYER that the BIDDER is the original manufacturer/integrator/authorised government sponsored export entity of the defence stores and has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to the BUYER or any of its functionaries, whether officially or unofficially to the award of the contract to the BIDDER, nor has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or recommendation.
- (f) The BIDDER, either while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of the BUYER or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.
- (g) The BIDDER will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract.
- (h) The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.
- (i) The BIDDER shall not use improperly, for purposes of competition or personal gain, or pass on to others, any information provided by the BUYER as part of the business relationship, regarding plans, technical proposals and business details, including information contained in any electronic data carrier. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.

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- (j) The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.
- (k) The BIDDER shall not instigate or cause to instigate any third person to commit any of the actions mentioned above.
- (l) If the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of the BUYER, or alternatively, if any relative of an officer of the BUYER has financial interest/stake in the BIDDER's firm, the same shall be disclosed by the BIDDER at the time of filing of tender. The term 'relative' for this purpose would be as defined in Section 2(77) of the Companies Act, 2013.
- (m) The BIDDER shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of the BUYER.

Section 3: Disqualification from tender process and exclusion from future contracts:

1. If the Bidder(s)/Contractor(s), before award or during execution has committed a transgression through a violation of Section 2, above or in any other form such as to put their reliability or credibility in question, the Institute/Buyer is entitled to disqualify the Bidder(s)/Contractor(s) from the tender process or take action as per the procedure mentioned in the "Guidelines on Banning of Business Dealing".
2. Any violation of Integrity Pact would entail disqualification of the bidder(s) and exclusion from future business dealings, as per the existing provisions of GFR-2017, PC Act, 1988 and other Financial Rules/Guidelines etc. as may be applicable to the organization concerned.

Section 4: Compensation for Damages:

1. If the Institute/Buyer has disqualified the Bidder(s) from the tender process prior to the award according to Section 3, the Institute/Buyer is entitled to demand and recover the damages equivalent to Earnest Money Deposit/Bid Security.
2. If the Institute/Buyer has terminated the contract according to Section 3, or if the Institute/Buyer is entitled to terminate the contract according to Section 3, the Institute/Buyer shall be entitled to demand and recover from the Contractor liquidated damages of the Contract value or the amount equivalent to Performance Bank Guarantee.

Section 5: Previous Transgression

1. THE BIDDER(S) to disclose any transgressions with any other public/government organization that may impinge on the anti-corruption principle. The date of such transgressions, for the purpose of disclosure by the BIDDER(s) in this regard, would be the date on which cognizance of the said transgression was taken by the competent authority. The period for which such transgression(s) is/are to be reported by the bidders

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shall be the last **three years** to be reckoned from date of bid submission. The transgression(s), for which cognizance was taken even before the said period of three years, but are pending conclusion, shall also be reported by the BIDDERS.

2. The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6: Equal Treatment of all Bidders/Contractors/Sub-Contractors:

1. In the case of sub-contracting, the principal/main Contractor shall take the responsibilities of adoption of the Integrity Pact by the Sub-contractor.
2. The BUYER will enter into agreements with the identical conditions as this one with all bidders and Contractors.
3. The BUYER will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

Section 7: Criminal Charges against violating Bidder(s)/Contractor(s)/Sub-Contractors:

1. If the Buyer obtains knowledge of the conduct of a Bidder, Contractor or Sub-contractor, or of an employee or a representative or an associate of a Bidder, Contractor or Sub-contractor which constitutes corruption, or if the Institute/Buyer has substantive suspicion in this regard, the Institute/Buyer will inform the same to the Chief Vigilance Officer, IIT Kanpur.

Section 8: Sanctions for Violations

1. Any breach of the aforesaid provisions by the BIDDER or anyone employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle the BUYER to take all or any one of the following actions, wherever required: -
 - (i) To immediately call off the pre contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.
 - (ii) The Earnest Money Deposit (in pre-contract stage) and/or Security Deposit/Performance Bond (after the contract is signed) shall stand forfeited either fully or partially, as decided by the BUYER and the BUYER shall not be required to assign any reason, therefore.
 - (iii) To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.
 - (iv) To recover all sums already paid by the BUYER, and in case of an Indian BIDDER with interest thereon at 2% higher than the prevailing Prime Lending Rate of State Bank of India, while in case of a BIDDER from a country other than India with interest thereon at 2% higher than the LIBOR. If any outstanding payment is due to the BIDDER from the BUYER in connection

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with any other contract for any other stores, such outstanding payment could also be utilized to recover the aforesaid sum and interest.

- (v) To encash the advance bank guarantee and performance bond/warranty bond, if furnished by the BIDDER, in order to recover the payments already made by the BUYER, along with interest.
 - (vi) To cancel all or any other Contracts with the BIDDER. The BIDDER shall be liable to pay compensation for any loss or damage to the BUYER resulting from such cancellation/rescission and the BUYER shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.
 - (vii) To debar the BIDDER from participating in future bidding processes of the Institute for a minimum period of two years, which may be further extended at the discretion of the BUYER.
 - (viii) To recover all sums paid in violation of this Pact by BIDDER(s) to any middleman or agent or broker with a view to securing the contract.
 - (ix) In cases where irrevocable Letters of Credit have been received in respect of any contract signed by the BUYER with the BIDDER, the same shall not be opened.
 - (x) Forfeiture of Performance Bond in case of a decision by the BUYER to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.
2. The BUYER will be entitled to take all or any of the actions mentioned at para 9.1 (i) to (x) of this Pact also on the Commission by the BIDDER or anyone employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal Code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.
3. The decision of the BUYER to the effect that a breach of the provisions of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER. However, the BIDDER can approach the Independent Monitor(s) appointed for the purposes of this Pact.

Section 9: Fall Clause

1. The BIDDER undertakes that it has not supplied/is not supplying similar product/systems or subsystems at a price lower than that offered in the present bid in respect of any other Ministry/Department of the Government of India or PSU and if it is found at any stage that similar product/systems or sub-systems was supplied by the BIDDER to any other Ministry/Department of the Government of India or a PSU at a lower price, then that very price, with due allowance for elapsed time, will be applicable to the present case and the difference in the cost would be refunded by the BIDDER to the BUYER, if the contract has already been concluded.

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Section 10: Independent Monitors

1. The IEMs have been appointed by the Ministry of Education in consultation with the Central Vigilance Commission. The details of the IEMs are as follows:
 - (a) Mr. Ranvir Singh, IEM1@iitk.ac.in
 - (b) Mr. P.V.V. Satyanarayana, IEM2@iitk.ac.in
2. The task of the Monitor shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.
3. The Monitor shall not be subject to instructions by the representatives of the parties and perform their functions neutrally and independently.
4. Both the parties accept that the Monitor has the right to access all the documents relating to the project/procurement, including minutes of meetings.
5. As soon as the Monitor notices, or has reason to believe, a violation of this Pact, he will so inform the Authority designated by the BUYER.
6. The BIDDER(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the BUYER including that provided by the BIDDER. The BIDDER will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to Subcontractors. The Monitor shall be under contractual obligation to treat the information and documents of the BIDDER/Subcontractor(s) with confidentiality.
7. The BUYER will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the parties. The parties will offer to the Monitor the option to participate in such meetings.
8. The Monitor will submit a written report to the designated Authority of BUYER within 8 to 10 weeks from the date of reference or intimation to him by the BUYER / BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.
9. A person signing the IP Pact shall not approach the Court while representing the matter to IEMs and shall await the decision in the matter.
10. The IP would be implemented through a panel of Independent External Monitors (IEMs), appointed by the Ministry. The IEM would review independently and objectively whether and to what extent parties have complied with their obligations under the Pact on receipt of any complaint by them from the Bidder(s).
11. Integrity Pact (IP), in respect of a particular contract, shall be operative from the date IP is signed by both parties. The IEMs shall examine all the representations/grievances/complaints received by them from the bidders or their authorized representatives related to any discrimination on account of lack of fair play in modes of procurement and bidding systems, tendering method, eligibility conditions, bid

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evaluation criteria, commercial terms & conditions, choice of technology/specifications etc.

12. For ensuring the desired transparency and objectivity in dealing with the complaints arising out of the tendering process, the matter should be examined by the full panel of IEMs jointly, who would look into the records, conduct an examination, and submit their joint recommendations to the Management. In case the full panel is not available due to some unavoidable reasons, the available IEM(s) will conduct examination of the complaints. Consent of the IEM(s), who may not be available, shall be taken on the records.

13. In the event of any dispute between the management and the contractor relating to those contracts where Integrity Pact is applicable, in case, both the parties are agreeable, they may try to settle dispute through mediation before the panel of IEMs in a time-bound manner. If required, the organization may adopt any mediation rules for this purpose.

In case, the dispute remains unresolved even after mediation by the panel of IEMs, the organization may take further action as per the terms & conditions of the contract.

The fees/expenses on dispute resolution shall be equally shared by both parties.

14. If the Monitor has reported to the Management of the BUYER a substantiated suspicion of an offense under the relevant IPC/ PC Act, the Management of the BUYER will take action after examination of the veracity of the intent of the action.
15. The word "**Monitor**" would include both singular and plural.

Section 11: Facilitation of Investigation

1. In case of any allegation of violation of any provisions of this Pact or payment of commission, the BUYER or its agencies shall be entitled to examine all the documents, including the Books of Accounts of the BIDDER, and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

Section 12: Law and Place of Jurisdiction

1. This Pact is subject to Indian Law. The place of performance and jurisdiction is the seat of the BUYER i.e., Kanpur Nagar.

Section 13: Other Provisions

1. The actions stipulated in this Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.
2. Changes and supplements, as well as termination notices, need to be made in writing. Side agreements have not been made.

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3. In case of a joint venture, all the partners of the joint venture should sign the Integrity Pact. In case of sub-contracting, the principal contractor shall be solely responsible for the adherence to the provisions of IP by the sub-contractor(s).
4. Issues like Warranty/Guarantee etc. shall be outside the purview of the IEMs.
5. This Integrity Pact is deemed as part of the contract.

Section 14: Validity

1. The validity of this Integrity Pact shall be from the date of its signing and extend up to 5 years or the complete execution of the contract to the satisfaction of both the BUYER and the BIDDER/Seller, including the warranty period, whichever is later. In case BIDDER is unsuccessful, this Integrity Pact shall expire after six months from the date of the signing of the contract.
2. Should one or several provisions of this Pact turn out to be invalid; the remainder of this Pact shall remain valid. In this case, the parties will strive to come to an agreement with their original intentions.

IN WITNESS WHEREOF, the parties hereunto set their hands and seals and executed this Integrity Pact as of the date/month/year first above written in the presence of following witnesses:

For & on behalf of
The Indian Institute of Technology Kanpur
(First Party)
 Signed, Sealed and delivered by

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 Name: **Vishwa Ranjan** विश्व रंजन / Vishwa Ranjan
 Designation: **Registrar** कुलसचिव / Registrar
 Address: **IIT Kanpur** भारतीय प्रौद्योगिकी संस्थान कानपुर
 (Authorized Signatory) INDIAN INSTITUTE OF TECHNOLOGY KANPUR
 कानपुर - 208 016 (उ.प्र.) भारत
 KANPUR - 208 016 (U.P.) INDIA

For & on behalf of
The M/s
(Second Party)
 Signed, Sealed and delivered by

Name:
 Designation:
 Address:
 (Authorized Signatory vide resolution
 dated passed by the Board of
 Directors)

In the presence of Witness:

1. (Indenter)
2.

1.
2.

Uish

PROFORMA OF SCHEDULES (A to F)

(For Civil & Electrical Work)

S. No.	Description	Hire charges per day	Place of Issue
1	2	3	4
	NIL		

SCHEDULE 'A'

Schedule of financial quote in Part E of NIT for Civil/Electrical/HVAC works.

SCHEDULE 'B'

Schedule of materials to be issued to the contractor.

S. No.	Description of item	Quantity	Rates in figures & words at which the material will be charged to the contractor	Place of issue
1	2	3	4	5
1	CRC steel bars			IIT Kanpur
a)	12 mm dia	21.52 MT		
b)	16 mm dia	22.38 MT		
c)	20 mm dia	19.39 MT		
d)	32 mm dia	8.38 MT		
e)	25 mm dia	28.40 MT		
	Total	100.07 MT		

SCHEDULE 'C'

Tools and plants to be hired to the contractor.

SCHEDULE 'D'

Extra schedule for specific requirements/document for the work, if any. **-NIL**

SCHEDULE 'E'

Reference to General Conditions of contract: General condition of contract for CPWD-23 for Construction works (with amendments up to previous date of last date of receipt of tender including extension, if any).

Name of Work: "Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"		
Estimated cost of the work:	Civil Items of Work-	Rs. 99,10,51,949.00 (without GST)
	Electrical Items of Work-	Rs. 15,01,04,195.00 (without GST)
	HVAC Items of Work-	Rs. 5,63,54,201.00 (without GST)
Earnest money	Rs. 129.75 Lacs (To be returned after receiving performance guarantee)	
Performance Guarantee	5% of the tendered value of the work	
Security Deposit	2.5% of the tendered value of the work	

SCHEDULE 'F' GENERAL RULES & DIRECTIONS

Officer inviting tender	Superintending Engineer, IWD, IIT Kanpur
Applicable Mode of contract	Percentage rate tender
Type of buildings	Permanent
List of approved construction technologies	Modular Aluminium Formwork Shuttering System (MAFSS) using Aluminium formworks as per GFC drawings, scope of work, Specifications, schedule of finishes etc. mentioned in the NIT.
Maximum percentage of quantity of items of work to be executed beyond which rates are to be determined in accordance with clause 12.2	See below

2. Definitions:

2 (i)	Engineer-in-charge	
	For civil item of works	Executive Engineer (C), IWD, IIT Kanpur
	For Electrical item of works	Executive Engineer (E), IWD, IIT Kanpur
2 (ii)	Accepting authority	Superintending Engineer, IWD, IIT Kanpur
2 (iii)	Percentage on cost of materials and labour to cover all overheads and profits	15%

	Compensation under Clause 2	Kanpur
Clause 2A	Whether Clause 2A shall be applicable	NA
Clause 5	i) Number of days from the date of issue of letter of acceptance for reckoning date of start ii) Time allowed for execution of work	15 days 18 Months
i)	Number of days from the date of issue of letter of acceptance for reckoning date of start	15 days
Authority to decide	Extension of time (EOT)	Dean of Infrastructure and Planning, Kanpur
	Rescheduling of milestones	Superintending Engineer, IWD IIT Kanpur
	Shifting of start in case of delay in handing over of site	Superintending Engineer, IWD IIT Kanpur

Mile stones for the work shall be as per Table given below:

Sl. No	Description of Milestone (Physical)	Time allowed in months (from date of start)	%age amount of total agreement amount to be withheld in case of non-achievement of Milestone
1	(a) Setting up of site office, site testing lab, approval of design mix and Automatic Batching plant, steel yard, cement store. (b) Barricading of construction site, mobilization of T & P for the project. (c) Submission of document for specialized agencies for all civil works and for all E & M works.	01 Month	0.50%
2	(a) Completion of Foundation work up to plinth level of All blocks. (b) Procurement of Aluminium shuttering for modular aluminium formwork shuttering system (MAFSS).	05 Months	0.75%

	(c) Procurement of conduits, Fan Boxes DB etc. (d) Approval for all samples of materials to be procured. Or gross work done of 15%		
3	(a) Completion of structural work of blocks 2 & 3 upto Level 8. (b) All Internal finishing work upto Level-6. (c) Internal Electrical work upto Level -5. (d) Approval of Sample Toilet & Room in all respect. Or gross work done of 35%	09 Months	0.75%
4	(a) Completion of structural work of blocks 2 & 3 upto level terrace Level including water proofing. (b) All Internal Finishing work upto Level-10. (c) Electrical work upto Level-10. (d) Structural work of block 1 & 4 upto Level-4. Or gross work done of 55%	12 Months	0.75%
5	a) Completion of block 2 & 3 in all respect may external finishing, lift & HVAC work. (b) Complete structural work of block 1 & 4. (c) Internal finishing work upto Level-9. (d) Electrical work upto Level-8. (e) Completed fixing of all Lifts. (f) Rainwater Harvesting system. Or gross work done of 75%	15 Months	0.75%
6	a) Completion or all works in all respect. (b) External Development work Completed. (c) Firefighting & Fire Alarm system work. (d) Obtaining Final NOC form fire Department and other statutory bodies. (e) Testing and Commissioning of water supply system, Drainage lines etc. (f) Installation and Testing, commissioning of all Lifts complete. (i) Building wise inventory (ii) As built drawings including completion	18 Months	0.75%

	plans of services. (iii) Submission of Final Fire NOC from Fire department. (iv) Submission of all original warranty certificates/bond from OEMs for all the equipment along with copy of bill Or gross work done of 100%		
Clause 7	Gross work to be done together with net payment /Adjustment of advances for material collected, if any, since the last such payment for being eligible to interim payment.	500 lacs	
Clause 7A	Whether clause 7A shall be applicable.	Yes	
Clause 8A	Authority to decide compensation on account if the contractor fails to submit completion plans	Superintending Engineer, IWD IIT Kanpur	
Clause 10A	List of testing equipment to be provided by the contractor at site lab.	As per Part B-1	
Clause 10B (ii), (iii)	Whether clause 10-B (ii) and 10-B (iii) shall be applicable.	APPLICABLE	
Clause 10 CC	Increase/Decrease in Price of materials/wages	NOT APPLICABLE	
S.No.	Relevant component of Material/Labour for price escalation	Percentage of total value of work	
1	Component of Cement. (CP)	15%	
2	Component of Labour. (LP)	15%	
3	Civil Component of other Construction Materials (CMp)	30%	
4	Electrical & Mechanical Component of other Construction Materials (EMp)	20%	
5	Component of POL (Diesel) (Fp)	0%	

6	Reinforcement steel bars/TMT bars/ structural steels (Sp)	20%
	Component of Bitumen (Bp)	NIL
	Total:	100%
Clause 11	Specification to be followed for execution of work:	
For Civil items of work	CPWD Specification vol.1 and vol.2, 2019),	
For Electrical items of works of HVAC	As per Component PART-C & PART-D	
Note: All above specification and other specifications, codes and standards mentioned elsewhere in the bid document as amended upto last date of submission of bid shall be applicable.		
Clause 12:		
Deviation limit beyond which clause 12.2 & 12.3 shall apply for Building works		100% (One hundred percent) for all the Substructure, Super structure, and E & M works
Clause 16		Competent Authority for deciding reduced rates
For Civil items of work		Superintending Engineer, IWD IIT Kanpur
For Electrical items of work		Superintending Engineer, IWD IIT Kanpur
Clause 17	Contractor liable for damages, defects during defect liability period.	Defect liability period shall be 36 months from the date of completion of the work
Clause 19C, 19D, 19G	Competent authority for deciding Penalty and its quantum for each default	Engineer-in-charge of major / minor component, as applicable.
19K		Applicable
Clause 25		
Conciliator	Dean of Infrastructure and Planning (DOIP)	
Arbitrator Appointing Authority	Director, IIT, Kanpur	
Place of Arbitration	Kanpur	

Clause 32 Requirement of Technical Representative (s) and Recovery Rate

Sl. No	Qualification	Number (major+ Minor Component)	Minimum Experience in years	Designation	Rate at which the recovery shall be made from the contractor in the event of not fulfilling provision of Clause 32
1.	Graduate Engineer	1	20	Project Manager	Rs. 1,00,000/- (Rupees One lakh only) per month, per person
2.	Graduate	1+1	12 years respectively	Dy. Project Manager cum Planning / quality / Site / billing Engineer (Civil)	Rs. 60,000/- (Rupees Sixty Thousand only) per month, per person
3	Graduate Engineer or Diploma Engineer	1+1	5 or 10 respectively	Project site Engineer	Rs. 40,000/- (Rupees Forty Thousand only) per month, per person
4	Graduate (a graduate with one year fulltime advance safety diploma from Central Labour/Mumbai/NICMAR/Hyderabad/Mahatma Gandhi Labour Institute Ahmedabad or an equivalent	1+1	Ten year in major construction project	Safety Engineer	Rs. 60,000/- (Rupees Sixty Thousand only) per month, per person
5	Graduate Engineer or Diploma Engineer	1+1	5 or 10 respectively	Project site Engineer	Rs. 25,000/- (Rupees Twenty-five Thousand only) per month, per person
6	Graduate Engineer	1+1	8 respectively	Quality Engineer	Rs. 40,000/- (Rupees Forty Thousand only) per month, per person
7	Graduate Engineer	1+1	6 respectively	Project Planning/Billing Engineer	Rs. 40,000/- (Rupees Forty Thousand only) per month, per person

8	Graduate Personnel	1	5 respectively	Documentation Executive-Green building parameters	Rs. 15,000/- (Rupees Fifteen Thousand only) per month, per person
9	Diploma Engineer	1	8 respectively	Surveyor	Rs. 30,000/- (Rupees Thirty Thousand only) per month, per person

Assistant Engineers retired from Government services who are holding Diploma will be treated at par with Graduate Engineers. **Diploma holder with minimum 10 years relevant experience with a reputed construction co. can be treated at par with Graduate Engineers for the purpose of such deployment subject to the condition that such diploma holders should not exceed 50% of requirement of degree engineer.**

The details of appointed engineers/technical staffs have to be verified and approved by Engineer- in-charge

Clause 38

i)	a)	Schedule/ statement for determining theoretical quantity of cement & bitumen on the basis of Delhi Schedule of Rates 2023 printed by CPWD	D.S.R. 2023 (with up to date correction slips)
ii)		Variations permissible on theoretical quantities	
	a)	Cement for works with estimated cost put to tender not more than Rs. 25.00 Lacs	3 % (plus/minus)
		For works with estimated cost put to Tender is more than Rs 25.00 Lacs	2 % (plus/minus)
	b)	Bitumen all works	2.5 % (plus & nil on minus side)
	c)	Steel reinforcement and structural steel Sections for diameter, section and category.	2 % (plus/minus)
	d)	All other materials	Nil

**LIST OF BASIC MINIMUM REQUIRED MACHINERY, TOOLS & PLANTS TO
BE DEPLOYED BY THE CONTRACTOR AT SITE**

Sl. No.	Name of Equipment	Numbers
1	Excavators (various sizes)	02 Nos.
2	Tower crane	02 Nos.
3	Builder's hoist	02 Nos.
	Equipment for Concrete work	
4	Fully Automatic batching plant of 30 cum/hour as per direction of Engineer-in-Charge	01 Nos.
5	Concrete pump	01 Nos
6	Concrete transit mixer	02 Nos.
7	Concrete mixer (diesel)	01 Nos.
8	Concrete mixer (electrical)	01 Nos.
9	Needle vibrator (electrical)	02 Nos.
10	Needle vibrator (petrol)	02 Nos.
11	Surface and Plate vibrator	02 Nos.
	Equipment for Building work	
12	Bar bending Machine	02 Nos.
13	Bar cutting machine	02 Nos.
14	Drilling machine	02 Nos.
15	Welding machine i/c transformer	02 Nos.
16	Cube testing machines automatic (Digital 100 MT)	01 Nos.
17	Aluminium shuttering	Minimum 01 set for each block along with additional sets of slab with each set.
18	M.S. pipes/telescopic props and other accessories.	As per requirement
19	Steel scaffolding system (cup lock type)	As per requirement
20	Grinding/polishing machines)	As per requirement
	Equipment for transportation	
21	Tippers	As per requirement of the project and milestones.
22	Trucks	As per requirement of the project and

		milestones.
	Pneumatic equipment	
23	Air compressors (diesel)	As per requirement of the project and milestones.
	Dewatering equipment	As per requirement of project.
	Power equipment	
24	Diesel generator (to meet requirement at site for uninterrupted work)	01 No. of required capacity
	Survey equipment's	
25	Total Work Station	01 Nos.
26	Vernier Calipers	02 Nos.
27	Weighing Machine	02 Nos.
28	Earth Compactor	01 Nos.

Note: The above list is only indicative and not exhaustive and contractor shall deploy plant and machinery as per actual requirement of the work so that the progress of the work is adequately maintained. However, No damages/compensation shall be payable on account of idle plant and equipment etc. for whatsoever reason.

Superintending Engineer

Details of Electrical Contractor
(To be submitted before award of work)

- i. Name of Electrical Contractor: M/s.....
- ii. Address:
- iii. Class of Registration:
- iv. Details of Registration of the Electrical Contractor

Sl. No.	Department	Registered Yes/No	Registration No	Tendering limits Rs. Lacs	Validity of Registration	Debarred from Tendering Yes/ No
1	2	3	4	5	6	7
1.						
2.						
3.						

Note: All columns of above Proforma must be filled in.

Contractor's signature

CONSENT LETTER

I hereby give my consent to work as electrical contractor till the completion of work. Also I will be responsible for necessary action to hand over the installation and for rectification of defects and repair during the obligatory maintenance period. I will execute the work as per CPWD Specifications and Additional Conditions of the Contract.

I will also engage suitable Engineer for the work as per condition of the contract. I further certify that the above particulars pertaining to me are correct.

Dated:

Signature of Electrical Contractor

PART–B1

GENERAL REQUIREMENT

GENERAL REQUIREMENTS OF TENDER

Name of Work: **"Construction of Hall of Residence No. 15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & Multipurpose Hall and facilities block including internal & external Electrification work, plumbing, firefighting, Fire alarm System, Lifts, Water tanks, Landscape, Roads, HVAC (Low side) at IIT Kanpur (U.P.)"**

- 1 The tenderer is advised to read and examine the tender documents for the work and the set of tender drawings. He should inspect and examine the site and its surroundings by himself before submitting his tender.
- 2 Separate conditions & specification and scope are included in this tender. The contractor shall quote the percentage rates in figures and words accurately in schedule of financial quote so that there is no discrepancy in figures and words.
- 3 Time allowed for the execution of work is **18 months**.
- 4 The contractor(s) shall submit a detailed program of execution in accordance with the **master programme/milestone within fifteen days** from the date of issue of letter of acceptance.
- 5 Contractor has to arrange and install **fully automatic concrete batching plant of 30 cum/ hour within 1.0 month of date of award of the work or handing over the site whichever is later and nothing extra will be paid on this account. In case of delay in installation of batching plant, recovery @ Rs. 5000/- per day shall be made from Running account bill of the contractor.**
- 6 Quality of the project is of utmost importance. This shall be adhered to in accordance with the provisions of CPWD specifications and guidelines given in the relevant paras.
- 7 Temporary Electric connection (Single/ Three phase) shall be provided by the Institute from its distribution network and the charges shall be realized prevalent commercial tariff of the institute presently recovery rate is Rs. 9.19 Per unit on the basis of actual consumption through the separate meter under the control of Engineer-In-Charge. If the rates are revised in future the same shall be applicable to the contractor. The contractor at his own cost shall arranged the cables for the service connection and the sub meter. The fixed charges shall be payable as per Institute policy.
- 8 No labor huts/jhuggis shall be allowed to construct in the campus except for the security persons at work site with proper sanitation arrangements after due approval of Superintending Engineer.
- 9 The contractor has to appoint qualified safety officer for proper adhering safety requirements during the entire period of contract. No work shall be allowed without presence of the safety officer. Fortnightly training of the workers shall

also to be conducted by the safety officer and the proper record of the maintained. All workers with using of proper safety gazettes only be allowed enter at side.

- 10 In case of any serious accident at work site, the Institute may cause an enquiry/ investigation into the accident and depending on the outcome of such enquiry/ investigation, the Institute may take such action against the contractor as may be deemed fit and appropriate in the discretion of the Director, which may also lead to termination of the contract, and or the contractor may be debarred from applying for further works in the campus for a specified period.
- 11 **Cement shall be arranged by the contractor himself.**
- 12 **Steel Reinforcement shall be arranged by the contractor himself.**
- 13 Contractor has to engage specialized agencies for following Civil works :-
 - i. Water Proofing
 - ii. Fire doors and fittings
 - iii. Aluminium work
 - iv. Upvc doors and windows
 - v. Piling work
 - vi. Modular Aluminium Formwork Shuttering System (MAFSS)
 - vii. Stainless Steel Railing (Grade-304)
 - viii. Treatment of Expansion joints of the buildingApproval of the specialized agencies for each specialized work shall be obtained from the SE, IWD, through Engineer-in-Charge within one month of award of work. Even if, such specialized items of work shall be executed by the specialized agencies, the work shall be deemed to be executed by the tenderer for all purposes and the responsibility of the quality of items of works executed etc. shall continue to be that of the tenderer only.
- 14 Contractor has to deploy basic minimum required machinery on the project to complete the work in time as stipulated in the tender in **Annexure -I**. In case the contractor fails to deploy the plant and machinery as per requirement of the work
- 15 The contractor shall submit the running bills in the shape of the computerized MB in pages of A-4 size as per the standard format of department and shall act as per modified Clause 6 A of CPWD-7.
- 16 Contractor has to provide reinforcement cover blocks made of approved proprietary pre packed free flowing mortars (Conbextra as manufactured by M/s Fosroc Chemical India Ltd. or approved equivalent) of high early strength.
- 17 The contractor has to take approval from the Engineer in charge for the boring for the use of water in construction work.

MATERIAL AND QUALITY ASSURANCE

1. The contractor shall ensure quality control measures on different aspects of construction including materials, workmanship and correct construction methodologies to be adopted. He shall have to submit quality assurance programme within two weeks of the award of work. The quality assurance programme should include method statement for various items of work to be executed along with check lists to enforce quality control.
2. The contractor shall depute Quality Manager exclusively for enforcement of quality control. Such Quality Manager should be qualified engineer with minimum Eight years similar experience for other staff to be deployed for quality assurance, the contractor may refer to clause 32 (i) under schedule "F" attached.
3. The contractor shall get the source of all other materials, not specified elsewhere in the document, approved from the Engineer-in-Charge. The contractor shall stick to the approved source unless it is absolutely unavoidable. Any change shall be done with the prior approval of the Engineer-in-Charge for which tests etc. shall be done by the contractor at his own cost. Similarly, the contractor shall submit brand/ make of various materials not specified in the agreement, to be used for the approval of the Engineer-in- Charge along with samples and once approved, he shall stick to it.
4. The contractor shall submit shop drawings of staging and shuttering arrangement, aluminum & glazing work, fire doors and fittings, Firefighting work, plumbing work and other works as desired by Engineer In Charge for his approval before execution. The contractor shall also submit bar bending schedule for approval of Engineer-in- charge before execution.
5. Frequency and type of tests of various Materials/items/ article shall be conducted as per specifications and relevant BIS-Codes. The test results confirm to the specification/codes.
6. **Test Laboratories:**

A. Laboratory at site :

The contractor shall establish a testing lab at site and provide testing equipment and materials for the field tests mentioned in the list of mandatory tests given in CPWD specifications 2009 Vol. 1 & 2. Nothing extra shall be payable to him on this account. In case of delay in establishment of Lab at site, a non refundable recovery of Rs. 1000/- per day shall be made from Running account bill of the contractor for each delayed days.

The representatives of the department shall be at liberty to inspect the testing facilities at site and conduct testing at random in consultation with Engineer in charge. The contractor shall provide all necessary facilities for the purpose. The laboratory shall be equipped, inter alia, with the following equipment's:

- a) **Balances:**
- i) 7 kg to 10 kg capacity, semi-self-indicating type – Accuracy 10 gm.
 - ii) 500 gm capacity, semi-self-indicating type Accuracy 1 gm.
 - iii) Pan Balance- 5 kg Capacity- Accuracy 10 gm.
- b) **Ovens-** Electrically operated, thermostatically controlled upto 1100C- Sensitivity 10C.
- c) **Sieves:** as per IS: 460
- i) IS Sieves – 450 mm internal dia of sizes 100 mm, 80 mm, 63 mm, 50 mm, 40 mm, 25 mm, 20 mm, 12.5 mm, 10 mm, 6.3 mm, 4.75 mm, complete with lid and pan.
 - ii) IS Sieves – 200 mm internal dia (brass frame) consisting of 2.36 mm, 1.18 mm, 500 microns, 425 microns, 300 microns, 212 microns, 150 microns, 90 microns, 75 microns with lid and pan.
- d) Sieve shaker capable of 200 mm and 300 mm dia sieves, manually operated with timing switch assembly.
- e) Equipment for slump test- slump cone, steel plate, taping rod, steel scale, scoop.
- f) Surveying Equipment- Total station-01 Nos.
- g) Digital meter, Digital Vernier caliper, Digital screw gauge, Depth gauge etc.
- h) Ultrasonic Pulse Velocity testing machine.
- i) Equipment for concrete testing

i) V-funnel	02 Nos.
ii) L-Box	02 Nos.
iii) Concrete cube moulds 15x15x15cm.	30 Nos.
iv) Pruning Rods 2Kg weight length 40cm and ramming face 25mm	01 Nos.
v) Extra Bottom plates for 15cm cube mould	06 Nos.
vi) Standard Vibration table for cubes	01 Nos.
vii) Dial gauges 25 mm travel- 0.01 mm/division Least count-	01 Nos.
viii) Automatic compression testing machine of 100 tonne capacity.	01Nos.
ix) Flow test apparatus	02 Nos.
x) Instant Moisture meter for aggregate	02 Nos.

Not less than 90% tests for material be performed at site lab with above stated equipment's, however at least 10% testing of materials shall be got done from external laboratories. However, for the tests to be carried out through the Institute structure lab, the contractor shall supply free of charge all the materials required for testing, including transportation. The cost of all tests to be conducted shall be borne by the Contractor.

B. Other Laboratories:

The all such tests which are not available in the Institute lab but required to be carried out from outside Institute laboratories the cost of such tests shall be borne by the contractor i/c all arrangements for conducting such tests.

C. Sampling of Materials:

C1. Sample of building materials fittings and other articles required for execution of work shall be got approved from the Engineer-in-Charge. Articles manufactured by companies of repute and approved by the Engineer-in-Charge shall only be used. Articles bearing BIS certification mark shall be used in case the above are not available, the quality of samples brought by the contractor shall be judged by standards laid down in the relevant BIS specifications. All materials and articles brought by the contractor to the site for use shall conform to the samples approved by the Engineer-in-Charge.

C2. The contractor shall ensure quality construction in a planned and time bound manner. Any sub-standard material/work beyond set out tolerance limit shall be summarily rejected by the Engineer-in-Charge.

C3. BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/materials. Wherever BIS marked materials are brought to the site of work, the contractor shall if required, by the Engineer-in-Charge furnish manufacturers test certificate to establish that the material produced by the contractor for incorporation in the work satisfies the provisions of BIS codes relevant to the material and/or the work done.

C4. The contractor shall procure all the materials in advance so that there is sufficient time to testing and approving of the materials and clearance of the same before use in work.

C5. All materials brought by the contractor for use in the work shall be got checked from the Engineer-in-Charge or his authorized representative of the work on receipt of the same at site before use.

C6. The contractor shall be fully responsible for the safe custody of the materials issued to him even if the materials are in double lock and key system.

C7. The Stone aggregate/stone, sand shall be brought from any quarries subjected to the said materials confirm CPWD specifications.

- 5 The day-to-day receipt and issue accounts of different grade/brand of cement shall be maintained separately in the standard proforma by the contractor in consultation with the Jr. Engineer/Assistant Engineer - in-Charge of work and which shall be duly signed by the contractor or his authorized representative.
- 6 The contractor shall render all help and assistance in documenting the total sequence of this project by way of photography, slides, audio-video recording etc. Nothing extra shall be payable to the contractor on this account.

- 7 The contractor shall be fully responsible for the safe custody of materials brought by him issued to him even though the materials are under double lock key system.
- 8 Separate Cement registers showing the receipt of the PPC shall be maintained at site. The contractor shall construct go down for storage of PPC at site and nothing extra on this account shall be payable.
- 9 Cement issued shall be for consumption at site only. No cement for factory made items and those not manufactured at site shall be issued.
- 10 In case there is any discrepancy in frequency of testing as given in the list of mandatory test and that in the individual sub-head of work as per CPWD specification 2019 Vol. 1& 2 the higher of the two frequencies of testing shall be adopted.

D) Maintenance of Registers:

1. All the register of tests to be carried out at construction site or in outside laboratories shall be maintained by the contractor which shall be issued to the contractor by Engineer-in-Charge to IWD field staff.
2. The test registers to be issued to the contractor are :
 - A) Materials at site account register such as steel, bricks, AAC blocks, coarse aggregates etc.
 - B) Cement register.
 - C) Master test registers.
 - D) Cube test register.
 - E) Paint register.
 - F) Any other test register as required.
3. All the entries in the register will be made by the designated engineering staff of the contractor and same should be regularly reviewed by JE/AE/EE.
4. Contractor shall be responsible for safe custody of all the test registers.
5. Submission of copy of all test registers, material at site register along with each alternate running account bill and final bill shall be mandatory. These registers should be duly checked by Engineer-in-Charge.
6. All Material received at site shall be entered in MAS Register and copy of supply order, MTC and bill-invoice shall be maintained in order.
7. All the registers of tests carried out at construction out a construction site laboratory or in outside laboratories shall be maintained by the agency. Which may be inspected by Engineer-in-Charge of his/her authorized representative at any point of time.
8. The agency shall allow access of Third party quality assurance agency (TPQAA) engaged by Engineer-in-Charge to have a control on quality and methodology of execution. All arrangements for transporting and getting them tested shall be made by the agency.

ADDITIONAL CONDITION FOR CEMENT

1. The contractor shall procure 43 grade Portland Pozzolana Cement conforming to IS: 1489 (Part-I) as required in the work, from reputed manufacturers of cement, such as A.C.C., Ultratech, Shree cement, Ambuja, Century Cement, Mycem cement & J.K. Cement. The tenderers may also submit a list of names of cement manufacturers which they propose to use in the work. The tender accepting authority reserves right to accept or reject name(s) of cement manufacturer(s) which the tenderer proposes to use in the work. No change in the tendered rates will be accepted if the tender accepting authority does not accept the list of cement manufacturers, given by the tenderer, fully or partially.
2. Supply of cement shall be made in bags or in Bulk as approved by Engineer-in-Charge .
3. The cement go down of minimum capacity of 5000 bags of cements shall be constructed by the contractor at site of work and/or 02 Nos silos of minimum capacity of 50 Tonne each shall be installed along with automatic batching plant. No extra payment shall be made for the same.
4. Samples of cement arranged by the contractor shall be taken by the Engineer- in-Charge and got tested in accordance with provisions of the relevant BIS codes. In case the test results indicate that the cement arranged by the contractor does not conform to the relevant BIS code the same shall stand rejected and shall be removed from the site by the contractor at his own cost within a week's time of written order from the Engineer-in- Charge to do so.
5. Double lock provision shall be made to the door of the cement go down. The keys of one lock shall remain with the Engineer-in-charge or his authorized representative and the key of the other lock shall remain with the contractor. The contractor shall be responsible for the watch and ward and safety of the cement go down. The contractor shall facilitate the inspection of the cement go down by the Engineer-in-Charge at any time.
6. The cement shall be got tested by the Engineer-in-Charge and shall be used on the work only after satisfactory test results have been received. The contractor shall supply free of charge the cement required for testing including its transportation cost to test laboratories. The cost of tests shall be borne by the contractor:
7. The actual issue and consumption of cement on work shall be regulated and proper accounts maintained as provided in clause 10 of the contract. The theoretical consumption of cement shall be worked out as per procedure prescribed in clause 42 of the contract and shall be governed by conditions laid therein. In case the cement consumption is less than theoretical consumption including permissible variation, recovery at the rate show prescribed shall be made. In case of excess consumption, no adjustment need to made.

8. The cement brought to site and the cement remaining unused after completion of the work shall not be removed from site without the written permission of the Engineer-in- Charge.
9. The damaged cement shall be removed from the site immediately by the contractor on receipt of a notice in writing from the Engineer-in-Charge. If he does not do so within three days of receipt of such notice, the Engineer-in-Charge shall get it removed at the cost of the contractor.
10. Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.
11. Till the time, BIS makes it mandatory to print the % age of fly ash on each bag of cement, the certificate from the PPC manufacturer indicating the same shall be obtained and permission obtained from Engineer-in-Charge before use of such cements in works.
12. The contractor may use OPC in place of PPC only after written permission of Engineer-in- Charge. In such case, no extra payment shall be made in any form to the contractor by the Department.
13. Use of flyash shall be allowed with OPC cement for design mix of self compacting concrete if required so.

ADDITIONAL CONDITIONS FOR STEEL REINFORCEMENT

1. For reinforced cement concrete, the reinforcement bars shall consist of Fe 500 D grades or as specified in the GFC drawings conforming to IS 1786:2008 (Indian Standard specification for high strength deformed steel bars and wires for concrete reinforcement) as per amendment 3, para 4.2 note 3 (Indian Standard specification for high strength deformed steel bars and wires for concrete reinforcement) as presently applicable and any further amendments issued during & upto the period of execution/completion. The primary producers of such Low Alloy Steel reinforcement TMT bars shall be as per approved list given in the "Preferred makes of the materials" incorporated in this tender document.

- 1.1 The contractor shall obtain manufacturers certificate stating the process of manufacture, chemical composition and test sheet giving result of each mechanical test applicable to the material purchased and submit it to the Engineer-in-charge. Each test certificate shall indicate the number of the cast to which it applies, corresponding to the number or identification mark to be found on the material.
2. The contractor shall have to obtain vouchers and furnish test certificates to the Engineer-in-charge in respect of all supplies of steel brought by him to the site of work.
3. Samples shall also be taken and got tested by the Engineer-in-charge as per the provisions in this regard in the relevant BIS codes. In case the test results indicate that the steel arranged by the contractor does not conform to the specifications as defined under para 1.1 and 1.2 above, the same shall stand rejected and it shall be removed from the site of work by the contractor at his cost within a week time of written orders from the Engineer-in-charge to do so.
4. The steel reinforcement shall be brought to the site in bulk supply of 50 tons or more or as directed by the Engineer-in-charge.
5. The steel reinforcement bars shall be stored by the contractor at site of work in such a way as to prevent distortion & corrosion, and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facilitate easy counting and checking.
6. For checking nominal mass, tensile strength, bend test, re-bend test etc. specimens of sufficient length shall be cut from each size of the bar at random at frequency not less than that specified below:

Size of bar	For consignment below 100 tons	For consignment over 100 tons
Under 10 mm dia bars	One sample for each 25 tons or part thereof	One sample for each 40 tons or part thereof
10 mm to 16 mm dia bars	One sample for each 45 tons or part thereof	One sample for each 50 tons or part thereof
Over 16 mm dia	One sample for each 50	One sample for each

bars	tons or part thereof	75 tons or part thereof

7. The contractor shall supply free of charge the steel required for testing including its transportation to testing laboratories. The cost of the all passed tests conducted through the Institute labs shall be borne by the Institute & the cost of failed tests shall be borne by the contractor.
8. The actual issue and consumption of steel on work shall be regulated and proper accounts maintained as provided in clause 10 of the contract. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 38 of the contract and shall be governed by the conditions laid therein. In case the consumption is less than theoretical consumption including permissible variations recovery at the rate so prescribed shall be made. In case of excess consumption no adjustment need to be made.
9. The steel brought to the site and the steel remaining unused shall not be removed from site without the written permission of the Engineer-in-charge.
10. Steel bars brought by the contractor for use in the work shall be got checked from the Engineer-in-Charge or his authorized representative of the work on receipt of the same at site before use. The contractor shall supply free of charge the steel required for testing including its transportation to testing laboratories. The cost of the all passed tests conducted through the Institute labs shall be borne by the Institute & the cost of failed tests shall be borne by the contractor.
11. If the quantity of steel actually used in the work is found to be more than the theoretical quantity of steel including authorized variation, nothing extra shall be payable to the contractor on this account. In the event of it being discovered that after the completion of the work the quantity of steel used is less than the quantity ascertained as herein before provided (allowing variation on the minus side as stipulated in clause 42). The cost of quantity of steel so less used shall be recovered from the contractor at rate as specified in schedule 'F'. Decision of the Engineer-in- Charge in regard to theoretical quantity of steel which should have been actually used and recovery of the rate specified shall be final and binding on the contractor.
12. In case the contractor brings surplus quantity of steel the same after completion of the work will be removed from the site by the contractor at his own cost after approval of the Engineer-in-Charge.
13. Reinforcement including authorized spacer bars and lap pages shall be measured in length of different diameters, as actually (not more than as specified in the drawing) used in the work, nearest to a centimeter. Wastage and unauthorized overlaps shall not be measured.
14. The standard sectional weights referred to as in Table 5.4 under para 5.3.4 in CPWD specifications for works 2009 Vol. 1 will be considered for conversion of length of various sizes of MS bars, Tor steel bars and TMT bars into standard weight.
15. Records of actual sectional weight shall also be kept dia-wise & lot-wise. The average sectional weight for each diameter shall be arrived at from samples from each lot of steel received at site. The decision of the Engineer-in-Charge

shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute one single lot for the purpose. The weight of steel by conversion of length of various sizes of bars based on the actual weighted average sectional weight shall be termed as derived actual weight.

16. Mixing of different type of steel/different grades of steel shall not be allowed in the same structural members as main reinforcement to satisfy clause 26.1 of IS:456.
17. Tolerances on Nominal Mass (individual sample) shall be as under:

Sl. No.	Nominal size mm	Tolerances on the Nominal Mass, percentage
1	Upto and including 10	-8%
2	Over 10 upto & including 16	-6%
3	Over 16	-4%

GENERAL TERMS & CONDITIONS

1 Order of Preference

Should there be any difference or discrepancy between the specifications and / or the drawings, the following order of preference shall be observed: -

- i) GFC drawings & details provided in bid document.
- ii) General specification and Schedule of finishes provided in bid document.
- iii) Additional & Special Conditions provided in bid document.
- iv) Any other terms & Condition provided in bid document.
- v) CPWD specifications including correction slips issued upto the last date of uploading/submission of bid.
- vi) Indian standard specifications of B.I.S.
- vii) ASTM, BS, or other foreign origin code mentioned in bid document.
- viii) Manufacturer's specifications if B.I.S specification is not available.
- ix) Sound Engineering Practices or well-established local construction practices.
- x) Decision of Engineer-in-Charge if none the above is available.

Above provision supersedes para 8.1 of General Conditions of Contract-2023 projects, as applicable.

If there are varying or conflicting provisions made in any one document forming part of the contract, the Accepting Authority shall be the deciding authority with regard to the intention of the document and his decision shall be final and binding on the contractor.

In case of any difference in the Hindi version and English version in any of the condition of contract, English version shall prevail.

- 2 The rates tendered by the contractor are deemed to be inclusive of site clearance, setting out work profile, establishment of reference bench mark, spot levels, construction of all safety and protection measure, 5m high barricades around the site, preparatory works, testing charges of materials working during monsoon, working etc. all-inclusive and shall apply to all heights, lifts, leads and depths of the work and nothing extra shall be payable to him on account of the same unless otherwise mentioned in the bid document.
- 3 The proposed building is a prestigious project and quality of work is paramount importance. Contractor shall have to engage well experienced skilled labor and deploy modern T&P and other equipment to execute the work. Many items like, stone flooring, aluminum, glazing, stainless steel, & plumbing work and other specialized works will specially require engagement of skilled workers having experience particularly in execution of such items.
- 4 a) The contractor (s) shall inspect the site of work before tendering and

acquaint himself with the site conditions and no claim on this account shall be entertained by the department.

b) The contractor (s) shall get himself acquainted with nature and extent of the work and satisfy himself about the availability of materials from kiln or approved quarries for collection and conveyance of materials required for construction.

- 5 The tenderer shall see the approaches to the site. In case any approach from main road is required by the contractor, the same shall be made good, improved and maintained by the contractor at his own cost. No payment shall be made on this account.
- 6 The contractor shall give to the Municipality, Police and other authorities all necessary notices etc. that may be required by law and obtain all requisite Licenses for temporary obstructions, enclosures etc. and pay all fee, taxes and charges which may be leviable on account of these operations in executing the contract. He shall make good any damage to the adjoining property whether public or private and shall supply and maintain light and other illumination on for cautioning the public at night.
- 7 The contractor shall take all precautions to avoid accidents by exhibiting necessary caution boards day and night speed limit boards red flags, red lights and providing barriers. He shall be responsible for all dangers and incidents caused to existing / new work due to negligence on his part. No hindrances shall be caused to traffic during the execution of the work.
- 8 Contractor shall provide permanent bench marks and other reference points for the proper execution of work and these shall be preserved till the end of work. All such reference points shall be in relation to the levels and locations, given in the Architectural and plumbing drawings.
- 9 The contractor shall make his own arrangement for obtaining electric connection if required and make necessary payments directly to the department concerned.
- 9 Other agencies doing works related with this project may also simultaneously execute their works and the contractor shall afford necessary facilities for the same. The contractor shall leave such necessary holes, openings etc. for laying/burying in the work, pipes cables, conduits, clamps, boxes and hooks for fan clamps etc. as may be required for the other agencies. Nothing extra over the Agreement rates shall be paid for doing these.
- 10 Some restrictions may be imposed by the security staff etc. on the working and for movement of labor, materials etc. The contractor shall be bound to follow all such restrictions/instructions and nothing extra shall be payable on account of the same.
11. The contractor shall fully comply with all legal orders and directions of the Public or local authorities or municipality and adhere by their rules and regulations and pay all fees and charges for which he may be liable in this regard. Nothing extra shall be paid/reimbursed for the same.
12. The building work shall be carried out in the manner complying in all

- respects with the requirements of the relevant bylaws and regulations of the local body under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-charge and nothing extra shall be paid on this account.
13. The contractor shall give a performance test of the entire installation(s) as per standing specifications before the work is finally accepted by making his own arrangements for water supply, electricity etc. and nothing extra whatsoever shall be payable for the same.
 14. If as per local Municipal regulations Huts for labor are not to be erected at the site of work, the contractor shall be required to provide such accommodation at a place as is acceptable to the local body and nothing extra shall be paid on this account.
 15. In case of items for which abbreviated nomenclature is not available in the aforesaid publication and also in case of extra and substituted items for which abbreviated nomenclature are not provided for in the agreement. Full nomenclature of item shall be reproduced in the measurement books and bill forms for running account bills.
 16. For the purpose of recording measurements and preparing running account bills, the abbreviated nomenclature indicated in the publications Abbreviated Nomenclature of Items of DSR 2023 shall be accepted. The Abbreviated Nomenclature shall be taken to cover all the materials and operations as per the complete nomenclature of the relevant items in the agreement and relevant specifications.
 17. For the final bill, however, full nomenclature of all the items shall be adopted in preparing abstract in the measurement books and in the bill forms.
 18. It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.
 19. The structural and architectural drawings shall at all times be properly correlated before executing any work. However, in case of any discrepancy, former shall prevail unless otherwise mentioned in bid document or as directed by the Engineer-in-Charge.
 20. The contractor shall maintain in perfect condition, all portions executed till completion of the entire work allotted to him. Where however phased delivery of work is contemplated these provisions shall apply separately to each phase.
 21. The entire royalty at the prevalent rates shall have to be paid by the contractor on all the boulders, metals, shingle sand, earth etc. collected by him for execution of the work, directly to the Revenue authority or authorized agents of the State Government concerned or the Central Government, as the case may be.
 22. All RCC work in Structural members shall be of M30/M35 design mix concrete. The contractor shall install automatic design mix plant having silos for storage of cement etc and transportation of Concrete from plant to concrete pump shall be made by Transit concrete mixer.
 23. Holes for passing and installation of sanitary, water supply, firefighting pipes and cables etc shall be made by using core cutting machine and proper

sealing of these joints / holes shall be done by using suitable non shrink grout material (Conbextra or equivalent) nothing extra shall be paid on this account.

24. The testing of the piles in pile foundation shall be carried out as per BIS 2911 (part 1 to 4)-1985 (Reaffirmed 2000) and NBC 2016.

26. **PROGRAM CHART**

26.1 The contractor shall submit a Detailed construction program (Time and Progress Chart) for execution of work in stipulated period of completion considering each mile stone within 15 days of date of issue of letter of acceptance. The Engineer-in-charge may within 30 days thereafter, if required modify, and communicate the program approved to the contractor failing which the program submitted by the contractor shall be deemed to be approved by the Engineer-in-charge. The work program shall include all details of balance drawings and decisions required by contractor without causing any delay in execution of the work. The chart shall be prepared in direct relation to the time stated in the contract documents for completion of items of the works. It shall indicate the forecast of the dates of commencement and completion of various trades of sections of the work and may be amended as necessary by agreement between the Engineer-in-charge and the contractor within the limitations of time imposed in the Contract documents, and further to ensure good progress during the execution of the work, the contractor shall in all cases in which the time allowed for any work, exceeds one month complete the work as per mile stones given in Schedule "F".

26.2 In case of non-submission of construction program by the contractor the Program approved by the Engineer-in-charge shall be deemed to be final.

26.3 The approval by the Engineer-in-charge of such program shall not relieve the contractor of any of the obligations under the contract.

26.4 The contractor shall submit the Time and progress Chart and progress report using the manually agreed software or in other format decided by by Engineer-in-charge for the work done during previous month to the by Engineer-in-charge on or before 5th day of each month failing which a recovery Rs 5000/- for works costing more than Rs 20.00 Crores shall be made

on

per week or part basis in case of delay in submission of the monthly progress report.

26.5 The program chart should include the following: -

26.5.1 Descriptive note explaining sequence of various activities.

26.5.2 BAR CHARTS prepared in mutually agreed software or in other format decided by by Engineer-in-charge which will indicate resources in financial terms, manpower and specialized equipment's for every important stage.

26.5.3 Program for procurement of materials by the contractor.

26.5.4 Program for arranging and deployment of manpower both skilled and unskilled so as to achieve targeted progress.

26.5.5 Program of deployment of machinery/equipment's having adequate capacity, commensurate with the quantum of work to be done within the stipulated period, by the contractor.

26.5.6 Program for achieving milestones.

27. The submission for approval by the Engineer-in-charge of such program or such particulars shall not relieve the contractor of any of the duties or responsibilities under the contract. This is without prejudice to the right of Engineer-in-charge to take action against the contractor as per terms and conditions of the agreement.

28. The submission for approval by the Engineer-in-charge of such program or the furnishing of such particulars shall not relieve the contractor of any of his duties or responsibilities under the contract. This is without prejudice to the right of Engineer-in-charge to take action against the contractor as per terms and conditions of the agreement.

29. If the work is carried out in more than one shift or during night, no claim on this accounts shall be entertained.

30. Existing drains, pipes, cables, over-head wires, sewer lines, water lines and similar services encountered in the course of the execution of work shall be protected against the damage by the contractor at his own expense. The contractor shall not store materials or otherwise occupy any part of the site in a manner likely to hinder the operation of such services.

31. The contractor shall be responsible for the watch and ward/guard of the buildings, safety of all fittings and fixtures including sanitary and water supply fittings and fixtures provided by him against pilferage and breakage during the period of installations and thereafter till the building is physically handed over to the department. No extra payment shall be made on this account.

32. The contractor shall bear all incidental charges of cartage, storage and safe custody of materials issued by department.

33. Any cement slurry added over base surface for continuation of concreting for better bond is deemed to have been built in the items and nothing extra shall be payable for extra cement considered in consumption on this account.

34. The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, compound wall, services etc. are to be constructed.

35. Any trenching and digging for laying sewer lines/water lines/cables etc. shall be commenced by the contractor only when all men, machinery and materials have been arranged and closing of the trench(s) thereafter shall be ensured within the least possible time.

36. The contractor shall submit for the approval of Engineer-in-Charge names of specialized agencies of repute along with their technical capacity proposed to be engaged by him, who must have executed satisfactorily works of value as specified in mandatory conditions.

37. The work shall be carried out in accordance with the Architectural drawings and structural drawings, to be issued from time to time by the Engineer-in-Charge. Before commencement of any item of work, the contractor shall correlate all the relevant architectural and structural drawings issued for the work and satisfy himself that the information available thereof is complete and unambiguous.

38. The discrepancy, if any shall be brought to the notice of the Engineer-in-Charge before execution of work. The contractor alone shall be responsible for any loss or damage executing by the commencement of work on the basis of any erroneous and or incomplete information.

39. The contractor shall take all precautions to avoid accidents by exhibiting necessary caution boards day and night speed limit boards red flags, red lights and providing barriers. He shall be responsible for all dangers and incidents caused to existing / new work due to negligence on his part.

40. Other agencies may also simultaneously execute and install the works and the contractor shall afford necessary facilities for the same. The contractor shall leave such recesses, holes, openings, trenches etc. as may be required for such related works (for which inserts, sleeves, brackets, conduits, base plates, clamps etc. shall be available as specified elsewhere in the contract) and the contractor shall fix the same at the time of casting of concrete, stone work and brick work, if required, and nothing extra shall be payable on this account.

41. The contractor shall conduct work so as not to interfere with or hinder the progress or completion of the work being performed by other contractor(s) or by the Engineer-in-Charge and shall as far as possible arrange his work and shall place and dispose of the materials being used or removed so as not to interfere with the operations of other contractor or he shall arrange his work with that of the others in an acceptable and coordinated manner and shall perform it in proper sequence to the complete satisfaction of others.

42. The works to be governed by this contract shall cover delivery and transportation up to destination, safe custody at site, insurance, erection, testing and commissioning of the entire works.

43. The contractor shall deploy resources e.g. manpower, labour, T & P plant & Equipment etc. as per actual requirement of work. No damages/compensation shall be payable on account of idle manpower, labour, T&P plant and Equipment and loss of profit etc. for whatsoever reason.

44. The work to be undertaken by the contractor shall inter-alia include the following:

- (i) Preparation of detailed SHOP drawings and AS BUILT drawings wherever

applicable.

- (ii) Obtaining of Statutory permissions where-ever applicable and required.
- (iii) Pre- commissioning tests as per relevant standard specifications, code of practice, Acts and Rules wherever required.
- (iv) Warranty obligation for the equipment's and /or fitting/ fixtures supplied by the contractor. Contractor shall provide all the shop drawings or layout drawings for all the co-ordinated services before starting any work or placing any order of any of the services etc.

45. Articles bearing BIS certifications mark shall only be used unless no manufacturer has got BIS/ISI mark for the particular material. Any material/fitting whose sample has not been approved in advance and any other unapproved material brought by the contractor shall be immediately removed as soon as directed. Where the make of any particular material is not specified in the Contract document, the material shall be supplied as per makes desired by the engineer-in-charge.

46. POUR CARD, CHECK-LIST FOR EXECUTION OF WORK

46.1 As and when any important item is taken up for execution, the agency shall submit the specifications and develop a checklist and pour card. This sample checklist should be got approved from the Engineer-in-Charge and should be used at site.

46.2 This check list should be shown to the Engineer-in-Charge or his/her designee during inspection. This procedure is to be followed for all hidden items, CC/RCC work, steel reinforcement, shuttering, cast-in-situ mosaic flooring, doors & windows, plumbing including water supply pipe lines, roof treatment, earth filling etc. The agency shall render all help and assistance in documenting the total sequence of this project by way of photography, slides, audio-video recording etc. nothing extra shall be payable on this account.

47. PREVENTION OF NUISANCE AND POLLUTION CONTROL

a) The contractor shall take all necessary precautions to prevent any nuisance inconvenience to the owners, tenants or occupiers of adjacent properties and to the public in general and to prevent any damage to such properties from pollutants like smoke, dust noise. The contractor shall use such methodology and equipment so as to cause minimum environmental pollution of any kind and minimum hindrance to road users and to occupants of the adjacent properties or other services running adjacent / near vicinity. The contractor shall make good at his cost and to the satisfaction of the Engineer-in-charge, any damage to roads, paths, cross drainage works or public or private property whatsoever caused due to the execution of the work or by traffic brought thereon by the contractor. All waste or superfluous materials shall be carried away by the contractor, without any reservation, entirely to the satisfaction of the Engineer-in-charge.

b) The contractor shall ensure that all the trucks or vehicles of any kind which are used for construction purpose / or are carrying construction material like cement sand and other allied materials are fully covered.

c) The contractor shall ensure that the construction materials including transportation of earth are covered by tarpaulin.

48. SECURITY AND TRAFFIC ARRANGEMENTS

a) In the event of any restrictions being imposed by the Security Officer of the Institute or any other authority having jurisdiction in the area on the working or movement of labour / material, the contractor shall strictly follow such restrictions and nothing extra shall be payable to the contractor on such accounts. The loss of time on these accounts, if any, shall have to be made up by augmenting additional resources whatever required.

b) No payment will be made for any damage caused by rain, snow fall, flood, earthquake or any other natural calamity, whatsoever during the execution of work. The contractor shall be fully responsible for any damage to the govt. property and the work for which payment has been advanced to him under the contract and he shall make good the same at his risk and cost. The contractor shall be fully responsible for safety and security of his material, T & P / Machinery brought to the site by him.

c) The contractor shall construct suitable godowns, yard at the site of work for storing all materials so as to be safe against damage by sun, rain, damages, fire, theft etc. at his own cost and also employ necessary watch and ward establishment for the purpose at his cost.

d) The Contractor shall keep himself fully informed of all acts and laws of the Central & State Governments, all orders, decrees of statutory bodies, tribunals having any jurisdiction or authority, which in any manner may affect those engaged or employed and anything related to carrying out the work. All the rules & regulations and bye-laws laid down by Collector / MC etc. and any other statutory bodies shall be adhered to, by the contractor, during the execution of work. The Contractor shall also adhere to all traffic restrictions notified by the local authorities. The Contractor shall arrange to give all notices as required by any statutory / regulatory authority and shall pay to such authority all the fees that is required to be paid for the execution of work. He shall protect and indemnify the Institute and its officials & employees against any claim and /or liability arising out of violations of any such laws, ordinances, orders, decrees, by him/her or by his/her employees or his/her authorized representatives. Nothing extra shall be payable on these accounts.

e) For works below ground level the contractor shall keep that area free from water. If dewatering or bailing out of water is required the contractor shall do it and nothing extra shall be paid except otherwise provided in the items of schedule of quantity.

f) The Contractor shall make all necessary arrangements for protecting from rains, fog or likewise extreme Weather conditions, the work already executed

and for carrying out further work, during monsoon including providing and fixing temporary shelters, protections etc.

g) In case of flooding of site on account of rain or any other cause and any consequent damage, whatsoever, no claim financially or otherwise shall be entertained notwithstanding any other provisions elsewhere in the contract agreement. Also, the Contractor shall make good, at his own cost, the damages caused, if any.

h) The contractor will take reasonable precautions to prevent his workman and employees from removing and damaging any flora (tree/plant/vegetation) from the project area.

49. Setting out

a) The contractor shall carry out survey of the work area, at his own cost, setting out the layout of buildings/roads/ services in consultation with the Engineer-in-Charge & proceed further. Any discrepancy between architectural drawings and actual layout at site shall be brought to the notice of the Engineer-in-Charge. It shall be responsibility of the contractor to ensure correct setting out of alignment. Total station survey instruments only shall be used for layout, fixing boundaries, and centre lines etc., Nothing extra shall be payable on this account.

b) The Contractor shall establish, maintain and assume responsibility for grades, lines, levels and benchmarks. He shall report any errors or inconsistencies regarding grades, lines, levels, dimensions etc. to the Engineer-in-Charge before commencing work.

c) If at any time, any error appears due to grades, lines, levels and benchmarks during the progress of the work, the Contractor shall, at his own expense rectify such error, if so required, to the satisfaction of the Engineer-in-Charge. Nothing extra shall be payable on this account.

d) The approval by the Engineer-in-Charge, of the setting out by the Contractor, shall not relieve the Contractor of any of his responsibilities and obligation to rectify the errors /defects, if any.

e) The Contractor shall be entirely and exclusively responsible for the horizontal, vertical and other alignments, the level and correctness of every part of the work and shall rectify effectively any errors or imperfections therein.

f) The rates quoted by the Contractor are deemed to be inclusive of site clearance, setting out work, profile, establishment of reference bench mark(s), taking spot levels, construction of all safety and protection devices, barriers, preparatory works, working during monsoon, working at all depths, height, lead, lift and location etc until / unless specified otherwise and any other incidental works required to complete this work. Nothing extra shall be payable on this account.

50. The contractor should have own constructions equipment required for the

proper and timely execution of the work. Nothing extra shall be paid on this account. No tools and plants including any special T & P etc. shall be supplied by the Department and the Contractor shall have to make his own arrangements at his own cost. No claim of hindrance shall be entertained on this account.

Wherever required for all execution of work, all the scaffolding shall be provided and suitably fixed, by the Contractor.

51. The contractor shall do proper sequencing of the various activities by suitably staggering the activities within various pockets in the plot so as to achieve early completion. The agency to deploy adequate equipment, machinery and labour as required for the completion of the entire work within the stipulated period specified. Also ancillary facilities shall be provided by contractor commensurate with requirement to complete the entire work within the stipulated period. Nothing extra shall be payable on this account. Adequate number/ sets of equipment in working condition, along with adequate stand-by arrangements, shall be deployed during entire construction period.
52. The contractor shall maintain all the work in good condition till the completion of entire work. The Contractor shall be responsible for and shall make good, all damages and repairs, rendered necessary due to fire, rain, traffic, floods or any other causes. The Engineer-in-Charge shall not be responsible for any claims for injuries to person/ workmen or for structural damage to property happening from any neglect, default, want of proper care or misconduct on the part of the Contractor or of any other of his representatives, in his employment during the execution of the work. The compensation, if any, shall be paid directly to the Department / authority/ persons concerned, by the Contractor at his own cost.
53. The contractor shall take all precautions to abide by the environmental related restrictions imposed by any statutory body having jurisdiction in the area as well as prevent any pollution of streams, rivines, river bed and waterways. All waste or superfluous materials shall be transported by the Contractor, entirely to the satisfaction of the Engineer-in-Charge and disposed at designated places only. No claim what so ever on account of site constraints mentioned above or any other site constraints, lack of public transport, inadequate availability of skilled, semi-skilled or unskilled workers in the near vicinity, non-availability of construction machinery spare parts and any other constraints not specifically stated here, shall be entertained from the Contractor. Therefore, the Tenderers are advised to visit site and get first-hand information of site constraints. Accordingly, they should quote their tenders. Nothing extra shall be payable on this account.
54. The contractor shall cooperate with and provide the facilities to the associate Contractors and other agencies working at site for smooth execution of the work. The Contractor shall indemnify the Department against any claim (s) arising out of such disputes. The Contractor shall:
 - a. Allow use of scaffolding, toilets, sheds etc.
 - b. Properly co-ordinate their work with the work of other Contractors.

- c. Provide control lines and benchmarks to his associate Contractors and the other Contractors.
 - d. Provide electricity and water at mutually agreed rates.
 - e. Provide hoist and crane facilities for lifting material at mutually agreed rates.
 - f. Co-ordinate with other Contractors for leaving inserts, making chases, alignment of services etc. at site.
 - g. Adjust work schedule and site activities in consultation with the Engineer-in-Charge and other Contractors to suit the overall schedule completion.
 - h. Resolve the disputes with other Contractors / associate contractors amicably and the Engineer-in-Charge shall not be made intermediary or arbitrator.
55. The work should be planned in a systematic manner so as to ensure proper co-ordination of various disciplines viz. sanitary & water supply, drainage, rain water harvesting, electrical, firefighting & fire alarm system, information technology, communication & electronics and any other services.
56. All fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on project location during excavation / construction shall be the property of the Government, and shall be dealt with as per provisions of the relevant legislation. The contractor will take reasonable precaution to prevent his work men or any other persons from removing and damaging any such articles or thing. He will, immediately upon discovery thereof and before removal acquaint the Engineer-in-Charge of such discovery and carry out the official instructions of Engineer-in-Charge for dealing with the same, till then all work shall be carried out in a way so as not to disturb / damage such article or thing.
57. He shall protect and indemnify the Institute and its officials & employees against any claim and /or liability arising out of violations of any such laws, ordinances, orders, decrees, by himself or by his employees or his authorized representatives. Nothing extra shall be payable on these accounts.
58. The Contractor shall assume all liability, financial or otherwise in connection with the contract and shall protect and indemnify the Department from any and all damages and claims that may arise on any account. The Contractor shall indemnify the Department against all claims in respect of patent rights, royalties, design trademarks- of name or other protected rights, damages to adjacent buildings, roads or members of public, in course of execution of work or any other reasons whatsoever, and shall himself defend all actions arising from such claims and shall indemnify the Department in all respect from such actions, costs and expenses. Nothing extra shall be payable on this account.

59. Supervision of work

The Contractor shall depute Site Engineer & skilled workers as required for the work. He shall submit organization chart along with details of Engineers and

supervisory staff. It shall be ensured that all decision making powers shall be available to the representatives of the Contractor at site itself to avoid any likely delays on this account. The Contractor shall also furnish list of persons for specialized works to be executed for various items of work. The Contractor shall identify and deploy key persons having qualifications and experience in the similar and other major works, as per the field of their expertise. If during the course of execution of work, the Engineer-in-Charge is of the opinion that the deployed staff is not sufficient or not well experienced, the Contractor shall deploy more staff or better experienced staff at site to complete the work with quality and in stipulated time limit. Principal Technical representative of the Contractor having minimum experience in similar nature of work as mentioned in the clause 32 of schedule-F, shall always be available at the site during the actual execution of the work.

60.Cleanliness of site

- a. The Contractor shall not stack building material / malba / muck on the land or road of the institute or on the land owned by the others, as the case may be. So the muck, rubbish etc. shall be removed periodically as directed by the Engineer-in-Charge, from the site of work to the approved dumping grounds as per the local bye laws and regulations of the concerned authorities and all necessary permissions in this regard from the local bodies shall be obtained by the Contractor. Nothing extra shall be payable on this account. In case the Contractor is found stacking the building material / malba as stated above, the Contractor shall be liable to pay the stacking charges / penalty as may be levied by the local body or any other authority and also to face penal action as per the rules, regulations and bye-laws of such body or authority. The Engineer-in-Charge shall be at liberty to recover, such sums due but not paid to the concerned authorities on the above accounts, from any sums due to the Contractor including amount of the Security Deposit and performance guarantee in respect of this contract agreement.
- b. The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, services and compound walls are to be constructed.
- c. The contractor shall take all care to prevent any water-logging at site. The waste water, slush etc. shall not be collected at site. For discharge into public drainage system, necessary permission shall be obtained from relevant authorities after paying the necessary charges, if any, directly to the authorities. The work shall be carried out in such a way that the area is kept clean and tidy. All the fees / charges in this regard shall be borne by the Contractor. Nothing extra shall be payable on this account.

61.Inspection of work

Officers of IWD,IITK/Third Party Quality Assurance Team/ users committee appointed by Institute shall be inspecting the on-going work at site at any time with or without prior intimation. The contractor shall, therefore, keep updated the following requirements and detailing.

- a. Display Board showing detail of work, weekly progress achieved with respect to targets, reason of shortfall, status of manpower, wages being paid for different categories of workers.
- b. Entrance and area surrounding to be kept cleaned.
- c. Display layout plan key plan, Building drawings including plans, elevations and sections.
- d. Up-to-date displays of Bar chart, CPM and PERT etc.
- e. Keep details of quantities executed, balance quantities, deviations, possible Extra item, substituted Item etc.
- f. Keep plastic / cloth mounted one sets of building drawings.
- g. Set of Helmets and safety shoes for exclusive use for officers / dignitaries visiting at site.

62. Insurance Policy

- (i) Before commencing the execution of work, the Contractor shall, without in any way limiting his obligations and liabilities, insure at his own cost and expense against any damage or loss or injury, which may be caused to any person or property, at site of work. **The Contractor shall obtain and submit to the Engineer-in-Charge proper Contractor All Risk Insurance Policy for an amount 1.25 times the contract amount for this work, with Engineer-in-Charge as the first beneficiary.** The insurance shall be obtained in joint names of Engineer-in-Charge and the Contractor (who shall be second beneficiary). Also, he shall indemnify the Department from any liability during the entire execution of the work.
- (ii) Further, agency shall obtain and submit to the Engineer-in-Charge, a third-party insurance policy for maximum Rs.....lakh for each accident, with the Engineer-in-Charge as the first beneficiary. The insurance shall be obtained in joint names of Engineer-in-Charge and the Contractor (who shall be second beneficiary).
- (iii) The Contractor shall, from time to time, provide documentary evidence as regards payment of premium for Insurance Policy for keeping them valid till the completion of the work. Without prejudice to any of its obligations and responsibilities specified above, the Contractor shall within 15 days from the date of letter of acceptance of the tender and thereafter at the end of each quarter submit a report to the Department giving details of the Insurance Policy along with Certificate of this insurance policy being valid, alongwith documentary evidences as required by the Engineer-in-Charge. No

work shall be commenced by the Contractor unless he obtains the Insurance Policy as mentioned above. Also, no payment shall be made to the Contractor on expiry of insurance policy unless renewed by the Contractor. Nothing extra shall be payable on this account. No claim of hindrance (or any other claim) shall be entertained from the contractor on this accounts.

63. On completion of work, the contractor shall submit at his own cost four prints of **"as built" drawings to the Engineer-in-Charge within 30 days of completion of work.** These drawings shall have the following information:

- a. Route of all piping and their diameters including soil waste pipes & vertical stacks.
- b. Ground and invert levels of all drainage pipes together with locations of all manholes and connection upto outfall.
- c. Route of all water supply lines with diameters, location of control valves, access panels etc.

64. Condition regarding secured advance

Secured advance shall be admissible only on those bonafide materials which are likely to be used in the work in a period not exceeding six months from the date of secured advance payment. If agency fails to use the material (in respect of which secured advance have been paid) in the work in this specified period of six month, the said component of secured advance shall be recovered from next running account bill paid to the agency.

65. Personal Safety Measures for Labour

Contractor shall provide the following items for safety of workers employed by contractor and associate agencies:

- (i) Protective footwear / helmet and gloves to all workers employed for the work on mixing, cement, lime mortars, concrete etc. and openings in water pipeline/sewer line.
- (ii) Welder's protective eye-shields to workers who are engaged in welding works.
- (iii) Safety helmet and Safety harness/ belt Provide adequate sanitation/safety facilities for construction workers to ensure the health and safety of the workers during construction, with effective provisions for the basic facilities such as sanitation, drinking water and safety equipment's or machinery.

- (iv) All the workers should be wearing helmet and shoes all the time on site.
- (v) Masks and gloves should be worn whenever and wherever required.
- (vi) Adequate drinking water facility should be provided at site, adequate number of decentralized latrines and urinals to be provided for construction workers.
- (vii) Full time workers (if any with the approval of Engineer-in-Charge) residing on site should be provided with clean and adequate temporary hutment.
- (viii) First aid facility should also be provided.
- (ix) Overhead lifting of heavy materials should be avoided. Barrow wheel and hand-lift boxes should be used to transport materials onsite.
- (x) Tobacco and cigarette smoking should be prohibited onsite.
- (xi) All dangerous parts of machinery are well guarded and all precautions for working on machinery are taken.
- (xii) Maintain hoists and lifts, lifting machines, chains, ropes and other lifting tackles in good condition. Provide safety net of adequate strength to arrest falling material down below.
- (xiii) Use of durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained.
- (xiv) Ensure that walking surfaces or boards at height are of sound construction and are provided with safety rails and belts. Provide protective equipment's such as helmets.
- (xv) Provide measure to prevent fire. Fire extinguisher and buckets of sand to be provided in fire prone area and elsewhere.
- (xvi) Provide sufficient and suitable light for working during night.
- (xvii) Ensure that measures to protect workers from materials of construction, transportation, storage and other dangers and health hazards are taken.
- (xviii) Ensure that the construction firm/division/company have sound safety policies.
- (xix) Comply with the safety procedure, norms and guidelines (as applicable) as

outlined in NBC 2005 (BIS 2005c).

- (xx) Adopt additional best practices and prescribed norms as in NBC 2005 (BIS2005).

66. Water Pollution

- (i) The Contractor shall take all precautionary measures to prevent the wastewater during construction to accumulate anywhere.
- (ii) The wastewater arising from the project is to be disposed of in the manner that is acceptable to the Engineer-in-Charge.

67. Air and Noise Pollution

Contractor shall use dust screens and sprinkle water around the construction site to arrest spreading of dust in the air and surrounding areas.

- (i) Contractor shall ensure that all vehicles, equipment and machinery used for construction are regularly maintained and confirm that emission levels comply with environmental emission standards / norms.
- (ii) For controlling the noise for Vehicles, Plants and Equipments, the Contractor shall confirm the following:
 - i. All vehicles and equipment used in construction will be fitted with exhaust silencers.
 - ii. Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.
- (iii) Noise emission from compactors (rollers) front loaders, concrete mixers, cranes (movable), vibrators and saws should be less than 75 dB (A).
- (iv) As per the standards / guidelines for control of Noise Pollution from Stationary Diesel Generator (DG) sets, noise emission in dB(A) from DG set (15-500 KVA) should be less than $94 + 10 \log_{10} (\text{KVA})$. The standards also suggest construction of acoustic enclosure around the DG Set and provision of proper exhaust muffler with insertion loss of minimum 25 dB(A) as mandatory.

68. Construction Vehicles, Equipment and Machinery

- a) All vehicles, equipment and machinery to be produced for construction shall conform to the relevant Bureau of India (BIS) Norms.
- b) Emission from the vehicles must conform to environmental norms.
- c) Dust produced from the vehicular movement and other site activities is to be mitigated by sprinkling of water.
- d) Noise limits for construction equipments shall not exceed 75 dB(A), measured at one meter from the edge of the equipment in free area, as specified in the Environment Protection Act, 1986, schedule VI part E, as amended on 9th May 1993. The maximum noise levels near the construction site should be limited to 65 dB (A) Leq (5 min) in project

area.

69. Construction Wastes Disposal

The pre-identified dump locations will be a part of solid waste management plan to be prepared by the Contractor in consultation with Engineer-in- Charge.

- a) Contractor shall get approved the location of disposal site prior to commencement of the excavation on any section of the project location.
- b) Contractor shall ensure that any spoils of material / construction waste will not be disposed off in any municipality solid waste collection bins.

70. Procurement of Construction Materials

1. All vehicles delivering construction materials to the site shall be covered to avoid spillage of materials and maintain cleanliness of the roads.
2. Wheel types of all vehicles used by the contractor, or any of his sub contractor or materials suppliers shall be cleaned and washed clear of all dust / mud before leaving the project premises. This shall be done by routing the vehicles through tyre washing tracks.
3. Contractor shall arrange for regular water sprinkling at least twice a day (i.e. morning and evening) for dust suppression of the construction sites and unpaved roads used by his construction vehicles.
4. Identify roads on-site that would be used for vehicular traffic. Update vehicular roads (if these are unpaved) by increasing the surface strength by improving particle size, shape and mineral type that make up the surface base. Add surface gravel to reduce source of dust emission. Limit amount of fine particles (smaller than 0.075mm) to 10-20%. Limit vehicular speed on site 10km/h. Nothing extra will be payable for this.
5. All material storages should be adequately covered and contained so that they are not exposed to situations where winds on site could lead to dust / particulate emissions.
6. Ensure that water spraying is carried out by wetting the surface by spraying water on :
 - Any dust material.
 - Areas where demolition work is carried out.
 - Any unpaved main-haul road and.
 - Areas where excavation or earth moving activities are to be carried out.
7. The contractor shall ensure the following:
 1. Cover and enclose the site by providing duct screen, sheeting of height not less than 6 meter or netting to scaffold along the perimeter of a building or group of the buildings.
 2. Covering stockpiles of dusty material with impervious sheeting.

3. Covering dusty load on vehicles by impervious sheeting before they leave the site.
4. Transferring, handling / storing dry loose materials like bulk cement and dry pulverized flyash inside a totally enclosed system.
5. Spills of dirt or dusty materials shall be cleaned up promptly so that the spilled material does not become a source of fugitive dust and also to prevent seepage of pollutant laden water into the ground aquifers. When cleaning up the spill, ensure that the clean-up process does not generate additional dust. Similarly, spilled concrete slurries or liquid wastes should be contained / cleaned up immediately before they can infiltrate into the soil / ground or runoff in nearby areas.
6. Clear vegetation only from areas where work will start right a way.
7. Adopt measure to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices should be followed (as adopted from international best practice documents and codes).
8. Provide sheet covering / barricading of site of not less than 6 meter height along the site boundary, next to a road or other public area. Nothing extra will be paid for this.
9. The contractor shall provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the method of working, plant equipment and air pollution control system to be used on-site should be made available for the inspection and approval of the Engineer-in-Charge to ensure that these are suitable for the project.
10. Employ measures to segregate the waste on-site into inert, chemical or hazardous wastes. Recycle the unused chemical / hazardous wastes such as oil, paint, batteries and asbestos. The inert waste is to be disposed off to Municipal Corporation / local bodies dump yard and land fill sites.
11. To preserve the existing landscape and protect it from degradation during the process of construction. Select proper timing for construction activity to minimize the disturbance such as soil pollution due to spilling of the construction material and its mixing with rainwater. The construction management plan including soil erosion control management plan shall be prepared accordingly for each month. The application of erosion control measures includes construction of gravel pits and tyre washing bays of approved size and specification for all vehicular site entry / exits, protection of slopes greater than 10%. Sedimentation Collection System and run-off diversion systems shall be in place before the commencement of construction activity. Preserve and protect the existing vegetation by not disturbing or damaging to specified site areas during construction.
12. The Contractor should follow the construction plan as proposed by the Engineer-in-charge to minimize the site disturbance such as soil pollution due to spilling. Use staging and spill prevention and control plan to

- restrict the spilling of the contaminating material on site.
13. Spill prevention and control plans should clearly state measures to stop the source of the spill. Measures to contain the spill and measures to dispose the contaminated material and hazardous wastes. It should also state the designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners and petroleum products.
 14. A soil Erosion and Sedimentation Control Plan (ESCP) should be prepared prior to construction and should be applied effectively.
 15. The contractor shall prepare and submit 'Spill prevention and control plans' before the start of construction, clearly stating measures to stop the source of the spill, to contain the spill, to dispose the contaminated material and hazardous wastes, and stating designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners, and petroleum products.
 16. The contractor shall ensure that no construction leaches (Ex: cement slurry) is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including reduction of wasteful curing processes, collection, basic filtering and reuse. The contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/ swale, etc. shall be constructed to carry the pollutant – laden water directly to the treatment device or facility (municipal sewer line).
 17. All lighting installed by the contractor around the contractor around the site and at the labour quarters during construction shall be CFL bulbs of the appropriate Illumination levels. This condition is a must, unless specifically prescribed otherwise.

No extra payment will be made for operation/ activity mentioned at
Sl.No. 1
to 18 above unless specifically mentioned otherwise.

71. National Green Tribunal Guidelines

- (i) The contractor shall not store/ dump construction material or debris on metalled road.
- (ii) The contractor shall get prior approval from Engineer-in-Charge for the area where the construction material or debris can be stored beyond the material road. This area shall not cause any obstruction to the free flow of traffic/ inconvenience to the pedestrians. It should be ensured by the contractor that no accidents occur on account of such permissible storage.
- (iii) The contractor shall ensure that all the trucks or vehicles of any kind which are used for construction purpose/ or are carrying construction material like cement, sand and other allied material are fully covered. The contractor shall take every necessary precaution that the vehicles are

properly cleaned and dust free to ensure that enroute their destination, the dust sand or any particles are not released in air/ contaminate air.

- (iv) The contractor shall provide mask to every worker working on the construction site and involved in loading, uploading and carriage of construction material and construction debris to prevent inhalation of dust particles.
- (v) The contractor shall provide all medical help, investigation and treatment to the workers involved in the construction of building and carry of construction material and debris relating to dust emission.
- (vi) The contractor shall ensure that C&D waste is transported to the C&D Waste site only and due record shall be maintained by the contractor.
- (vii) The contractor shall compulsory use of wet jet in grinding and stone cutting.
- (viii) The contractor shall comply all the preventive and protective environmental steps as stated in the MoEF guidelines, 2010.
- (ix) The contractor shall carry out on-Road-Inspection for black smoke generating machinery.
- (x) The contractor shall use cleaner fuel.
- (xi) The contractor shall ensure that all DG sets comply emission norms notified by MoEF.
- (xii) The contractor shall use vehicles having pollution under control certificate. The emissions can be reduced by a large extent by reducing the speed of a vehicle to 20 kmph. Speed bumps shall be used to ensure speed reduction. In cases where speed reduction cannot effectively reduce fugitive, the contractor shall divert traffic to nearby paved areas.
- (xiii) The contractor shall ensure that the construction material is covered by tarpaulin. The contractor shall take all other precaution to ensure that no dust particles are permitted to pollute air quality as a result of such storage.
- (xiv) The paving of the path for plying of vehicles carrying construction material is more permanent solution to dust control and suitable for longer duration projects.
- (xv) The natural drainage system should be maintained by the contractor at his own cost. Local Bye-law/ provisions on Rain Water Harvesting should be followed.

No extra payment will be made for operation/ activity mentioned at Sl.No. 71 (i) to 71 (xv) above.

72. Project Monitoring

- (i) The Agency shall prepare the phase wise (monthly) resource chart (materials, manpower and machinery) based on the project execution schedule as per clause 5.1 of GCC.
- (ii) The Agency shall submit the photographs & videos of progress of work on fortnightly basis to make it possible to create a short film of the entire execution of the work to be kept in archive.
- (iii) Agency shall submit a detailed Monthly progress & program report to the

Engineer-in-Charge by 5th of every month. The format of monthly progress & program report shall be as approved by Engineer-in-Charge.

- (iv) The agency will make it possible to be represented by a senior level executive who have sufficient financial powers to take decisions required for completing the project in time.
- (v) The agency shall stick to the construction schedule, if there is any hindrance or delay due to any reason the same shall be mitigated through engaging extra manpower, material and machinery.

73. Documentation of work: Agency shall make documentation in regard to the various stages of progress of work. Nothing shall be paid on this account to the contractor. The scope includes:-

- (i) Colour photography of the work at month interval or lesser interval as per direction of Engineer-in-Charge and at the completion of work covering the entire work up to that stage and supplying the same in soft copy with storage instrument of required capacity as per direction of Engineer-in-Charge.
- (ii) Videography of the execution of work every three months or lesser interval and at completion of work i/c preparation of documentary with voice over showing the progress of work as directed by Engineer-in-Charge.
- (iii) Each photograph / video shall be suitably captioned and dated.
- (iv) The photographs/ video and materials including soft copy shall form a part of the records of CPWD and the prints cannot be supplied to anybody else or published without the written permission of Engineer-in-Charge.
All documents i/c photograph/video and other documents in hard copy shall be submitted by the agency to the Engineer-in-Charge on monthly basis for record purpose.

1.0 SCOPE OF WORK

1.1 The work shall be executed in accordance with the layout plan, architectural, structural, MEP, External Development and services drawings attached with bid document with the intent to complete and hand over the project in satisfactory condition and ready for occupation.

1.2 The Contractor's attention is drawn toward present site condition. All the area marked in layout plan attached with this bid document shall be handed over to contractor. The works shall be done on ground as available; therefore, no claim for extra cost or time shall be entertained on this account. The land is free from encroachment and there is no hindrance to execute the work. The agency shall fix a permanent bench mark at the site of work. Plinth level shall be fixed above the General finished ground level as per drawings and decided by Engineer-in-charge. The data provided in this document are for general guidance. Changes, if any, would not affect the agreed rates and no claim on this account shall be entertained.

1.3 To carry out survey of the site for execution of the project and shall verify the site dimensions as per the site plan provided with bid document/ or made available by Engineer-in-Charge.

1.4 Providing and erecting 05 (five) metre high temporary/ barricading of brand –new profile sheet with MS tubular members of appropriate sizes as approved by Engineer-in-Charge on the construction site. After completion of work, the contractor will take away all the barricading material. Nothing shall be paid on this account.

1.5 The work is to be executed as per Good for Construction (GFC) drawings attached and General specifications, Schedule of finishes, and other terms and conditions mentioned in the bid document.

1.6 CPWD Specifications 2019 Vol-I and Vol-II as amended upto last date of submission of bid shall be applicable for all the items/ sub-items to be executed as per Good for Construction (GFC) drawings.

1.7 Those items which are to be executed under the scope of this NIT and for which CPWD specifications are not available, such items shall be executed in compliance with the specifications mentioned separately in this document and/or as per relevant IS codes, International Standards etc. as applicable or as per the direction of Engineer-in-Charge.

1.8 Execution of all **internal services** like internal sanitary, water supply, drainage system etc. complete including all its fittings, fixtures and testing etc.

complete to make the buildings habitable shall be within the scope of work.

1.9 Execution of all **External services** like water supply, sewerage, drainage system, Rain water harvesting system, Roads, Pathways, Providing and laying HT & LT electrical cable, HVAC lines, parking and all connected sub-structures and superstructures within the premises (as marked in layout plan), as per bye-laws and norms of the local bodies including making connections with the peripheral services after getting the services approved from Engineer-in-Charge within the scope of work.

1.10 The scope also includes construction / installation of underground water tank and pump house, firefighting tanks including SITC of pumps and stand by pumps for water supply and for firefighting both, including required connections as per approved drawings / specifications and as directed by Engineer-in-Charge.

1.11 Construction of Electric Sub-station (ESS) Building as per GFC drawings including SITC of LT & HT Panels etc. is within the scope of work.

1.12 The scope also includes boring and development of Tubewell as per specification / schedule of finishes given in bid document.

1.13 Execution of the roof top rainwater harvesting system for recharging the sub-soil water including laying of pipelines and construction of substructure / superstructures as per GFC drawings is within the scope of work.

1.14 Complete leveling / dressing including filling of earth, its supply from outside of the campus or disposal of surplus earth as required to maintain the finished level as per the GFC drawings is within the scope of work.

1.15 Taking all precautionary measures to safeguard safety measures against any accidents for the agency's employees, labour, public, and staff of IWD by providing all necessary safety equipment, helmets etc. at work site.

1.17 The Agency shall construct/provide one site office (semi-permanent structure) with modern outlook and having Air Conditioning, for use by Engineer-in-charge and his staff consisting of room with toilet (not less than 40 sqm) and one conference Room with toilet having area not less than 50 sqm for CPWD officers & staff. The location and plan shall be got approved from Engineer-in-Charge. Specification for the site office shall be suitable and matching for running an office which shall be got approved from Engineer-in-charge. The Agency shall provide a typical plan of site office & conference room (having light fixtures, wiring &, AC etc.) with specification within 15 days of award of work and shall construct after approval of Engineer-in-Charge. All running cost & charges (i/c one office attendant, one data entry Operator and AMC etc.) for office including Electricity, water supply, RO/ drinking water etc. shall be provided and cost shall

be borne by the agency.

1.19 The agency shall provide the following furniture (new) for use of IWD staff at site office and will take them away these items after completion of work.

S.No.	Articles	Quantity
1.	Office Tables	2 Nos.
2.	Office Chairs	2 Nos.
3.	Steel Almirah (Big)	1 No.
4.	Visitor chairs	4 Nos.
5.	Conference Table (10-seater) with chair	1 No
6.	Air Conditioner of appropriate capacity	02 No. of 2.0 Ton capacity (01 in each room)

1.20 The scope as described above is only indicative and not exhaustive. In additions to the above the agency shall be responsible for executing all the items required for completing the building in all respect to make the building habitable and ready for occupation with electrical works complete as per direction of Engineer-in-charge.

1.21 The above scope of work includes cost of all materials, manpower, equipment's, T&P fixtures, accessories, royalties, all taxes (excluding GST) watch & ward till handing over the complete premises to the department and all other essential elements for completion Any change, modification, revision etc. required to be done by user's Committee, IWD etc. in accordance with applicable standards and bye- laws will have to be done at agency's cost and nothing extra shall be payable.

1.22 All GFC drawings shall be made available to contractor from start of work and if there is any clarification required by contractor, the same will be issued as per requirement of work.

1.23 **External Bulk Services** as per GFC drawings and execution upto completion as per scope of work complete.

1.24 **External Bulk Services:** Execution upto completion of 1. Water supply, 2. Sewerage system, 3. Storm water drains, 4. Roads, 5. Paths, 6. Rain Water Harvest, 7. UG Tank, Cabling etc. all complete as per GFC drawings, are in the scope of work.

1.25 Execution of Internal Electrification, Fire Alarm System, Fire-fighting system, CCTV, Point wiring, Lifts, with all equipment's and external lighting, and any other services all complete as per GFC drawings, as per the direction of the Engineer-in-Charge and also required for satisfactory completion of project etc. are within the scope of work.

1.26 The cost of deficiency charges and rectification of any defect at the end of the job, if any is also to be borne by the agency.

1.27 The above scope of work includes cost of all materials, manpower, workmanship, equipment's, T&P fixtures, accessories, royalties, taxes excluding GST watch & ward, incidentals till handing over the complete premises so the department or IIT Kanpur.

1.28 Contractor has to install and maintain the adequate Nos of CCTV cameras at site during execution to provide feed of the various construction activities in the portal of Institute to be accessible by the IWD, senior officers.

1.29 Local Body Approvals

The status of local body approvals is as under: - Pre-constructional local body approvals from different statutory bodies is the responsibility of the Architect who has been already appointed. The Architect shall obtain Provisional Fire NOC from fire department. Final approvals/NOC/permissions etc. shall be obtained by the contractor at his own level. Nothing extra shall be paid on this account.

PART B-2

GENERAL GUIDELINES PARTICULAR SPECIFICATIONS AND SCHEDULE OF FINISHES FOR CIVIL WORK

GENERAL GUIDELINES

1. All the items of Delhi Schedule of rates are in the scope of work against the tender, as may be applicable for all the items to be executed as per Good for construction drawings.
2. CPWD Specifications Vol-I and Vol-II as amended from time to time shall be applicable for all the items to be executed as per Good for Construction drawings.
3. Provisions contained in Harmonized Guidelines for Universal Accessibility in India 2021 of Ministry of Housing and Urban Affairs, Government of India shall be complied with.
4. All the work shall be carried out as per GFC drawings and schedules of finishes civil and Electrical specifications mentioned in bid document.
5. Type of cement to be used in the work shall be as per provisions of IS:456 with regard to exposure conditions including Sulphate attack.
6. Only potable water shall be used in the work.
7. Plinth filling shall be done as per GFC drawings with earth suitable for plinth filling including filling of sand of grading zone IV or V as per CPWD specifications and thickness as per GFC drawing.
8. All the horizontal, vertical, inclined projections of the structure like porticos, slab projections, staircases, mumty, lift machine rooms, water tanks, any other architectural features shall be constructed as integral part of the structure.
9. Leveling course to be provided on the top of RCC slab before laying flooring as per site requirement.
10. CC grading to provide necessary slope in toilet/ kitchen/ Balcony shall be provided.
11. NP3 / HDPE pipe of required diameter including testing of joints as per specification shall be provided at road crossings.
12. Manholes shall be provided as per GFC drawings.

PARTICULAR SPECIFICATIONS

1.0 EARTH WORK:

1.1 General.

The excavation work shall be done in accordance with CPWD specifications 2019 Volume-I & II.

Any trenching and digging for laying sewer lines/water lines/cables etc. shall be commenced by the contractor only when all men, machinery and materials have been arranged and closing of the trench(s) thereafter shall be ensured within the least possible time.

The final development level is to be achieved as per drawings. If there is any requirement of additional earth, the same shall be brought by contractor from outside IIT Kanpur campus and nothing extra shall be payable on this account. Similarly, if there is any disposal of extra earth, rubbish, malba etc., the same shall be done by contractor as per direction of Engineer-in-Charge. Nothing extra shall be payable on this account.

1.2 Setting out

The Contractor shall be responsible for accurately setting out the works to the specified positions, dimensions, levels, and building lines and also surveying the site for dimensional and level accuracy and reporting any discrepancies before the commencement of work.

Any errors in position, level, dimension or alignment of any part of the work any time shall be rectified by the contractor at his own expense. The contractor shall provide the Engineer-in-Charge or his authorized representative with all facilities, equipment and labour to enable him to check the setting out point, line or level by the Engineer-in-Charge or his authorized representative shall not in any way receive the Contractor of his responsibility.

1.3 Applicable Standards

The Contractor shall ensure to follow the applicable Standards/ Specifications related to the excavation including local building regulations and statutory regulations.

1.4 Labour and Equipment:

The Contractor shall provide all labours, equipment, materials and any incidentals necessary to complete all aspects of work included in the drawings and specifications.

1.5 Related works:

- 1.5.1.1 Clearing, grubbing, and removing all vegetation from the site.
- 1.5.1.2 Excavation including getting out and necessary dressing to make surface ready to receive the building.
- 1.5.1.3 Filling, back filling and compaction of fills
- 1.5.1.4 Removal and disposal of surplus material.
- 1.5.1.5 Dewatering.
- 1.5.1.6 Road, path drains etc.

1.5.1.7 Bringing shortage of earth from outside the IIT Kanpur campus to raise the NGL as per GFC drawings.

1.6 Disposal of Surplus earth & supply of shortage earth

All excavated material including excavated earth declared as surplus and not useful, shall be removed from the site by the contractor as per approved plan. The removal of surplus material shall only be undertaken by the contractor when instructions in this regard are obtained from Engineer-in-Charge. No payment/ fees on this account shall be entertained by the department. Royalty, if any, to be paid to bring shortage of earth by the contractor, nothing extra shall be paid.

No excess excavated earth, malba/ rubbish, etc. shall be dumped by the agency at any place inside the campus. Contractor shall also obtain necessary permissions/ approvals authorization from the competent authority of local body/ traffic/ police as the case may be for removal of excavated earth/ material. No payment/ fees on this account shall be entertained by the department. The same system vice versa will be followed by contractor for bringing shortage earth at side from outside. No payment / fees on this account shall be entertained by the department.

1.7 The contractor may encounters rock/ stones/ boulders during excavation of foundation, trenches or any other earthwork the contractor shall remove the rocks from the site upto any lead and nothing extra shall be paid on this account.

2.0 Dewatering

Dewatering is in the scope of contract as per this tender document. Dewatering shall be performed as per CPWD Specifications Volume-I & II with correction slips upto the last date of submission of bid. The contractor shall arrange to have the entire dewatering system throughout the course of the work.

2.1 The Contractor shall install, maintain and operate a system of wells, trenches and pumps as required for performing the excavations for the areas and subsequent construction of the structure and placement of backfill, in dry condition.

2.2 Dewatering of the excavation shall be accomplished in a manner that will prevent seepage, boils, loss of fines, corrosion, softening of the strata, and that will maintain the stability of the bottom and slopes of excavation.

2.3 During excavation/ filling of earth, if any, water supply line, sewer line, electrical cable or any such services are encountered/ getting damaged these shall be restored/ shifted by the contractor at his own cost as directed by Engineer-in-Charge and nothing extra shall be paid on this account.

2.4 In case any damage is caused to the work, in the opinion of Engineer in charge, due to inadequacy or failure of the dewatering system, in part or in whole, then the supply of all labour, materials and plant required to make good for such damage shall be undertaken and re-done by the contractor at his own cost.

2.5 The dewatering system shall be designed to operate on a continuous basis in such a manner that during excavation, the water level shall be kept below the working level for laying of PCC, concrete or any other work, etc.

2.6 Contractor shall obtain necessary permissions from the competent authority of local body regulatory body/ traffic/ irrigation department etc, at his own level to drain pumped out water. The arrangement shall include cost of material in respect of laying pipes, making drains from site to the final disposal of dewatering pump out water shall be made by the contractor at his own level and cost. No claim shall be entertained on this account by the department.

3.0 Landscape area

All cutting and filling of earth required to maintain the required finished level of complete in the area as mentioned in the layout/building/GFC drawings is in the scope of contractor. All filling should be done with available excavated earth and as per CPWD specifications and if the earth is not available, the same of approved quality to be brought from outside as decided by Engineer-in-Charge and Contractor strictly advised to assess the required quantity before hand to quote his rate accordingly and nothing extra shall be paid on this account.

4.0 Sand filling

Supplying and filling with local sand including watering, ramming, consolidating and dressing complete as per CPWD specifications shall be done as mentioned in GFC drawing.

5.0 CONCRETE WORK

5.1.1 Plain cement Concrete / Lean Cement

Plain cement Concrete / Lean Concrete of required proportions and in required thicknesses as per GFC drawings shall be laid below the foundation, kerb stone, road, footpath, courtyards, under floors and wherever required as per drawings, particular specifications & CPWD Specifications Volume –I & II with correction slips up to the last date of submission of bid. 40/20 mm nominal size graded stone aggregate derived from natural sources shall be used in all Plain Cement Concrete / lean concrete, unless specified otherwise or as directed by the Engineer-in-Charge.

Light weight sunken floor filling

Sunken floor filling shall be done with cement concrete 1:3:6 as shown in GFC drawings. The sunken floors shall be filled with machine mixed cement concrete in volumetric proportion 1:3:6 in specified thickness including centering and shuttering if required, laying spreading, ramming, consolidating as per requirement and curing etc. complete as directed by the Engineer-in-Charge and as per GFC drawings.

Damp Proof Course

Damp Proof Course shall be with 50 mm thick cement concrete 1:2:4 mixed with approved water proofing compound painted at top with a coat of residual petroleum bitumen of grade VG-10 of approved quality at 1.7 kg/sqm.

Plinth Protection and external development:

Plinth Protection and external development shall be as shown in GFC drawings.

6.0 REINFORCED CEMENT CONCRETE WORK

The work shall be done as per CPWD specifications 2019 Volume- I & II with correction slips up to the last date of submission of tender documents. The RCC work shall be carried out by using Normal Design mix concrete or Self Compacting design mix Concrete of M30/M35 Grade or above as shown in the GFC drawings and schedule of finishes or as directed by the Engineer-in-Charge.

6.1.1 If the quantity of cement actually used in the work is found to be more than the theoretical quantity of cement including authorized variation, nothing extra shall be payable to the contractor on this account. Normally as per Mix Design of various grades cement content goes high and extra cement is consumed. The consumption of extra cement shall be included in the scope of work and nothing extra shall be paid on this account.

6.1.2 For non-scheduled items, the decision of the Superintending Engineer, IWD, IIT Kanpur regarding theoretical quantity of the cement which should have been actually used shall be final and binding on the contractor.

6.1.3 Cement brought to site and cement remaining unused after completion of work shall not be removed from site without written permission of the Engineer-in-Charge.

6.1.4 In case the contractor brings surplus quantity of cement the same after completion of the work will be removed from the site by the contractor at his own cost after approval of the Engineer-in-Charge.

6.1.5 Separate Cement Register for the cement procured in bags and bulk shall be maintained at site. Cement bags shall be stored in separate godowns to be constructed by the contractor at his own cost as per sketch (which is only indicative and actual size will depend on the site requirements) given in CPWD specifications with weather proof roofs and walls. Each godown shall be provided with a single shutter door with two locks. The key of one lock shall remain with Engineer-in-charge or his authorized representative and that of the other lock with the authorized agent of the contractor at the site of work so that the cement is issued from the godown according to the daily requirements with the knowledge of both parties and proper account for the same is maintained in the standard proforma.

6.1.6 Grade slab as per drawings shall be provided at ground floor level covering entire plinth area of building.

PROFORMA FOR THE CEMENT REGISTER PARTICULARS OF RECEIPT & ISSUE

Date of receipt	Quantity received	Progressive total	Date of issue	Quantity issued	Items of work for which issued
1	2	3	4	5	6

Qty. returned at the end of the day	Total issued	Daily balance in hand	Contractor's initial	JE/AE's initial	Remarks (AE/EE's periodical check)
7	8	9	10	11	12

6.1.7 DESIGN MIX CONCRETE:

The contractor shall be required to submit two separate design mix of concrete with and without using plasticizers, separately for machine batched mix concrete of all grades as M10,M30,M35 etc. The decision of the engineer-in-charge to specify the design mix of concrete based on above shall be final.

- 6.1.7.1 Coarse aggregate: As per CPWD Specifications
- 6.1.7.2 Fine Aggregate: As per CPWD Specifications.
- 6.1.7.3 Water: It shall conform to requirements laid down in IS:456 : 2000 and CPWD specifications.
- 6.1.7.4 Cement: Cement arranged by the contractor will be PPC (in bags) conforming to IS: 1489-Part-I. If for any reasons, cement other than that specified in this para for example OPC of grade 43 or higher grade is brought to site by contractor, the issue, payments rate as well as the quantity to be used in the design mix concrete will remain unchanged.
- 6.1.7.5 Slump: Design slump should be clearly specified in the mix design.
- 6.1.7.6 Admixtures shall not be used without approval of Engineer-in-charge. Wherever required, admixtures of approved quality shall be mixed with concrete as specified. The admixtures shall conform to IS: 9103. The chlorides content in the admixture shall satisfy the requirements of BS: 5075. The total amount of chlorides admixture mixed in concrete shall also satisfy the requirements of IS: 456. The contractor shall not be paid anything extra for admixture required for achieving desired workability without any change in specified water cement ratio for RCC/CC work.

6.1.7.7 Grade of Concrete : The compressive strength of various grades of concrete shall to be given as below:

	Grade designation	Compressive strength on 15 cm cubes min. 7 days (N/mm ²)	Specified characteristic compressive strength at 28 days (N/mm ²)	Minimum cement quantity (Kg. per cum. Mtr.)	Maximum water cement ratio
i.	M25	As per design	25	330	0.50
ii.	M30	As per design	30	340	0.45
iii.	M35	As per design	35	350	0.45
iv.	M40	As per design	40	360	0.40

Note-

(i) In the designation of a concrete mix letter M refers to the mix and number to the specified characteristic compressive strength of 15 cm x 15 cm x 15 cm – cube 28 days expressed in N/mm²

(ii) Normally as per Mix Design of various grades cement content goes high and extra cement is consumed. The consumption of extra cement shall be included in the scope of work and nothing extra shall be paid considered on this account.

(iii) Design slump has to be constantly monitored and maintained during placing of concrete through slump tests carried out as per CPWD specification 2019 Vol. 1 for Mortar, Concrete and RCC works, and records maintained accordingly.

The concrete mix design/laboratory tests with and without admixture shall be got done by contractor at his own cost and will be carried out by the contractor through one of the following laboratory/Test houses:

(i) IIT (BHU), Varanasi

(ii) IIT Kanpur

(iii) HBTU Kanpur

(iv) IIT Roorkee

(v) Approved Lab/Govt. Engineering Institutions as directed by the Engineer-in-charge.

The various ingredients for mix design / laboratory tests shall be sent to the test houses through the Engineer-in-Charge and the samples of such aggregate & cement shall be preserved at site by the department.

6.1.7.8 The contractor shall submit the mix design report from any of above approved laboratory for approval of Engineer-in-Charge within 30 days from the date of issue of letter of acceptance of the tender. No concreting shall be done until the mix

design is approved by the Engineer-in-charge. In case of white portland cement and the likely use of admixtures in concrete with PPC/white portland cement the contractor shall design and test the concrete mix by using trial mixes with white cement and/or admixtures also for which nothing extra shall be payable.

6.1.7.9 The source of coarse and fine aggregate shall be got approved from Engineer-in-Charge well before execution of work. In case of change of source or characteristic properties of the ingredients used in the concrete mix during the work, a revised laboratory mix design report conducted at above mentioned approved laboratory shall be submitted by the contractor as per the direction of the Engineer-in-Charge. No payment will be made for revised mix design.

6.1.8 APPROVAL OF DESIGN MIX

The mix design for a specified grade of concrete shall be done for a target mean compressive strength $T_{ck} = F_{ck} + 1.65s$.

Where F_{ck} = Characteristic compressive strength of 28 days

s = Standard deviation which depends on degree of quality control

The degree of quality control for this work is —Good|| for which the standard deviation (s) obtained for different grades of concrete shall be as bellows:

Grade of Concrete	For "Good" quality of control
M 25	4.00
M 30	5.00
M 35	5.00
M 40	5.00

Of the six specimen of each set three shall be tested at seven days and remaining three at 28 days. The preliminary tests at seven days are intended only to indicate the strength to be attained at 28 days.

- 6.1.8.1 All cost of mix designing and testing connected therewith including charges payable to the laboratory shall be borne by the contractor.
- 6.1.8.2 The batching plant shall conform to IS:4925. It shall have the facilities of presetting the quantity to be weighed with automatic cutoff when the same is achieved. Concreting at places may have to be resorted to through concrete pump for which nothing extra shall be paid.
- 6.1.8.3 All other operations in concreting work like Mixing, Slump, Laying Placing of concrete, compaction curing etc. not mentioned in this particular specification for Design Mix of concrete shall be as per CPWD specification.

6.1.9 WORK STRENGTH TEST TEST SPECIMEN

Work strength test shall be conducted in accordance with IS: 456 on random sampling.

Each test shall be conducted on six specimens, three of which shall be tested at 7 days and remaining three at 28 days. Additional samples shall be prepared, if required, as per direction of Engineer-in-charge for testing samples cured by accelerated method as described in IS:9103.

TEST RESULTS OF SAMPLE

The test result of the sample shall be the average of the strength of three specimen. The individual variation shall not be more than 15 percent of the average. If more the test results of the sample are invalid. 90% of the total test shall be done at the laboratory established at site by contractor and remaining 10% in the laboratory of CPWD or in any other laboratory as directed by the Engineer-in-Charge.

Lot size:

The minimum frequency of sampling of concrete of each grade shall be according to the following: -

Quantity of concrete in the work cubic metre per day	Number of samples.
1-10	1
11-30	2
31-60	3
61-100	4
101 & above	4 + one additional sample for additional 50 cubic metre or part thereof.

Note: At least one sample shall be taken from each shift.

6.1.10 STANDARDS OF ACCEPTANCE

- (i) In case the test result of all the samples is above the characteristic compressive strength, the concrete shall be accepted.
- (ii) In case the test result of one or more samples fails to meet the requirement (i) above it shall be accepted if both the following conditions are met:
 - a) Any individual test result is not less than $(F_{ck} - 4) \text{ N/mm}^2$
 - b) The mean of test result from any group of four consecutive samples is more than $(F_{ck} + 4) \text{ N/mm}^2$.
- (iii) Concrete of each grade shall be assessed separately.
- (iv) Concrete is liable to be rejected if it is porous or honeycombed, its placing has been interrupted without providing a proper construction joint the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge for which nothing extra is payable to the contractor.

- (v) MS centering /shuttering and scaffolding material unless & otherwise specified shall be used for all RCC. Work to give an even finish of concrete surface. However marine ply shuttering in exceptional cases as per site requirement may be used on specific request from contractor on approval by the Engineer-in-Charge.
- (vi) In case of actual average compressive strength being less than specified strength which shall be governed by para —Standard of Acceptance|| as above the rate payable shall be worked out accordingly on prorated basis.
- (vii) In case of rejection of concrete on account of unacceptable compressive strength governed by para “Standard of Acceptance” as above, the work for which samples have failed shall be re done at the cost of contractors. However, the Engineer-in-Charge may order for additional test to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the sample has been used, can be retained on the basis of results of individual or combination of these tests.
- (viii) Necessary arrangements shall be made for field tests and all required equipment's shall be arranged by establishing field lab by the Agency for mandatory tests of the materials as specified in CPWD specifications or as per direction of Engineer-in-Charge. No extra payment shall be paid on this account.

6.1.11 Cover blocks to be used for RCC works shall be made of Conbextra GP2 grout of FOSROC of equivalent approved makes. The precast cover blocks shall also be allowed to be used if the quality of the same is found satisfactory by Engineer-in-Charge.

6.1.12 All the required registers such as Master Test Register, Cement Register, Cube Register, M.A.S Register, Drawings Register, Side order Book, Steel Register, Paint Register & Inspection Register etc. shall be properly maintained by contractor's Engineer as per direction of Engineer-in-Charge.

6.1.13 All the test report, done from outside lab, shall be properly maintained in folder as well as in register.

6.1.14 All the testing charges, for the all materials to be used in the work, shall be borne by contractor.

6.1.15 Copies of all the material's bills shall be produced by contractor as per direction of Engineer-in-Charge.

6.1.16 All the batch mixed plant slips shall be systematically maintained in folder and no slip should be missing.

6.2 RCC WORK (SELF COMPACTING CONCRETE)

6.2.1 General

The RCC work shall be with design mixed Self Compacting Concrete / normal reinforced cement concrete of specified grade at locations as shown in the GFC drawings and as directed by the Engineer-in- Charge, produced

at site in fully automatic computerized batch mix concrete (BMC) plant conforming to IS: 4925 after approval of the Engineer-in- Charge.

- a) The mix design shall be carried out as per EFNARC Specifications and Guidelines for Self Compacting Concrete/ European Guidelines for Self Compacting Concrete. For mix design, all three workability parameters need to be assessed to ensure that all aspects are fulfilled.
- b) In the designation of a concrete mix, letter M refers to the mix and the number to the specified characteristic compressive strength of 15 cm Cube at 28 days expressed in N/mm².
- c) Self Compacting Concrete shall include all quantity of cement as per design mix. The consumption of any quantity of cement as per approved design mix shall be included in the scope of work and no extra payment shall be considered on this account.

i) **Ingredients**

The sources of coarse aggregate, fine aggregate, water, mineral admixture, chemical admixture and cement to be used in self compacting concrete work shall be identified by the contractor and he will satisfy himself regarding their conforming to the relevant specifications and their availability before getting the same approved from the Engineer-in-Charge. The contractor, before proposing any of these materials for approval of Engineer-in- Charge, shall himself assure that the proposed materials conform to the relevant specifications and standards.

(a)	Coarse Aggregate	It shall conform to IS:383 Max size: Upto 20 mm content ranges from 750 kg/cum to 1000 kg/cum
(b)	Fine Aggregate	It shall conform to IS:383 (content more than 38% by mass of cementitious material)
(c)	Water	It shall conform to IS:456
(d)	Cement	OPC 43 Grade conforming to IS:8112-1989
(e)	Mineral Admixture	It shall conform to standards, as applicable.
(f)	Chemical Admixture	High range water reducing admixture of Master Gelanium of Fosrac or equivalent conforming to IS: 9103 in appropriate dosage.
	Powder/ Fine (size less than 0.125 mm)	Preferably be in the range of 400 kg/cum to 600 kg/cum (including quantity of cement)
	Water to Powder Ratio	0.85 to 1.0 (by volume)

ii) **Design mix from laboratories**

The contractor shall engage outside/ independent laboratories of any

Government Institutes, Indian Institute of Technology, National Institutes of Technology, Central and State Research Centers, Centrally and state funded laboratories and other such approved labs mentioned elsewhere in this NIT for design mix of batch concrete/self compacting concrete and testing of materials connected there with relevant Specifications.

Cement arranged by the contractor will be OPC 43 Grade conforming to IS:8112-1989. If for any reasons, cement other than that specified in this para, for example PPC conforming to IS:1489-Part-I, is brought to side by contractor, the issue payments rate as well as the quantity to be used in the design mix concrete will remain unchanged. This shall be subject to the approval of design mix by the Engineer-in- Charge.

The various ingredients for mix design and laboratory tests connected therewith shall be sent to the lab/test houses through the Engineer-in-charge and the samples of such aggregates sent shall be preserved at site by the department.

In the event, if all the above laboratories are unable to carry out the requisite design / testing connected therewith, the contractor may have it done from any other Govt laboratory with prior approval of Engineer-in-Charge.

iii) Charges of design mix

All cost of mix designing and testing connected therewith including charges payable to the laboratory shall be borne by the contractor including redesigning of the concrete mix whenever required and as directed by the Engineer-in-charge.

iv) Preparation of mixes as per approved design mix and conducting confirmatory test at field lab.

- a) The contractor shall make the cubes of trial mixes as per approved mix design at site laboratory for all grades using sample of approved materials proposed to be used in the work prior to commencement of concreting and get them tested for 7 days and 28 days. Test cubes shall be taken from trial mixes as follows.
- b) For each mix, a set of six cubes shall be made from each of the three consecutive batches. Three cubes from each set of six shall be tested age of 7 days and remaining three cubes at age of 28 days. The evaluation of test results will be done as per IS: 456.

v) Standard for acceptance

- a) Standard of acceptance of hardened concrete of batch concrete shall be same as specified in CPWD Specifications / IS: 456.

- b) The accepted values of fresh concrete of self compacting concrete in field tests shall be as under for which contractor has to arrange all necessary testing equipment in field / site laboratory:

S.No	Test	Unit	Value Range
1	Slump flow	mm	550-850
2	T50 cm slump flow	Sec	2-5
3	V-funnel	Sec	6-12*
4	L-Box	H2/H1 Ratio	0.8-1.0
5	Time increase, V-funnel at T5 minutes	Sec	0-3

* maximum upto 25 second and/or as per approved design mix.

vi) Form work/Shuttering (Aluminium)

The form work shall be designed to take care of flow ability and cohesion of the self compacting concrete (SCC), rate of vertical rise and the method of placing from the top. The formwork including support and fixing systems shall be designed to with stand the full hydrostatic concrete pressure. The contractor shall ensure that the formwork shall not deform during placing by providing adequate outer supports and/ or the tie rod system and their spacing. The contractor shall ensure that there shall be no leakage at formwork joints and there shall be no movement at joints or bending of the formwork under pressure of the concrete.

vii) Transportation and placing

- a) Mixed concrete from the batching plant shall be transported to the point of placement by transit mixers or through concrete pumps or steel closed bottom buckets capable of carrying 0.6 cum concrete.
- b) In case concrete is to be transported by pumping, the conduit shall be primed by pumping a batch of mortar / thick cement slurry through the line to lubricate it. Once the pumping is started, it shall not be interrupted as concrete standing idle in the line is liable to cause a plug. The lines shall always be maintained clean and shall be free of dents.
- c) Self- compacting concrete shall be placed in one continuous pour by concrete pumps/ boom pumps or tower crane bucket. The delivery rate of concrete should be matched to placing rate to avoid stoppages due to lack of concrete or long delays in placing after the concrete reaches site.

viii) Laying of SCC

All concrete from the plant shall be laid with the help of concrete pump of adequate capacity at all heights for which nothing extra shall be paid over and above the quoted rates. However, small quantity can be allowed without the pump with prior written approval of Engineer-in- Charge as per site requirement.

6.3 STEEL WORK (REINFORCEMENT STEEL)

- 6.3.1 The steel work shall be carried out as per CPWD specifications 2019 Volume- I & II with correction slips up to the last date of submission of bid. The Contractor shall procure corrosion resistant steel reinforcement TMT bars of various grades from the steel Manufacturers mentioned in preferred make list for civil works or their authorized dealers/ authorized distributors/ channel partners.
- 6.3.2 For reinforced cement concrete, the reinforcement bars shall consist of the grades as specified in the GFC drawings conforming to IS 1786:2008 as per amendment 3, para 4.2 note 3 as presently applicable and any further amendments issued during and upto the period of execution/completion. The primary producers of such Low Alloy Steel reinforcement TMT bars shall be as per approved list given in the "Preferred makes of the materials" incorporated in this tender document.
- 6.3.3 The Contractor shall obtain manufacturer's certificate stating the process of manufacture, chemical composition and test sheet giving result of each mechanical test applicable to the material purchased and submit it to the Engineer-in-charge. Each test certificate shall indicate the number of the cast to which it applies, corresponding to the number or identification mark to be found on the material.
- 6.3.4 Steel bars brought by contractor for use in the work shall be got checked by the Engineer-in-charge or his authorized representative of the work on receipt of the same at site before use. Samples shall be taken and got tested by the Engineer-in-charge as per the provisions in this regard in the relevant BIS codes. In case the test results indicate that the steel arranged by the contractor does not conform to the specifications as defined under para 1.1 and 1.2 above, the same shall stand rejected and it shall be removed from the site of work by the contractor at his cost within a week time of written orders from the Engineer-in-charge to do so.
- 6.3.5 The steel reinforcement shall be brought to the site in bulk supply of 50 tonnes or more or as directed by the Engineer-in-charge.
- 6.3.6 The steel reinforcement bars shall be stored by the contractor at site of work in such a way as to prevent distortion & corrosion, and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facilitate easy counting and checking.
- 6.3.7 All the expenditure to be incurred for testing of samples i.e., packaging, sealing, transportation, loading, unloading, etc including testing charges shall be borne by the contractor.
- 6.3.8 If the quantity of steel actually used in the work is found to be more than the theoretical quantity of steel including authorized variation, nothing extra shall be payable to the contractor on this account. In the event of it being discovered that after the completion of the work the quantity of steel used is less than the quantity ascertained as herein before provided

(allowing variation on the minus side as stipulated in clause 42). The cost of quantity of steel so less used shall be recovered from the contractor at rate as specified in schedule 'F'. Decision of the Engineer-in-Charge in regard to theoretical quantity of steel which should have been actually used and recovery of the rate specified shall be final and binding on the contractor.

In case the contractor brings surplus quantity of steel the same after completion of the work will be removed from the site by the contractor at his own cost after approval of the Engineer-in-Charge.

6.3.9 The standard sectional weights referred to as in Table 5.4 under para 5.3.4 in CPWD specifications for works 2009 Vol. 1 will be considered for conversion of length of various sizes of MS bars, Tor steel bars and TMT bars into standard weight.

6.3.10 Records of actual sectional weight shall also be kept dia-wise & lot-wise. The average sectional weight for each diameter shall be arrived at from samples from each lot of steel received at site. The decision of the Engineer-in-Charge shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute one single lot for the purpose. The weight of steel by conversion of length of various sizes of bars based on the actual weighted average sectional weight shall be termed as derived actual weight.

6.3.11 If the derived actual weight is found more than the standard weight then the standard weight as worked out in para 12 above shall be taken for payment. In such case nothing extra shall be paid for the difference between the derived actual weight and the standard weight.

6.3.12 Mixing of different type of steel/different grades of steel shall not be allowed in the same structural members as main reinforcement to satisfy clause 26.1 of IS:456.

6.3.13 Tolerances on Nominal Mass (individual sample) shall be as under:-

Sl. No.	Nominal size mm	Tolerances on the Nominal Mass, percentage
1	Upto and including 10	-8%
2	Over 10 upto & including 16	-6%
3	Over 16	-4%

6.3.17 The scope of work also includes providing and fixing circular/Hexagonal M.S sheet box for ceiling of internal dia 140 mm, 73 mm height, top lid of 1.5 mm thick M.S sheet with its top surface hacked for proper bonding, top lid shall be screwed into then M.S sheet box by means of 3.3 mm dia round

headed screws, one lock at the corners. Providing and fixing M.S fan clamp type I or II of 16 mm dia M.S. bar, bent to shape with hooked ends in R.C.C. slabs or beams during laying, including painting the exposed portion of loop, all as per standard design complete for all terrace slabs/beams.

- 6.3.18 Chairs, spacer bars etc. shall be provided as per GFC drawings or as per CPWD Specification and/or as per direction of Engineer-in-charge for which nothing extra shall be paid.

7.0 MS STRUCTURAL STEEL WORK:-

The structural steel work using structural steel as per GFC drawing shall be done based on the shop drawings prepared by contractor and got approved from Engineer-in-charge before actual execution.

The work includes labour, fabrication, delivery, assembly, erection, lifting, painting, finishing, supervision and Non-destructive testing of welded steel work etc. complete.

All other incidental works not specified herein mentioned but necessary for the satisfactory completion of the works, shall be deemed to be included. All the specifications for structural steel works shall be as per CPWD Specifications Volume-I & II with correction slips up to the last date of submission of tender documents.

Structural steel of grade E250 confirming to IS:2062 shall be used as per GFC drawings. M.S Tube sections shall be of grade E310 for pipes/E350 for RHS & SHS shall be used for Architectural Pergolas, Façade members if any as per corresponding Architectural/ Structural drawings.

MS support at wall / ceiling for services line shall be provided as per approved shop drawing, design and direction of Engineer-in- Charge. MS supports to be fixed with 100x8 mm anchor fasteners in concrete / hold fast with grade of concrete as shown in drawing.

M.S. Gratings: Top of floor drain shall covered with M.S. grating of size and detail as shown in GFC drawing & finished with Enamel paint as per manufacturers specification.

Painting & finishing of Steel work: All MS structural steel works shall be finished with two or more coat of Enamel paint over a coat of primer complete as per CPWD specification.

STAINLESS STEEL WORK

7.1 **Stainless steel grade AISI 304 railing**

Staircase and balcony railings coming at different location shall be of 304 grade Stainless steel as mentioned in GFC drawings.

General details are as under:

- 7.1.1 S.S Railing in staircases comprising of 50.8 mm (+/- 1 mm) dia tube top handrail, 42.4 mm (+/- 1 mm) dia pipe single vertical balusters on alternate treads, 03 Nos. mid rail of S.S tube dia 19 mm as per GFC Drawings.
- 7.1.2 S.S Railing in Balconies comprising of 50.8 mm (+/- 1 mm) dia tube top handrail, vertical balustrade SS Tube 50x50 mm of 3 mm minimum thickness at least 1.0 meter C/C distance, 03 nos. mid rail of SS Flat of 50x6 mm size as per GFC drawings.

DETAIL DESCRIPTION

A. Staircase Railing:

Providing & fixing modular passivated satin stainless 304 grade railing system at all locations & levels of approved size and shape conforming to grade AISI 304 with all modular accessories using flexible bends & modular system or expansion & ball socket system as per manufacturer's specifications or as per GFC Drawings shall be within the scope of work. The material comprising of top handrail of S.S tube dia 50.8 mm (+/- 1mm)x 1.5 mm (+/-0.1 mm) minimum thickness, **single vertical balusters of 42.4 mm (+/- 1mm) dia pipe of 1.5 mm (+/- 0.1mm) minimum thickness & fixed as per spacing/ center to center distance given in GFC drawings & at turning with 03 Nos.**

B. Balcony Railing:

Providing & fixing modular passivated stainless steel 304 grade railing system at all locations & levels of approved size and shape conforming to grade AISI 304 shall be within scope of work. Top handrail shall be S.S square tube of 75x50mm (+/- 1mm)x 2 mm minimum thickness, **vertical balustrade shall be of 50x50 mm of 3 mm minimum thickness at least 1.00 metre C/C distance and at corners, 4 nos. mid rail of SS Flat of 50x6 mm size or as given in GFC drawings and** fix by welding to all balusters to provide proper support as per manufacturers specification, GFC drawings and as directed by the Engineer-in- Charge.

Samples & Shop drawings: All work to be done as per GFC drawing. Shop drawings and samples shall be submitted by the contractor for approval of Engineer-in- Charge prior to the execution of work.

The work also includes protecting the railing by wrapping bubble sheet till completion/ handing over of the building whichever is later. If any scratches and damages occur, these shall be replaced or rectified by the contractor at his own cost and nothing extra shall be paid against the same.

8.0 **Doors, Windows ventilators fitting and fixtures**

8.1 Doors, Frames and shutters:

Door frame and shutters shall be provided as per GFC drawings.

8.2 All Window and ventilators shall be provided as per GFC drawings.

8.3 Provision of wire mesh shutters made of SS Tabular frames with Stainless steel 304 grade mosquito proof wire mesh as per GFC Drawings and schedule of Finishes (Civil) No.17

8.4 Fire Resistant glazed doors frame and shutters shall be as per DSR items mentioned in Finishes of fire doors.

8.5 Fire Rated Matelled Doors, Fames & Shutters.

Providing and fixing of Hollow metal ISI marked Un-Insulated fire rated doors as per IS:3614 2021, for stability and integrity shall be within the scope of work. Pressed galvanized steel confirming to IS 277 with following specification. Contractor/ manufacturer shall provide test certificate not older than one year for the prototype tested as per IS/ISO 3008 part 1 tested at CBRI/Certifier or third party certified lab, for maximum rating of 2 Hrs, in latched / unlatched condition. Labeled doors with certification shall be with vision glass as a part of complete assembly. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied shall be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory from Approved manufacturer or equivalent.

Size of door frame and shutter shall be as per the manufactures specification with 2 Hrs fire rated. Door frame shall be single rebate grooved profile of size 125x55 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet.

Door leaf shall be 46 mm thick fully flush double skin door, Un-insulated with or without vision liter as per GFC drawing. Door leaf shall be manufactured from 1.2 mm (18 gauge) minimum thick galvanized steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware.

All doors and frames should be zinc phosphated and finished with minimum 50 micron Thermosetting Powder Coating of approved colour and shade / finish in desired RAL shade and shall have passed minimum 500 hours of salt spray test.

2 Hrs Fire Rated door single/double leaf of size as mentioned in GFC Drawing with vision panel 200x1000 mm with hardware set stainless steel grade 304 ball bearing butt hinges, stainless steel grade 304 pull handle of 300 mm long on both side, mortise dead lock with both side cylinders, Fire rated surface mounted door closer with spring size 224, groove seal for smoke, all hardware are as per List of preferred makes & inclusive of PUFF Grouting. All hardware fittings should be minimum two hour fire rated.

Hardware for Fire doors;

1. External Trim with panic device with cylinder & Key

2. Stainless steel Ball bearing hinges ("4x3"x 3 mm thick)
3. Door closer (fire rated)
4. Flush bolt 19 mm dia x 300 mm long
5. Automatic Drop down Seal Mortise dead lock 288a with 55 mm backset, 20 mm square for end and prepared for euro profile cylinder including strike plate in satin stainless steel as per EN 12209, CE marked. CR 6612 escutcheons prepared for euro profile cylinder & 3006, 6 pin Euro profile half cylinder with one side key operation.

ADDITIONAL SECURITY DEPOSIT FOR FIRE RATED DOORS

Additional security deposit @10% of cost shall be retained as an additional security deposit for fire rated doors and the amount so withheld would be released after ten years from the date of expiry of defect liability period under the agreement, if the performance of the work done is found satisfactory. If any defect is noticed during the guarantee period, it shall be rectified by the contractor within seven days of receipt of intimation of defects in the work. If the defects pointed out are not attended within the specified period, the same will be got done from other agency at the risk and cost of contractor. This additional security may be released if contractor submits Bank Guarantee/ FDR of matching value and validity issued from a scheduled commercial bank pledged in favor of Engineer-in-Charge.

The security deposit against this item of work shall be in addition to the security deposit mentioned elsewhere in contract form.

8.6

HARDWARE

All the hardware required for all the doors, windows, ventilators, door-windows, cupboards etc. are within the scope of work. The system shall be made fully operational and if any hardware is left and required for the work, the same will be considered to be included in the scope of work. All hardware to be installed as per Schedule of hardware of doors given in schedule of finishes and approved by the Engineer-in-Charge.

Samples & shop drawing: The contractor shall submit the shop drawings & samples of all hardware to be used in the work for approval of Engineer-in-Charge prior to the execution of work. The shop drawing shall include the details of all hardware of doors/ windows/ ventilators/door cum windows etc. to be used in the work.

8.7

WINDOWS & VENTILATORS:

uPVC windows, doors, Door cum windows, ventilators etc. including glazing specifications:

- 8.7.1 Extent and Intent:** - All uPVC elements shall be manufactured in the factory/site work shop by the contractor who shall furnish all material, labour, accessories, equipment, tool and plants and incidentals required for providing and installing anodized/powder coated aluminium doors, windows, claddings, louvers and other items as called for on the GFC drawings. The drawings and specifications cover the major requirements only. The supplying of additional fastenings, accessories, fixtures and other items not mentioned specifically herein, but which are necessary to make a complete installation shall be a part of this contract. Hinges for casement uPVC window shall be stainless steel Friction stays of Grade AISI 304 of approved make.
- 8.7.2 General:** - Aluminium doors, windows etc. shall be of sizes, section details as shown on the Architectural drawings. The details shown on the drawings indicate generally the sizes of the component parts and general standards. These may be varied slightly to suit the standard adopted by the manufacturers. Before proceeding with any manufacturing, the contractor shall prepare and submit complete manufacturing and installation drawings for approval of the Engineer-in-Charge and no work shall be performed until the approval of these drawings is obtained.
- 8.7.3 Samples:** - Samples of doors, windows louvers etc. shall be fabricated, assembled in the factory/site work shop and submitted to Engineer-in-Charge for his approval. They shall be of sizes, types etc. as decided by Engineer-in-Charge. All samples shall be provided at the cost of the contractor.
- 8.7.4 Sections:** - All uPVC doors and windows shall be fabricated from extruded sections of profiles as detailed on drawings. The sections shall be extruded by the manufacturers approved by the Engineer-in-Charge.
- 8.7.5 Handling and Stacking:** -
Fabricated materials shall be carried in an approved manner to protect the material against any damage during transportation. The loading and unloading shall be carried out with utmost care. On receipt of material at site, it shall be carefully examined to detect any damaged pieces. Arrangements shall be made for expeditious replacement of damaged pieces/ parts. Materials found to be acceptable on inspections shall be repacked in crates and stored safely.
- 8.7.6 Installation:**
- 8.7.6.1 The window door, door cum windows, ventilators etc. must be aligned in plumb and water level and installed to the window sill using high quality steel fasteners. The outer frame of window and sill must be sealed with silicone based sealants from outside and acrylic paintable sealant from inside. Installation shall be done by manufacturer.

- 8.7.6.2 The gap between uPVC window/door and adjacent RCC/Brick/stone cladding work shall be filled with weather proof silicon sealant of approved make to maximum 5mm depth and 5mm width to allow expansion/contraction of uPVC profiles. Silicon sealant of matching colour of uPVC profile shall be applied over backer rod.
- 8.7.6.3 The fasteners to be used for fixing window/door units to the opening shall be hot-dip galvanized of minimum 8mm dia & required length so as to have minimum penetration of 50mm in the structural members i.e. side jambs, sill or soffits, if any.
- 8.7.6.4 The fasteners distance shall be 150-200 mm from the edge of the frame and at maximum interval of 600 mm.
- 8.7.6.5 **TPV / Neoprene gaskets:** The contractor shall provide and install TPV / Neoprene gaskets of approved size and profile at all locations as shown and as called for to render the doors, windows etc. absolutely airtight and weather tight. The contractor shall produce samples of the gaskets for approval and shall procure the same after approval only.
- 8.7.6.6 **Fittings:** Hinges, stays, handles, tower bolts, locks and other fittings shall be of quality and manufacturer as approved by the Engineer-in-Charge. All the fittings of window, door, door cum windows, ventilators etc. are included within the scope of work and the contractor shall clearly indicate these in the shop drawings. Samples of all the fittings shall be submitted by the contractor for obtaining approval of the Engineer-in-Charge before placing any bulk orders.
- 8.7.6.7 **Manufacturer 's Attendance:** It shall be responsibility of the contractor that the approved manufacturer immediately prior to the commencement of glazing shall adjust and set all windows and doors and accept responsibility for the satisfactory working of the opening frames.
- 8.7.6.8 **Silicon sealant:** The gaps between frames and supports and also any gaps in the door and windows sections shall be raked out as directed and filled with poly-sulphide of approved colour and make to ensure complete water tightness. The poly-sulphide 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 conditions of weather. The sample of poly-sulphide to be used for this purpose shall be got approved from the Engineer-in-Charge before its actual use.
- 8.7.6.9 **Details of Test:** The various tests on uPVC sections shall be conducted as per CPWD Specifications Vol-I & Vol-II. The uPVC extruded hollow profile used in the windows and doors shall confirm to the Specification as per EN 12608 & other standard as mentioned below: -

S.No.	Name of the test	Test Method	Specified Parameter
1	Vicat Softening Temperature	EN ISO -306	Shall not be < 750 C
2	Charpy Impact Strength	EN ISO -179-I	Shall not be < 20KJ/m2
3	Flexural Modulus Elasticity	EN ISO -178	Shall not be < 2200N/mm2
4	Tensile Impact Strength	EN ISO -8256	Shall not be < 600 KJ/m2
5	Mean Breaking Stress for welded corner		
	a) For the tensile bending test	EN -514	Shall not be < 25 N/mm2
	b) For the compression bending test		Shall not be < 35 N/mm2
6	Heat Reversion Test	EN -479	Shall not be > 2.0%
7	Surface Spread of flame	BS:476- Part 7	Classification 1

8.7.6.10 Fabrication: -

- (a) The structural design and drawing proof checked from a Government Engineering Institute shall be provided by uPVC window/ door manufacturer and submitted through the contractor to the Engineer-in-Charge for approving good for fabrication.
- (b) According to the drawing, the required dimension and length of uPVC frame, sash and mullion profiles shall be mitered cut and reinforced with galvanized iron section of required length and thickness.

8.7.6.11 Reinforcement

- i. The reinforcement material should be non-hygroscopic and should have no adverse effect on the performance of the window/door and it shall conform to any grade of IS 1079 or IS 513.
- ii. Mild steel section reinforcement made from roll forming process and shall be hot dip zinc galvanized in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.
- iii. The reinforcement of uPVC window/door shall cater the strength and serviceability requirements.
- iv. Shape and thickness of the reinforcement should be as per uPVC profile manufacturer recommendation and fixed to ensure adequate fastener retention.
- v. Galvanized mild steel reinforcement section is to be inserted in uPVC frame. Sash and mullion profile of required length with in 6 to 15 mm distance from the face of weld/and then shall be screwed at 150mm from

the end at every 400mm pitch to uPVC profile so that it does not move or rattle.

- vi. Galvanized mild steel reinforcement section thickness shall be changed according to floor level keeping in consideration of wind load factor and minimum thickness should be as below:

(a) Structure height upto 20m = minimum 1.5 mm

(b) Structure height above 20m=minimum 2.0 mm

8.7.6.12 Glazing / Wiremesh

- (i) After fusion welding and cleaning of the corner of the sash prescribed **type & thickness of glazing glass panes as per approved design required conforming to IS: 16231** shall be placed after fitting EPDM gasket and uPVC beading of approved quality and make.
- (ii) Before placing the glass pane in position, glazing supports shall be provided on frame or sash profile in order to distribute the load of the glass, and spacers of required thickness between the glazing supports & glass edges to hold the glass in place. The supports and spacers shall be placed in such a way so as not to block the drainage holes/slots.
- (iii) Window sash shall be made in such a way that glazing or re-glazing is possible at site without the need to remove the outer frame.
- (iv) The plastic spacer shall be used to provide support to the glass in sash/frame.
- (v) Fly proof wire mesh of stainless steel grade 304 wire gauge, shall be fixed to windows and clerestory windows using wire gauge with average width of aperture 1.4 mm in both directions with wire of dia. 0.50 mm all complete as per GFC drawings or as directed by Engineer-in-Charge after fitting gaskets of approved quality and make.

8.7.6.13 Glazing gasket & Weather pile strip/Wool pile

- i. Material for glazing gaskets shall be of EPDM and shall be used on both side of glass panes in uPVC sash and glazing beads profile.
- ii. Weather pile strip/ Wool pile shall be used in uPVC sliding door and window to reduce air filtration and water penetration.

8.7.6.14 Windows/ Door Hardware Fittings For casement windows

Approved quality stainless steel friction hinges with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top one at bottom or one on each side in case of Top hung windows.

For casement Doors

Minimum three numbers of approved quality 3D hinges with necessary SS screws shall be provided in the casement door shutter up to 0.90 meter in width and 2.10 meter in height for more than 2.10 metre height minimum four numbers 3D hinges to be used.

For sliding windows/ doors

- i. **For sliding Window or Door cum Window-** one pair **stainless steel 304 grade body with adjustable** double nylon roller having **weight bearing capacity of designed panel weight of approved quality in each shutter of sliding** door shall be provided.
- ii. In case of wire mesh, stainless steel fly proof wire mesh shall be provided of approved make duly approved by the Engineer-in-Charge before fixing at site of work. Wiremesh must be fixed with EPDM gasket in sash profile as the glass sash profile.

Tolerance on finished window/ door

The tolerance in dimensions of finished window/door in size shall be within+ 5mm from the approved drawing dimension/ opening achieved post plastering/ cladding of jambs, sill and lintel soffit.

8.7.6.15 Hardware Fittings For uPVC Doors & Windows

All requisite Hardware fitting for uPVC doors/ windows shall be included in the scope of work and contractor shall provide all the hardware fittings as per corresponding items of DSR' 2023 mentioned in schedule of finishes as per direction of Engineer-in-Charge.

- 8.7.6.16 There are four series of profiles which can be used depending upon the size and design of window, door, door cum windows, ventilators etc and the different loads acting on it. These are given in table as below:

Range	R1	R2	R3	R4
Description	Dimensions-Depth x width (in mm)			
Recommended Application	Windows of height upto 0.90 m	Windows of height upto 1.2 m	Windows of height upto 1.8 doors of height upto 2.5m	Windows of height above 1.8 m doors of height above 2.5m
Wall thickness (mainprofiles)	Minimum 1.7 mm	Minimum 1.7 mm	Minimum 2.1 mm	Minimum 2.5 mm
2 Track Frame	X	(40 & above)x (40& above)	(55 & above)x (40& above)	(64 & above)x (40& above)
2.5 Track Frame	X	(65 & above)x (40& above)	(85 & above)x (40& above)	X
3 Track Frame	X	(70 & above)x (40& above)	(98 & above)x (40& above)	(115 & above)x (45& above)
Sliding window	X	(25 & above)x	(30 & above)x	(44 & above)x

sash		(50& above)	(55& above)	(55& above)
Sliding door sash	X	X	(30 & above)x (74& above)	(44 & above)x (85& above)
Sliding Fly screen window sash	X	(18 & above)x (40& above)	(20 & above)x (50& above)	X
Interlock/Inline Sash Adaptor	X	As per system supplier	As per system supplier	As per system supplier
Glazing Bead for sliding	X	As per system supplier	As per system supplier	As per system supplier

X- Not recommended / suggested.

Note:

- i. Profiles sizes and Application of series mentioned are for guidance of the contractor and he shall prepare shop drawings giving due regard to the above provisions and also loads acting on window door. Any such changes must be properly assessed.
- ii. In a window / door no two profiles from different series shall be combined.
- iii. For combination of windows and doors individual item specification shall be followed. Different windows shall be combined using suitable coupling profile.

8.7.6.17	Tolerance in profile dimension: No tolerance on lower side than the minimum thickness of profiles as well as steel reinforcement shall be admissible. For cross section of uPVC profile dimensional tolerances as per EN 12608 shall be acceptable. However, for higher thickness of profiles and reinforcement or cross sectional size of profiles used, nothing extra shall be payable.
8.7.6.18	Joining Methodology for two different units: couplers shall be used to combine two different frame, vertically or horizontally.
8.7.6.19	Fly proof wire mesh: Fly proof wire mesh of stainless steel grade 304 wire gauge, fixed to windows, clerestory windows, ventilators, doors etc shall be with average width of aperture 1.4 mm in both directions with wire of dia. 0.50 mm all complete as per manufacturers specification or as directed by Engineer-in-Charge.

GUARANTEE BOND:

Five (05) years guarantee bond in prescribed proforma shall be submitted by the contractor which shall also be signed by both the specialized agency and the contractor to meet their liabilities under the guarantee bond. However, the sole responsibility about efficiency of uPVC work shall rest with the building contractor.

Additional security deposit @10% of the cost shall be retained and the amount so withheld would be released after five years from the date of completion of the entire work under the agreement, if the performance of the work done is found satisfactory. If

any defect is noticed during the guarantee period, it shall be rectified by the contractor within seven days of receipt of intimation of such defects in the work. If the defects pointed out are not attended to with the specified period, the same shall be got done from another agency at the risk and cost of the contractor this additional security may be released if contractor submits Bank Guarantee/FDR of matching value and validity issued from a scheduled commercial bank pledged in favour of Engineer-in-Charge.

The security deposit against this item of work shall be in addition to the security deposit mentioned elsewhere in contract form.

8.8 GLAZING WORK

Glazing in doors, windows, ventilators shutters etc shall be with 6 mm thick High performance toughened glass/ Double glazed dual sealed insulated glass (6T+12A+6T) with norton tape, silicon structural sealant and weather proofing sealant complete as per the direction of Engineer-in-Charge and GFC drawings.

Details of different type of glazing is as follow:-

6 mm thick High performance toughened glass: Providing and fixing 6 mm thick high performance toughened glass of approved make with coating on face 2 in door, window, ventilator shutters etc. complete as per GFC drawings and the directions of Engineer-in-Charge shall be within the scope of work. The glass shall be fixed with necessary EPDM rubber/neoprene gasket of the approved colour, make, size and shape with silicone sealant of neural grade.

- 1) Light Transmission – 64% to 68%
- 2) Reflection (Ext.) –18% to 22%
- 3) Reflection (Int.) –18% to 25%
- 4) Solar factor –0.67 to 0.70
- 5) U value –5.5 to 5.8 W/Sqm K.

8.8.1 Installation:-

The glass shall be cut exact size, toughened and brought to site for installation. The glass panes shall be so cut that it fits slightly loose in the frames. Glazing shall be provided on the outside of the frame unless otherwise specified. Before fixing the glass all joints and glazing pockets to be cleaned by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt or glazing compounds and protective coatings.

Fixing of glass panes may be done with Aluminium / uPVC beading/ section as shown in shop drawings or as directed by the Engineer-in-Charge.

8.8.2 SAMPLES /SHOP DRAWINGS:

The contractor shall submit samples & shop drawings based on the GFC drawing for approval of Engineer-in-Charge before execution of work.

9.0 FLOORING WORK:

General (applicable for all kinds of flooring and dado / cladding works under this sub- head):

- 9.1 The work under this sub-head in general shall be carried out as per the CPWD Specifications, as per the GFC drawings and as per the direction of Engineer- in-Charge.
- 9.2 Various types of flooring, skirting, dado and window sill work shall be carried out by the contractor referring the floor finishing layouts as per GFC drawings. Contractor needs to refer schedule of finishes attached with tender document.
- 9.3 The Engineer-in-Charge or his representative may, if required, visit the source of supply of the various stones to assess the quality as well as availability of the material in the required quantities. The Department shall bear the cost of such visits of the officers of the Department.
- 9.4 Based on the samples approved by the Engineer-in-Charge for various flooring and dado /cladding materials as specified hereinafter, the contractor shall prepare mock up(s) at site of work as specified under relevant flooring and dado / cladding items, for approval of quality of workmanship and material specified. If the quality of the workmanship and the material is as per the required standards and approved by the Engineer-in- Charge, the mock up shall be allowed as part of the work and measured for payment. Otherwise, it shall be dismantled by the contractor as directed by the Engineer-in-Charge and taken away from the site of the work at his own cost. The mock up(s) so made shall be kept till completion of respective works for reference.
- 9.5 The stones / tiles shall be transported to site well packed in boxes or otherwise. These shall be handled carefully to prevent any damage. The various types of stones and tiles, procured shall be free of any surface defect or any edge damage. The damaged stones and tiles shall not be allowed to be used in the work. So, the contractor shall procure additional quantity of the stone and tiles to cover such contingencies.
- 9.6 For the skirting in the enclosures with curvilinear profiles, the tiles / stones shall be cut to the required size and the shape to match the profile and/ or the joints as per the architectural drawings. Similarly, the skirting shall be fixed in a manner as to flush or project from the finished face of the wall as per the architectural drawings and as directed by the Engineer – in– Charge. Any chasing of the RCC/CC/Brick/ACC masonry works required for such fixing is deemed to be included in the scope of work.
- 9.7 Proper gradient shall be given to flooring for toilets, verandah, kitchen, courtyard etc. so that the wash water flows towards the direction of floor trap. Any reverse slope if found, these shall be made good by the contractor by ripping open the floor/ grading concrete and nothing shall be paid for such rectifications.
- 9.8 The flooring and skirting will be executed as per pattern shown in the approved shop drawings based on architectural drawings. Skirting height shall be 100-150mm or as per sizes mentioned in architectural drawings.
- 9.9 Samples of flooring material are to be deposited well in advance to the Engineer – in– Charge for approval.
- 9.10 Agency shall maintain the uniform level of the finished flooring of the different types unless specially mentioned in the architectural drawings.

- 9.11 For flooring work, the joints between the different types of flooring shall be located as per the GFC drawings.
- 9.11 All the flooring works specified under this sub-head shall be adequately protected by a layer of plaster of Paris which shall be laid over a 400 micron PVC film. The protective layer shall be maintained throughout the execution of works and removed just before handing over of the site for which nothing extra shall be payable.
- 9.12 At the time of handing over, flooring & dado / cladding shall be free of any scratches, stains etc. The flooring & dado / cladding shall be properly cleaned before handing over. However, abrasive/acid cleaners shall not be used to clean the marks and other scratches.
- 9.13 Pattern for any type of flooring/ dado shall be as per approved shop drawings prepared on the basis of GFC drawings. All material, workmanship, labour, pattern, colour, style, skirting etc. complete is within the scope of work.
- 9.14 Flooring works should be protected by laying 2mm thick POP over paper till completion/handling over of the building whichever is later. If any scratches and damages occur they shall be replaced or rectified at their own cost and nothing shall be paid against the same.
- 9.15 All flooring shall be perfectly levelled in slopes as shown in the GFC Drawings or as directed by the Engineer – in- Charge.
- 9.16 All work in general shall be carried out as per CPWD Specifications-2019- Vol. I & II as amended upto last date of submission of bid.
- 9.17 Whenever flooring is to be done in patterns tiles/stone, the contractor shall get samples of each pattern laid and approved by the Engineer – in- Charge before final laying of such flooring for which nothing extra shall be paid.
- 9.18 Laying of different stones / tiles in patterns/ combination as shown in the GFC drawings shall be within the scope of work and nothing extra shall be payable on this account.
- 9.19 The proper gradient shall be given flooring for toilets, verandah, kitchen, courtyard, etc. as per the direction Engineer – in- Charge. For this contractor may have to lay extra thickness of adhesive/ dry mortar below the tiles/ stone slabs which shall be included in the scope of work and nothing extra shall be paid on this account.
- 9.20 One-piece stone for treads / risers in staircase or as directed by the Engineer – in- Charge shall be used and nothing extra shall be paid on this account.
- 9.21 Contractor while quoting rates must keep following minimum base rates (including GST) for following items in mind. Contractor to provide tax invoices of following items as and when demanded by the Engineer – in- Charge or his authorized representative.
- 9.22 **Minimum base rate (F.O.R at site including GST)** Minimum base rate of all items shall as per DSR'2023.
- 9.23 **IPS Flooring (Cement Concrete Flooring):** Laying of 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 and top layer 12 mm thick cement hardener consisting of

mix 1:2:6 by volume, hardening compound mix @ 2 litre per 50 Kg of cement all complete as per manufacturer's specifications, GFC drawings and as directed by the Engineer – in- Charge is within the scope of work.

- 9.24 **Vacuum dewatered flooring/ Pavement:** C.C Pavement of design mix concrete of minimum M30 grade as mentioned in GFC drawing or as directed by the Engineer – in- Charge is within the scope of work.

- 9.25 **Gang-saw-cut 30 mm thick sand blasted leather finish Granite (of approved shade) for flooring in Treads of all Staircases as per DSR'2023, Item No. 16.87.1.**

Gang-saw-cut 30 mm thick sand blasted leather finish Granite of required size, approved shade, colour and texture laid with cement based high polymer modified quick set tile adhesive conforming to IS: 15477, in average 6 mm thickness, including grouting of joints with approved quality ready made epoxy grout etc all complete including rubbing, curing, molding and polishing the edges to give high gloss finish etc. is within the scope of work.

The treads & risers of steps should be in one single long piece up to 2000 mm length as per the drawing. Nosing and side edges of treads shall be moulded and polished to give high gloss finish etc.

18 mm thick Granite wall Cladding as shown in GFC drawings shall be provided in all blocks at all floors.

All skirting shall be 100-150 mm of same material unless specified otherwise on the GFC drawings or as directed by the Engineer – in- Charge.

Mirror Polish: Mirror polishing on Granite work/ stone work shall be done where ever required as shown GFC Drawings to give high gloss finish complete as per direction of the Engineer – in- Charge.

Sand blasted Leather finish: Sand blasted Leather finish on Granite work shall be done in stair cases as shown in GFC Drawings or as directed by Engineer – in- Charge.

- 9.26 Is quality ceramic wall tiles of 600x300mm size: wall cladding/ dado in Toilets/bath/WCs/Kitchen shall be laid with cement based high polymer modified quick set tile adhesive conforming to IS: 15477, in average 6 mm thickness, including grouting of joints 3 mm wide & minimum 4 mm deep alround & filled with approved quality epoxy grout all complete is within the scope of work.

- 9.27 All tiles shall be of 1st quality as per approved sample, brand, manufacturer, colour and shade **Epoxy-grout-** Grouting the joints of flooring tiles having joints of 3 mm width and minimum 4 mm deep & stone floorings having joints of 4mm wide & minimum 6mm deep, using readymade epoxy grout including filling/ grouting and finishing complete as per direction of Engineer – in- Charge.

Stone with Epoxy Grout: - Providing and laying of Granite stone slabs shall be laid as per detail specification below:

- 1) Cleaning the surface the roughly with wire brush.
 - 2) Applying bonding coat with neat cement slurry@2.75 kg/sqm on mother surface.
- 9.28 Fixing stone laid with cement based high polymer modified quick set tile adhesive conforming to IS:15477, in average 6mm thickness, including grouting of joints, keeping the joints 3 mm wide & minimum 4 mm deep around & filled with approved quality epoxy grout all complete is within the scope of work.

The joint should be filled with approved quality anti-fungal readymade epoxy grout of approved make, as per manufacturer specifications or as directed by the Engineer – in– Charge.

Skirting/Facia/Risers/Dado: All Skirting/Facia/Risers/Dado etc shall be laid with 18 mm thick Granite stones with cement based high polymer modified quick set tile adhesive conforming to IS: 15477, in average 6mm thickness, including grouting of joints, keeping the joints 3 mm wide and minimum 4 mm deep around & filled with approved quality epoxy grout all complete is within the scope of work.

Tactile Tile Flooring: Providing and laying tactile tile of size 300x300x9.8 mm having water absorption less than 0.5% and conforming to IS:15622 of approved make in all colours and shades for different floors such as footpath, court yard, multi models location etc. at location as indicated in the GFC drawings shall be within the scope of work. The tiles shall be laid on the substrate as provided for the adjoining floor i.e. the tactile tiles shall be laid on 20 mm thick base of cement mortar 1:4 cement based high polymer modified quick set tile adhesive conforming to IS:15477 if the adjoining flooring material is stone/tile, as the case may be. Nothing extra shall be payable for extra depth of bedding mortar/adhesive required for laying the tactile tile in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete as per GFC drawings and as per direction of Engineer – in– Charge.

Installation:

1. Before installation of tiles the plastered Surface should be dry & free from dirt, dust, oil, grease & foreign matter. Surface unevenness, cracks etc.
2. Thoroughly dust tile surface by rubbing with clean cloth or brush.
3. The tiles including insert tiles shall be fixed using only white thin set tile adhesive average 3 mm thick (varies from 2mm to 4mm) i.e. LATICRETE/ARDEX/KERAKOLL or any other approved make as per manufacturers specification.
4. Prepare area on which tile is to be set by thoroughly cleaning to allow bonding of thin set adhesive to the floor/wall.
5. Remove tiles from several boxes and mix them together to have a good mixture of colors for each grid.

6. Begin installation making sure each tile has at least 90 percent coverage of the thin set adhesive.
7. Thin set tile adhesive should be trowelled on a small area of floor/ wall at a time.
8. Place tile on the trowelled section with a twisting motion while pressing down with hand and spacing to desired joint (2mm to 4 mm). Spacers should be used for uniform grouting.
9. With the wooden handle of tool tap over the tile surface. If a hollow sound is heard pick up the tile and butter with more thin set tile adhesive to the area where coverage was not initially attained.
10. Do not let Adhesive set on the tile, Please clean immediately after installation with MYK Laticrete CLENZAEG or approved equivalent.
11. After tiles are installed, allow a 24-hour period before grouting.
12. Before grouting all the tiles must be firmly set and all spacers, string and ropes should be removed.
13. Use readymade grouts of Laticrete /Ardex /Kerakoll on approved make for floor as well as wall grouting as per manufacturers specification and as directed by the Engineer – in– Charge.
14. Grout in a diagonally motion with a hard sponge and let it set for about 10 to 15 minutes before washing the excess away. DO NOT LET GROUT SET ON THE TILE. DO NOT USE ACID ON TILES. Grouting level should be slightly below the tile level.
15. Use a damp sponge and water in a circular motion to wash excess grout away. Clean up grout completely and immediately. Do not leave any grout on the tile over night. Otherwise, it will set on the tiles surface.
16. After clean up allow grout to cure for about 72 hours before use.

Protection: After the installation of tiles is complete, the floor/walls must be covered till all construction work is complete. Polythene sheet and jute bags should be used for covering. Further, after tile installation, no metal scaffolding, metal ladders etc. should be used on the floor/walls to avoid damage.

9.29 **Mirrors:** Mirror shall be 6 mm thick beveled edge mirror of superior float glass complete fixed with Stainless Steel Glass fixing Spacer with necessary screws and PVC sleeves etc complete or as directed by Engineer in charge.

9.30 **Over Head Tanks:** Internal floor and wall finish of overhead Water Tanks/domestic/fire/ flushing tanks shall be finished with 300x300 mm glazed Ceramic tiles with cement based high polymer modified quick set tile adhesive conforming to IS:15477, in average 6 mm thickness, including grouting of joints, filled with approved quality readymade epoxy grout including pointing in white cement mixed with pigment of matching shade complete after waterproofing with Acrylic Cementitious Modified two component waterproofing as per manufacturers specification finished and as directed by Engineer in charge shall be within the scope of work.

- 9.31 **Over Head Tank top covers:** Over Head Tank top covers shall be 455x610 mm rectangular CI Cover with frame including lockable arrangement, the total weight of cover and frame to be not less than 38 kg (weight of cover 23 kg and weight of frame 15 kg) and rungs shall be orange colour safety foot rest of minimum 6mm thick plastic encapsulated as per IS:10910 on 12mm dia steel bar conforming to IS:1786 having minimum cross section as 23mmx25mm and over all minimum length 263mm and width as 165mm with minimum 112 mm space between protruded legs having 2mm tread on top surface by ribbing or cheque ring besides necessary and adequate anchoring projections on tail length on 138 mm as per standard drawing or as per CPWD specification.

10.0 FALSE CEILING WORKS:

Execution of False ceiling work shall be carried out by the contractor referring the false ceiling layouts as per GFC drawings and as directed by the Engineer-in-charge all complete shall be within the scope of work. Scope of work shall include all material, labour, machinery, workmanship etc. required to complete the work upto the satisfaction of Engineer-in-charge. Contractor needs to refer schedule of finishes attached with tender document for details of false ceiling work.

Contractor will submit samples as per approved make of each item proposed in tender document to Engineer-in-charge for approvals before executing the respective job. The necessary shop drawings shall be prepared by contractor and got approved from Engineer-in-charge before installation at site.

All false ceiling work shall be executed through the specialized vendors. The engagement of specialized agency/associated agency shall be approved by the Engineer-in-charge on submission of work experience certificate of that agency. The cost of work for this purpose shall be calculated as provided in Part-A of the tender document.

Materials shall be of the best-approved quality obtainable and they shall comply with the respective latest standard Specifications. Sample of all materials shall be got approved from the Engineer-in-charge before placing bulk order and the approved sample shall be deposited with the Engineer-in-charge, which will be displayed at site as a control sample.

Materials shall be tested in any approved testing Laboratory and the test certificate in original shall be submitted to the Engineer-in-charge.

All work to be done by Manufacturer's Authorized/Approved/Trained Installer or as approved by Engineer-in-charge.

10.1 Aluminium tile false ceiling

10.1.1 Lay-in perforated tile aluminium false ceiling

Material: Aluminium Metal ceiling system Microlook, Micro Perforated consisting of 600mmx600mm/600mmx1200mm lay in tiles in 0.7 mm thick

Aluminium pre coated to Global white color with Acoustical fleece of soundtex or equivalent make hot pressed on the back of the perforated tile. The tile shall be Powder coated minimum 60 to 80 microns in the manufacture's standard colour shades.

The tiles would have NRC of 0.70. The tiles would have Fire Performance of Class 0/Class 1 as per BS476 Part 6 & 7 standard in module size of 600x600 mm.

10.1.2 Frame work & Installation aluminium false ceiling:-

All tiles to be installed on a Standard 600mmx600mm module 15mm table exposed metal grid. Grid system to be designed to satisfy ASTM C635 loading & deflection criteria. The main and cross runners to be provided with bayonet coupling for quick installation and shall have a height of 38mm.

The tile false ceiling suspended on inter locking metal grid of hot dipped galvanized steel sections consisting of Silhouette profile grid system with 15mm white flanges incorporating a 6mm central reveal in black colour and with a web height of 38mm and a load carrying capacity of minimum 9.5 kg/sqm with a minimum pullout strength of 110 kg. Silhouette main runners & cross tee of Silhouette profile to have metered ends and "birds mouth" notches to provide metered cruciform junctions. The Silhouette profile shall be made from 0.30 mm thick sheet of size 15x38mm, spaced at 1200mm center to center spaced between main "T" at 600mm center to profile length 600mm to be interlocked at middle of the 1200x600mm panel to form grids of 600x600mm and wall angle of size 19x19x0.3mm and laying false ceiling tiles of approved type and design in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc. Main "T" of Silhouette profile runners to be suspended from ceiling using M6 Anchor Fasteners with hanger hole, pre Straightened Hanger wire of dia 2.5mm of 1.80m length having a tensile strength of 344-413 Mpa and a minimum pull strength of 110 kgs. Adjustable hook clips of 0.7mm thick, galvanized spring steel can also be used for installation purpose as an additional accessory. The adjustable clip also consists of a 4 mm aquiline wire to be used with the main runner.

Finally the tiles shall be laid in place from below into the standard grid. In case of end tiles lesser than 600mm, use lay-in end cap/edge profile for installation to have a Microlook effect on perimeters. This system also including the cost of making opening, for light fittings, grills, diffusers, cutouts made with frame of perimeter channel suitably fixed all complete as per drawing and specification and direction of the Engineer-in-charge.

10.1.3 General Information:

1. The work in general shall be carried out as per the CPWD specifications, as per the manufacturer's specifications, as per architectural drawings and as per directions of Engineer-in-Charge.

2. False ceiling shall be done in different levels in linear and curvilinear pattern in plan and elevation as specified in GFC drawings.
3. The tiles and the suspension system shall be as specified in the item nomenclature. The contractor shall procure and submit the samples of tiles and grid system of approved make, for the approval of the Engineer-in-charge prior to execution of the item.
4. The Contractor shall prepare the mock-up at site for approval of material and quality of workmanship by the Engineer-in-Charge. Only after the approval of Mock-up, the Contractors shall start the mass work. If the quality of the workmanship and the material is as per the required standards and approved by the Engineer-in- Charge, the mock up shall be allowed as part of the work , Otherwise, it shall be dismantled by the contractor as directed by the Engineer-in- Charge and taken away from the site of the work at his own cost. The mock up(s) so made shall be kept till completion of respective works for reference. Nothing extra shall be kept till completion of respective works for reference.
5. Once the material and mock-up are approved, the entire material (tiles as well as grid system) shall be procured from the approved manufacturer or its authorized dealer.
6. The installation shall be got done through an approved specialized agency.
7. The material shall be transported to site well packed. The ceiling material procured shall be free of any surface defect, edge damage and any other such defects. The contractor shall ensure careful handling and storage and prevent any rough handling, rolling of cartons or dropping cartons to prevent any edge damage or breakage. The defective / damaged material shall not be allowed to be used in the work. So, the contractor shall procure additional quantity of material to cover such contingencies.
8. Adequate care shall be taken before installation as well as afterwards till completion of the work. It shall be protected from rains, excessive humidity, chemical fumes, vibrations, dust etc. Any tile with edge damaged or crack etc. shall not be allowed to be used in the work and shall be replaced by the contractor at his own cost. Similarly, adequate care shall be taken by the contractor while placing or removing and handling the tiles so as not to cause any damage. The ceiling shall be cleaned as per manufacturer's specifications. Abrasive cleaners shall not be used to clean the marks.
9. The Contractor shall obtain and submit to the Engineer-in-charge the manufacturer's test certificate /report for compliance of the material to the relevant standards along with each lot of material supplied for the work.
10. The suspension system for false ceiling shall be as per item nomenclature and as per manufacturer's specifications. The false ceiling tiles shall be fixed on to coordinated suspension ceiling system with supporting grids system that fully integrates with the ceiling tiles as per manufacturer's specifications. It shall be ensured that the suspension system shall be suitable to take all designed dead, imposed and all incidental loads efficiently and shall not sag. The true line and levels for false ceiling work shall be maintained.
11. The luminaries, air grills / diffusers, signages etc. shall be as far as possible independently supported to avoid any over loading of the ceiling system which may result in excessive deflection or twisting of grids. Any strengthening of grid system by providing additional hangers, fasteners, runners, cross tees etc. or providing additional bracing may be carried out as required for any specific locations or for specific purpose for which nothing extra shall be payable.

12. The scope of various false ceiling system shall include cost of all inputs of labour, materials, wastage if any, T&P, scaffolding, staging or any other temporary enabling structure /services etc. and all other incidental charges including making necessary cut outs for A.C diffusers, Light fittings, grills, Fire detection, alarm, sprinklers devices and fittings etc. No deduction in the area shall be made for openings nor anything extra shall be payable for making the openings. Also nothing extra shall be payable on account of any wastage in materials. Also nothing extra shall be payable on account of any strengthening of the supporting suspension system for the false ceiling, around the openings in the false ceiling by using additional hangers, fasteners, runners, cross tees, cross channels, etc.

11.0 FINISHING WORK

The work shall be done in accordance with CPWD Specifications Volume-I & II with correction slips up to the last date of submission of tender documents.

Wherever directed by the Engineer in charge, all joints between concrete frames and masonry in filling shall be expressed by a groove cut in the plaster. Where grooves are not called for, the joints between concrete members and masonry in filling shall be covered by plaster mesh strips of Arpitha or equivalent make of nominal thickness of 0.35 mm thick G.I wire with zinc coating of 120 gsm shall be used over junctions of concrete and masonry or two dissimilar materials about 200mm wide fixed with GI wire nails etc. which shall be in position before plastering.

11.1 PAINTING & FINISHING

Agency needs to refer all interior drawings, schedules of finishes, etc. to identify various items to be carried out in the section and locations.

Contractor will submit sample of each finishing items as per agreement to Engineer in charge before executing the work for approval.

11.2 Internal Painting

All internal RCC surfaces shall be painted as per schedule of finishes, with premium acrylic emulsion paint of interior grade in two or more coats on new work over white cement based putty in addition to priming coat to achieve even colour and shade.

- 11.2.1 **Base Preparation:** Base Preparation by grinding/rubbing/sand papering to remove mortar dropping and other foreign materials from the RCC surface.
- 11.2.1.1 Applying one or more coat cement primer of approval brand and manufacturer over cleaned base of concrete surface.
- 11.2.1.2 Applying white cement based putty of average 1.5mm thick to make the surface smooth and plain.
- 11.2.1.3 Applying premium acrylic emulsion paint of interior grade in two or more coats on new work over white cement based putty.

All staircases, Lift lobby, Circulation areas and Service areas at Ground floor walls and ceiling shall be finished same as Internal finishing in Quarters.

Lift Shaft: Lift shaft shall be finished with two or more coat of distemper over a priming coat of cement primer.

All service shaft shall be finished with two or more cement paint over water thinnable cement primer as per specifications.

11.3 EXTERNAL FINISHING

The work shall be carried out as per schedule of finish in accordance with CPWD Specifications Vol. I & Vol. II, and relevant IS codes of latest edition as amended upto last date of submission of bid.

Scaffolding: for all external plaster work/finishing work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed. This shall be included in scope of work and nothing extra shall be paid on this account.

11.4 Under Ground Tank (UGT)/ Over Head Tanks

PVC water stops to be compulsorily provided at the construction joint during casting of wall of water tank and waterproofing compound shall be mixed in Concreting and plastering of all tanks as per direction of Engineer-in-charge in proportion recommended by the manufacturer.

Providing PVC water stops conforming to IS:12200 for construction/expansion joints between two RCC members and fixed to the reinforcement with binding wire before pouring concrete etc. complete with Serrated central bulb. All complete as per GFC drawings and as per direction of the Engineer-in-charge shall be within the scope of work.

Internal floor & wall finish of all tanks in UGT, over head Tank shall be acrylic cementitious modified two component waterproofing as per manufacturers specification finished with 300x300mm glazed Ceramic tiles with cement based high polymer modified quick set tile adhesive conforming to IS:15477, in average 6mm thickness, including grouting of joints and pointing in white cement mixed with pigment of matching shade all complete as per GFC drawings and direction of Engineer-in-charge.

Spouts/ Sleeves: Wherever shown in Drawings or as required. GI spouts/sleeves of diameter as per GFC drawing, average 400mm long or as required shall be fixed at all levels and locations including cutting & making good the walls/concrete with primer & painting complete as shown in drawing or as directed by the Engineer-in-charge.

11.5 GLASS REINFORCEMENT CONCRETE (GRC) JALI:-

All external shafts shall be covered with GFRC screens/jellies and got approved from Engineer-in-charge before actual installation at site.

11.5 GRC Customized Screens casted with Power Spray methodology

Providing and fixing Glass Reinforcement Concrete (GRC) screens casted with 'Spray mix' concrete design in approved size, shape, colour & pattern as

shown in GFC drawings or as approved by the Engineer-in-charge, thickness of 40-50mm on the outer Border & 25-30mm for Internal member or overall thickness of 35mm and shade. The Screens should be made from '43 grade' Portland cement manufactured by 'JK cement' or Ultratech, White Quartz fine graded sieve Silica Sand, Alkali Resistant glass Fibre manufactured by 'NEG Japan, Owens Corning 'Saint Gobain' or equivalent, Super Plasticizers manufactured by 'Karochem' or equivalent, polymers manufactured by 'Nova Polychem' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation manufactured by 'Phenochem' industries or equivalent. The screens casting shall take place with layering methodology using- Direct Power Spray machines.

The GRC Screens flexural strength average L.O.P should be above or equivalent to 6 N/mm^2 M.O.R should be above or equivalent to 12 N/mm^2 for tests done on 28 days cured samples, dry bulk density shall be between 1800 to 2000 kg/cum & water absorption shall be 8 to 12%.

The fixing of Screens should be done using 'Dry fixing' method onto structural support members i.e. MS Framework made of welded Tabular sections, (as per details given in GFC drawings) with stainless steel grade 304 L shaped Clamps, anchor fasteners of Hilti/Fischer or self-tapping screws as per detail shown in GFC drawings or as per approved shop drawings approved by Engineer-in-charge. Contractor shall submit shop drawings of the same, the drawings to be duly approved by the Engineer-in-charge.

12 WATER PROOFING WORKS

General

- 12.1 All water proofing works, in general, shall be executed as per CPWD Specifications as amended upto last date of submission of bid, relevant IS codes/Standards, manufacturer's Specifications and as per the direction of the Engineer-in-charge , as applicable.
- 12.2 The contractor shall be responsible for the water proofing design, proper installation and performance of waterproofing systems to make the sub-structure and superstructure completely water tight.
- 12.3 The contractor shall engage a qualified waterproofing specialist sub-contractor, preferably manufacturer/authorized applicator to install or supply & install the waterproofing system, all in accordance with the manufacturer's recommendations & approved water proofing details.
- 12.4 For the Quality assurance and quality of workmanship, waterproofing specialist applicator should be proficient in handling and installing water proofing system and the applicator shall be approved by CPWD as per qualification criteria from list of approved vendors/make.
- 12.5 Waterproofing specialist applicator should have the proven track record, technical reliability, capability and agreement to supply full technical assistance, expert supervision during installation and performance guarantee. The determination of estimated cost of water proofing work under this item shall be done by the Engineer-in-charge as provided in Part-A of the tender document whose decision shall be final and binding on the contractor.

- 12.6 All inside surfaces of underground water tanks overhead water tanks will be provided with suitable size ceramic tiles applied with adhesive after all water proofing work is done.
- 12.7 Different types of waterproofing treatment to be executed by contractor at locations mentioned in schedule of finishes or as directed by the Engineer-in-charge.

Heat Resistant Tile: Providing and fixing ceramic based Heat Resistant Terrace Tiles (300mmx300mmx10mm) with SRI (solar refractive index)>90, solar reflection>0.78 and initial emittance >0.78, Water absorption<0.5% on waterproof and sloped surface of terrace, including fixing tiles with cement based high polymer modified quick set tile adhesive conforming to IS:15477, in average 6mm thickness, keeping the joints 4mm wide & minimum 4 mm deep around & the joint should be filled with approved quality Cementitious grout 500 series sanded grout and grout admix 1776 manufactured by M/s Laticrete or super grout & admix GT1 of Ardex Endura or approved equivalent as per manufacturer specifications or as directed by the Engineer-in-charge.

Skirting upto 150mm height shall be provided along the parapet walls in the same manner as shown in the GFC drawing or as directed by the Engineer-in-charge.

Grading of roof/sunken floor shall be done to provide the required slope wherever required.

Cement concrete screed 1:2:4 mixed with water proofing compound conforming to IS: 2645 as per manufacturer's specification to provide required slope/ gradient to take required flooring over it.

Rain water Pipes

As shown in GFC drawing, centrifugally cast iron spigot and socket pipes, fittings and accessories shall conform to IS 3989 & shall be as per CPWD Specifications Vol. I & Vol. II and relevant IS codes of latest edition as amended upto last date of submission of bid. The joint of CI pipes & fittings shall be made with non shrinkable free flowing mortar (Conbextra as manufactured by M/s Fosroc Chemical India Ltd or equivalent approved make).

Painting: All sand cast iron/cast iron (Spun)/hubless cast iron pipes and fittings shall be painted with shade to match the colour of the background with required paint as shown in GFC drawing or as directed by the Engineer-in-charge.

Khurra: Making khurras 45cmx45cm with average minimum thickness of 5cm cement concrete 1:2:4 finished with 12mm cement plaster 1:3 and a coat of neat cement rounding the edges and making and finishing the outlet complete as per GFC drawing or as directed by the Engineer-in-charge.

Spouts/sleeves: Wherever required GI spouts/sleeves of diameter as per GFC drawing, average 400 mm long or as required shall be fixed at all levels and locations including cutting & making good the walls/concrete with primer & painting complete as per GFC drawing or as directed by the Engineer-in-charge.

GUARANTEE BOND: Ten (10) years guarantee bond in prescribed proforma shall be submitted by the contractor which shall also be signed by both the specialized agency and the contractor to meet their liabilities under the guarantee bond. However, the sole responsibility about efficiency of Waterproofing work shall rest with the building contractor.

Additional security deposit @ 10% of cost shall be retained and the amount so withheld would be released after five years from the date of completion of the entire work under the agreement, if the performance of the work done is found satisfactory. If any defect is noticed during the guarantee period, it shall be rectified by the contractor within seven days of receipt of intimation of such defects in the work. If the defects pointed out are not attended to with the specified period, the same shall be got done from another agency at the risk and cost of the contractor this additional security may be released if contractor submits Bank Guarantee/FDR of matching value and validity issued from a scheduled commercial bank pledged in favour of Engineer-in-Charge.

The security deposit against this item of work shall be in addition to the security deposit mentioned elsewhere in contract form.

13 SANITARY INSTALLTIONS, WATER SUPPLY AND DRAINAGE:

1.0 SCOPE OF WORK

- 1.1 The work in general shall be carried out as per CPWD Specifications-2009 Volume-I to II with up to date correction slips.
- 1.2 The rules and regulations of Local Authority Having Jurisdiction, and as per the statutory regulations applicable.
- 1.3 The codes of the latest National building code, Uniform Plumbing Code of India and relevant British Standards shall be used as a general guide for good engineering practice, design and workmanship norms.
- 1.4 Work under this section shall consist of furnishing all Material and labour as necessary and required to completely install all Sanitary Fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter.
- 1.5 Without restricting to the generally, the foregoing the Sanitary Fixtures and CP Fittings and Accessories etc. shall be selected as per the guidelines given in the table no. 1 in the end of this section and as per the approval of the engineer-in-charge as necessary and required for the Building.

- 1.6 Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.
- 2.0 **GENERAL REQUIREMENTS**
- 2.1 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 Specifications and Drawings.
- 2.2 All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/ Interior designer's requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.
- 2.3 Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge / Owner.
- 2.4 All Fittings and Fixtures shall be fixed in a neat workmanlike manner true to Levels 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 Contractors cost.
- 2.5 When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge/Owner. Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.
- 3.0 **EUROPEAN W.C.**
- 3.1.1 European W.C. shall be wash down, single or double siphonic type, wall mounted set, flushed by means of exposed flushing cistern, Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair/bolts as per approval.
- 3.1.2 Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.
- 3.2 **INDIAN W.C.**
- 3.2.1 Indian W.C. pan shall be Orissa pattern of the required size. Each W.C. shall be provided with a 100 mm dia cast iron or porcelain P or S trap with or without vent horn.
- 3.2.2 W.C. shall be flushed by means of an exposed or concealed type cistern.
- 3.2.3 The W.C. shall be fixed in level in a neat workmanlike manner. The W.C. and trap shall be set in cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone

aggregate 20 mm nominal size) joints between W.C. and flush pipe shall be made with a putty or white lead and linseed oil and caulked well or with an approved rubber joint.

4.0 URINALS

- 4.1 Urinals shall be white glazed Vitreous China flat back half stall.
- 4.2 Half stall Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one C.I. bracket and two C.I. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge/Owner.
- 4.3 Half stall urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.
- 4.4 Urinals shall be flushed by means of automatically sensor operated flushing system.

5.0 SINKS

- 5.1 Sinks shall be of stainless steel as per the manufacturer's specifications.
- 5.2 Each sink shall be provided with R.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Fixing shall be done as directed by Engineer-in-Charge / Owner.

6.0 WASH BASIN

- 6.1 Wash Basins shall be white glazed vitreous chinaware of required size, shape and type.
- 6.2 Each Basin shall be provided with R.S. or C.I. brackets duly painted. The clips and the basin securely fixed to wall and have the required accessories. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Architect/Consultants.
- 6.3 Each basin shall be provided with 32 mm dia. C.P. waste of standard pattern with pop-up waste or rubber plug and chain as specified in the detailed engineering, PDR and system requirement, 32 mm dia. C.P. brass bottle trap and angle valve with C.P. pipe to wall and flange.
- 6.4 Each basin shall be provided with auto closing pillar cock.
- 6.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cm or as directed by Architect/Consultants.

7.0 **ACCESSORIES**

- 7.1 Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge / Owner.
- 7.2 All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with raw plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge/Owner.
- 7.3 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.

8.0 **URINAL PARTITIONS**

- 8.1 Urinal partitions shall be white glazed vitreous china or 25mm thick marble of required size.
- 8.2 Porcelain 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 Engineer-in-Charge / Owner.

9.0 **EWC PAN CONNECTOR**

The EWC pan connector shall be Flexible, soft and shall be made of single body construction with integral fins. The pan connector must be supplied with factory fitted spring loaded seal guard.

While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush / adaptor shall be used. The connector socket is pushed fully home onto the pan spigot, thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such a easy as to ensure that the seals and fins turn inward to ensure proper sealing.

10.0 **Hand Drier:**

- 10.1 The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position.
 - 10.2 The hand drier shall be fully hygienic, rated for continuous repeat use (CRU).
 - 10.3 The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds.
 - 10.4 The hand drier shall be of wall mounting type suitable for 230V, single phase, 50 Hz, AC power supply.
- 11.0 Toilets for Differently Abled:

- 11.1 Where specified in washroom facilities designed to accommodate differently abled, accessories should be provided as per detail given in the Table and as approved by the Engineer-in-Charge.
- 11.2 Stainless steel grab bars of required size suitable for concealed or exposed mounting and non-slip gripping surface shall be provided in all washrooms to be used by differently abled as directed by Engineer-in-Charge.
- 12. **Shower Channel:**
Shower drain Channel shall be provided as per the model given in the table and as per manufacturer's specifications.

SOIL, WASTE & VENT PIPES

1.0 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 as required by the drawings, specified hereinafter.
- 1.2 Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:
 - a) Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps, and connections to Fixtures.
 - b) Connection of pipes to Gully Traps & Manholes etc.

2.0 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 / Owner.
- 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.
- 2.6 All works shall be executed as directed by Engineer-in-Charge / Owner.

3.0 CAST IRON PIPES & FITTINGS (IS: 15905)

3.1 Pipes & Fittings

All pipes & fittings shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects & shall conform to the specifications as per IS:15905 for Hubless Cast iron soil, waste, ventilating and rain water pipes fittings & accessories, complete in all respects.

3.2 **Other Fittings**

- a) Other casted CI Fittings used for drainage pipes shall confirm to the required specifications & as per site conditions & wherever possible to the relevant IS code.

3.3 Fixing

- 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).
- 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.
- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building Contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surface.

3.4 Jointing

CI pipes shall be jointed with EPDM rubber gasket with SS 304 coupling of approved make.

4.0 **CLAMPS / STRUCTURAL SUPPORTS**

- 4.1 G.I. clamps shall be of standard design and fabricated from M.S. flat 40x3mm thick with required Galvanization.
- 4.2 Where G.I. clamps are to be fixed on RCC columns or slotted angles, walls or beam they shall be fixed with 40x3mm flat iron "U" type clamps with anchor fasteners of approved design or 6mm nuts and bolts.
- 4.3 Structural clamps shall be fabricated from G.I. (Galvanized) 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. Wooden saddles, where required shall be provided free of cost.
- 4.4 Slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings, 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.
- 4.5 Wherever G.I. 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 stone aggregate 20mm nominal size) as directed by the Engineer-in-Charge / Owner.

5.0 **TRAPS**

5.1 Floor traps shall be of CI, 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 cm of the required depth. Where traps are suspended below ceilings, they shall be provided with proper structural supporting arrangements.

5.2 Urinal Traps

Urinal traps shall be of uPVC deep seal traps with or without Vent and set in cement concrete block specified in Para above without extra charge.

5.3 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 G.I. inlet hopper without or with one, two or three inlet sockets to receive the waste pipe. Hopper shall be connected to trap with at least 50 mm seal (Hopper and traps shall be paid for separately).

5.4 C.P./Stainless Steel Gratings

Floor and Urinal Traps shall be provided with 100-150 mm square or round C.P./Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4-5 mm.

6.0 **CLEANOUT PLUGS**

Contractor shall provide 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 male threaded adaptor.

7.0 **WASTE PIPE FROM APPLIANCES**

7.1 Waste pipe from appliances e.g. wash basins, sinks, urinals, water coolers shall be of G.I. heavy duty as shown on the drawings.

7.2 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 at approved spacing.

8.0 CEMENT CONCRETE

Soil and Waste pipes under floors 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 20 mm size) 75 mm in bed and allround. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals as directed by Engineer-in-Charge/Owner.

9.0 CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as buildings proceeds. Contractor shall provide all necessary holes cutouts 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.

10.0 INSPECTION & TESTING

10.1 Inspection

Work should be inspected during installation and tests applied on completion, care being taken that, all work which is to be encased for concealed is tested before it is finally enclosed.

Inspection should be carried out to ensure the following:

- (a) Work accords with the drawing and specifications.
- (b) All pipe brackets, clips etc. are securely fixed.
- (c) Fixtures are correctly spaced.
- (d) Pipe is protected where necessary by Thermal Insulation.
- (e) Embedded pipe work is properly protected before sealing-in
- (f) All access covers, caps or plugs.

- Are accessible
- Are so made that the internal faces truly complete in internal bore.
- Cause no obstruction in the pipe bore
- Are well joined.

10.2 Testing

The soil, waste piping system and rain water should be tested after installation as follows:

(a) Water Test

The pipes shall be tested after installation & before the appliances are connected, preferably in sections so as to limit the static head of 4.5m. The pipe shall be filled with water for at least 10 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. Then it will be necessary to seal all openings and leaks at joints immediately as observed during the test and all defective pipes shall be rejected and removed from the site. Pipes with minor sweating shall be accepted at the discretion of the Engineer-in-Charge/Owner.

(b) **Smoke Test**

Alternatively, the Contractor may test all Soil, Waste and Rainwater stacks by smoke testing machine. The smoke test shall be carried out as under:

Smoke shall be pumped into the stack after plugging all inlets and connections at the lowest points from a smoke testing machine which consists of a bellow & burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detected by sight as well as by smell, if there is leak at any points of the pipe. The top end shall however be left open. The stack shall then be observed for leakiness and all defective pipes and fittings removed or repaired as directed by the Engineer-in-Charge / Owner.

- 10.3 A test register shall be maintained and all entries shall be signed and dated by Contractors and Engineer-in-Charge/Owner.

WATER SUPPLY SYSTEM

1.0 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.
- 1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following: -
 - a) All water lines to different parts of the hostel building from their respective O.H. Tanks and making connection from source etc.
 - b) Pipe protection and painting.
 - c) Control valves, masonry chambers and other appurtenances.
 - d) Connections to all toilets, storage tanks and appliances.
 - e) Excavation and refilling of pipe trenches, wherever required.
 - f) Trenches for taking pipe lines for these services.

2.0 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 Engineer-in-Charge / Owner.
- 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. As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.
- 2.4 Pipes shall be fixed in a manner so 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 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

3.0 G.I. PIPES & FITTINGS FOR FROM CENTRALIZED WTP TO OH TANK, FROM OH TANK TO TOILETS AND OTHER WATER DELIVERY POINTS

- 3.1 All pipes inside the buildings and where specified, outside the building shall be galvanized steel tubes conforming to I.S. 1239-1979 of class specified.
- 3.2 Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall

include Couplings, Bends, Tees, Reducers, Nipples, Unions, Bushes, Fittings shall be of I.S:1879 - (part I to X) 1975.

- 3.3 Pipes and fittings shall be jointed with screwed fittings. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. Genuine red lead with grummet and a few strands of fine hemp shall be applied. 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 be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other as shown on drawings.

4.0 **STAINLESS STEEL PIPES INSIDE THE SHAFT, TERRACE, INSIDE THE TOILETS AND FOR DRINKING WATER SYSTEM**

The SS pipe shall be of grade SS-316L & conforming to EN 10312 standard compete with Press type fittings with SC-Contour in accordance with international regulation (DVGW - W534) & as per approved makes & specifications, complete as per the instructions of Engineer-in-charge.

5.0 **UPVC PIPES FOR GARDEN HYDRANT SYSTEM**

5.1 Definition

UPVC 10 Kg/cm² pipe means unplasticized Polyvinyl Chloride pipe, confirming to IS: 4985. It has density of Approx. 1.43 g / Cm³ as such it is less than 1/6th the weight of C.I. and steel pipes, therefore easier to handle during installation and transportation.

- 5.2 The uPVC Pipes to be used for horticultural purpose, water to be odorless and hygienic, and should have inside surface mirror smooth.

- 5.3 The Pipes should have high corrosion resistance and should be immune to chemical electrolytic and galvanic action.

- 5.4 These Pipes should be longer lasting because of corrosion resistance property.

5.5 Handling Guidelines

Pipes should be kept on an even surface while storing. They should be properly supported and should not be stacked for heights more than 1.5 meters for longer duration.

5.6 Jointing Instructions

The uPVC Pipes are of two types i.e. Selfit and Ringfit. The following procedure may be adopted while jointing the Pipes: -

(a) Selfit Pipes

- Cut the Pipes as square as possible and ensure fitment of Pipes with socket of fitting is correct. Total length of insertion of sockets to be marked from the Pipe.
- The Pipe and the socket should be clean and dry. Dust, Oil, water, grease etc. should be wiped out with dry cloth or cleaner from the surfaces to be coated with Solvent Cement.
- Roughen the outside of Pipe and inside of Socket using sand Paper up to the entry mark. Stir adhesive i.e. Solvent Cement thoroughly.
- Apply thick coat of Solvent Cement using a flat clean brush evenly on the inside of the socket mouth for full length of insertion and then outside of the Pipe end up to the marked line.
- After application of Solvent Cement, insert the Pipe within one minute in to the Socket. Hold the Joint for few seconds and ensure that the Pipe does not come out of the fittings. Wipe off extra cement and allow it to dry for at least 24 Hours. The PVC Pipe with joint is ready for use.

Consumption of Solvent Cement

Diameter of Pipe (mm)	20	25	32	40	50	63	75	90	110	160	200	250	315	400
Approx. No: of joints which can be made per liter of Solvent cement	324	270	225	180	130	125	103	79	54	27	15	9	5	2

(b) Ring-fit Pipes

- Clean the inside of Socket. Remove all traces of mud, dirt, grease, gravel and also clean sealing ring.
- Form the EPDM ring into heart shape by pinching a portion of ring inside. Insert it into the socket and release to seat in to the groove.
- Mark the insertion depth on spigot portion of the pipe. Clean and apply lubricant to insertion depth before pushing in to the Socket. Ensure that no sand or dirt adheres to the lubricated surface of the Pipe.
- Push the Spigot into the Socket until it reaches the depth of entry mark, taking care not to over insert. This can be done manually. Make sure that the insertion of Spigot end inside the socket should be at correct angle. The Pipe and Joint are ready for use.
- In case of large diameter Pipes if crow bar does not give sufficient leverage, use of jointing jack may be helpful.

Precautions

1. uPVC Pipes and Fittings should not be cleaned by Solvent Cement.
2. For large diameter and Higher class Pipes (6 kgf/cm² & above), use heavy duty Solvent cement.
3. uPVC pipes and fittings to be used of same Brand and Manufacturer.

6.0 CLAMPS

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Engineer-in-Charge / Owner. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

7.0 UNIONS

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge / Owner.

8.0 FLANGES

Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge / Owner. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge / Owner. Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

9.0 TRENCHES

The external water supply pipes below ground shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 150mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earthwork in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

10.0 PAINTING

10.1 All surfaces shall be thoroughly cleaned before painting.

10.2 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 color code specified by Engineer-in-Charge/Owner.

10.3 All pipes in chases and below floor shall be provided Anti-corrosive treatment.

11.0 PIPE PROTECTION

All pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of material of approved make over the pipe.

12.0 BALL VALVES

The Ball Valve shall be made from forged brass and tested to 20 Kg/cm² pressure. The valve shall be internally threaded to receive pipe connections. The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body bonnet gasket and gland packing shall be of Teflon. The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm² pressure. The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degrees.

13. BUTTERFLY VALVES

- The Butterfly Valve shall be suitable for waterworks. The Valves conforming to IS : 13095 shall be provided. All valves shall be suitable to withstand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve).
- The direction of opening and closing shall be marked and an open / shut indicator fitted.
- The material of valves shall be as under:-
 - Body -Cast iron
 - Disc -Ductile Iron
 - Seat -EPDM/Nitrile rubber
 - Shaft -Stainless Steel
- The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.
- Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.

- Butterfly valves shall be provided on all branches as shown in the drawings or as specified.

14.0 **Fittings and Inspection Chambers**

Fittings and chambers shall be provided as required.

14.1 Anchor Block

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

14.2 Rubber Joints

Joints between two pipes shall be made by pre-moulded rubber joints with suitable tackles in a manner recommended & approved by the manufacturer. No joints shall be covered until the lines are hydraulically tested.

15.0 **VALVE CHAMBERS**

- 15.1 Contractor shall construct chambers for all full way valves, butterfly valves and other type of valves. These shall be made, in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) on cement concrete foundations 150mm thick 1:5:10 mix (1 cement: 5 coarse sand: 10 graded stone aggregate 40mm nominal size) 12 mm thick cement plaster 1:3(1 cement : 3 coarse sand) inside finished with a floating coat of neat cement with 8mm thick M.S surface box with hinged cover and locking arrangement, 150 mm thick reinforcement cement concrete top slab of 1:2:4 (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size), as specified and shown in drawings, including excavation, back filling rammed complete.

- 15.2 Valve chambers shall be constructed of following sizes:

	Length (mm)	Width (mm)	Depth (mm)
For pipes dia. Up to 80 mm	600	600	1000
For pipes dia. 80 mm and above	750	750	1000

16.0 **TESTING**

- 16.1 All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm² in any case and with the consent of Engineer-in-Charge / Owner.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. (+10%). A test register shall

be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

16.2 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 during the defects liability period without any extra cost.

16.3 After completion 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.

17.0 **DISINFECTION**

17.1 After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.

17.2 After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable.

18.0 **PRE COMMISSIONING**

18.1 Ensure that all pipes are free from debris and obstructions.

18.2 Check all valves for effective opening and closing action. Defects should be rectified or valves replaced.

18.3 Ensure that all Connections to Branches have been made.

18.4 Ensure that mains have been connected to the respective pumps, underground and overhead tanks.

18.5 Water supply should be available at main Underground tank.

18.6 All main line Valves should be closed.

19.0 **COMMISSIONING**

19.1 Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

19.2 Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

- 19.3 After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).
- 19.4 Fill Overhead tank to full.
- 19.5 Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.
- 19.6 Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.
- 19.7 Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.
- 19.8 The entire water supply system should be disinfected with bleaching powder and system flush cleaned.
- 19.9 Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).
- 20.0 **RESPONSIBILITY**
Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

**EXTERNAL WATER SUPPLY SYSTEM
(DOMESTIC/MUNICIPAL/HORTICULTURE/
BORE WELL WATER)**

1.0 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 indicative list of items.
- 1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following: -
- Tubewell Rising Main to Water Treatment Plant.
 - Municipal Rising Main to Water Treatment Plant
 - Domestic Water rising main Distribution System from Water Treatment Plant to each block OHT of the Girls' hostel.
 - Flow metre
 - External Garden Hydrant System ring mains from the Water treatment plant including Garden Hydrant points.
 - Construction of control valves, masonry chambers & all other appurtenances whatever required.

2.0 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 Engineer-in-Charge / Owner.
- 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. As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.
- 2.4 Pipes shall be fixed in a manner so 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 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.
- 3.0 DUCTILE IRON PIPES
Ductile Iron Pipes for water supply mains shall be ductile iron grade-I, cement mortar lined conforming to IS : 8329 as classified in indicative list of item

3.1 Ductile Iron Pipe Fittings & Inspection Chambers

Fittings used for DI pipes shall conform to IS: 9523, BS: EN: 545/1995, Class 'A'. The fittings shall have external bitumen coating and internal cement mortar lining.

4.0 **G.I. PIPES & FITTINGS**

4.1 All pipes where specified as G.I. pipes shall be galvanized steel tubes conforming to I.S. 1239-1979 of class specified. When class is not specified they shall be medium class.

4.2 Fittings shall be malleable iron galvanized fittings, of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings for G.I. pipes shall include Couplings, Bends, Tees, Reducers, Nipples, Unions, Bushes, Fittings shall be of I.S:1879 - (part I to X) 1975.

4.3 The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over. Teflon Tape should be used on threads instead of 'Dhaaga/ Safeda'. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

5.0 **CLAMPS**

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Engineer-in-Charge / Owner. Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

6.0 **UNIONS**

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge / Owner.

7.0 **FLANGES**

Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge / Owner. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge / Owner. Bolt

hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

8.0 TRENCHES

The galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	75 cms
65mm to 100mm	45 cms	90 cms
150mm	60 cms	120 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earthwork in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

9.0 PAINTING

9.1 All surfaces shall be thoroughly cleaned before painting.

9.2 All pipes above ground shall be painted with one coat of Red Oxide Primer and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard color code specified by Engineer-in-Charge/Owner.

9.3 All pipes in chases and below ground floor shall be provided Anti-corrosive treatment.

10.0 Thrust Blocks:

Thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) of adequate size and shape shall be provided on all bends to transmit the hydraulic thrust to the ground, spreading it over a sufficient areas, depending upon the type of soil met with.

10. UPVC PIPES FOR GARDEN HYDRANT SYSTEM

10.1 UPVC Pipes

UPVC pipes confirming to I.S: 4985 and of 10 Kg/cm² as specified in indicative list of items. The details of the nominal outer diameter, weight and working pressure at 200C shall be as per the above standards, for the respective pressure rating as specified in the indicative list of item.

All pipes shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects.

10.2 Jointing of PVC Pipes

UPVC pipe as per I.S: 4985 shall be jointed with solvent cement as per manufacturer's specifications and relevant I.S. codes.

Pipes shall be tested after installation for a pressure equal to twice the maximum working pressure in the line or as per manufacturers specifications or as specified subsequent relevant codes.

11.0 **PIPE PROTECTION**

Corrosion protection tape shall be wrapped on pipes to be buried in ground. This corrosion protection tape shall comprise of coal tar/asphalt component supported on fabric of organic or inorganic fibre and minimum 4 mm. thick and conform to requirement of IS:10221 - code of practice for coating and wrapping of underground line. Before application of corrosion protection tape all foreign matter on pipe shall be removed with the help of wire brush and suitable primer shall be applied over the pipe thereafter. The primer shall be allowed to dry until the solvent evaporates and the surface becomes tacky. Both primer and tape shall be furnished by the same manufacturer. Corrosion protection tape shall then be wound around the pipe in spiral fashion and bounded completely to the pipe. There shall be no air pocket or bubble beneath the tape. The overlaps shall be 15 mm and 250 mm shall be left uncoated on either end of pipe to permit installation etc. This area shall be coated insitu after the pipe line is installed. The tape shall be wrapped in accordance with the manufacturer's recommendations. If application is done in cold weather, the surface of the pipe shall be pre-heated until it is warm to touch and traces of moisture are removed and then primer shall be applied and allowed to dry.

12.0 **VALVES**

12.1 Ball Valves

Ball Valves have body material as Forged Brass Chrome plated with Spindle Brass Nickel Plating & Lever handle Steel Chrome plated with green plastic cover. The valve is suitable for water maximum working pressure up to 16 bar (PN 16). The valve is operated by turning. The rotation from open to close is a quarter turn (90o) which closes in a clock-wise direction.

12.2 Butterfly Valves

- (a) Butterfly valves of approved quality for pressure rating of PN 16 with locking arrangement and gearbox with handle operated or gearbox with lid shall be provided or as given in the Indicative list of items.
- (b) Butterfly valves shall be of specified quality conforming to IS: 13095 or BS: 5155.
- (c) Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.
- (d) Butterfly valves shall be provided on all branches as shown in the drawings or as specified.

12.3 Scour Valves

Scour valves shall be C.I. sluice valves as specified above. They shall be installed at the lowest level or tail end of the system as shown on drawings and directed by Engineer-in-Charge / Owner.

12.4 Air Release Valves

- (a) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.
- (b) Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

13.0 VALVE CHAMBERS

13.1 Contractor shall construct chambers for all full way valves, butterfly valves and other type of valves as specified in the indicative list of items. These shall be made, in brick masonry in cement mortar 1:4 (1 cement: 4 coarse sand) on cement concrete foundations 150mm thick 1:5:10 mix (1 cement: 5 coarse sand: 10 graded stone aggregate 40mm nominal size) 12 mm thick cement plaster 1:3(1 cement : 3 coarse sand) inside finished with a floating coat of neat cement with C.I surface box with hinged cover and locking arrangement, 150 mm thick reinforcement cement concrete top slab of 1:2:4 (1 cement : 2 coarse sand: 4 graded stone aggregate 20mm nominal size), as specified and shown in drawings, including excavation, back filling rammed complete or as specified in drawings

13.2 Valve chambers shall be constructed as specified in drawings but generally shall be of following sizes:

	Length (mm)	Width (mm)	Depth (mm)
For pipes dia. Up to 50 mm	300	300	500
For pipes dia.65 to 80 mm	600	600	750
For pipes dia. above 100 mm	900	900	1000

14.0 TESTING

14.1 All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times the working pressure and subject to minimum of 10 kg/cm² in any case and with the consent of Engineer-in-Charge / Owner.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall

be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

14.2 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 shall be made good during the defects liability period without any extra cost.

14.3 After completion 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.

15.0 **DISINFECTION**

15.1 After completion of the work Contractor shall flush clean the entire distribution systems with filtered water after connection has been made.

15.2 After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable.

16. **PRE COMMISSIONING**

16.1 Ensure that all pipes are free from debris and obstructions.

16.2 Check all valves and garden hydrant for effective opening and closing action. Defects should be rectified or valves replaced.

16.3 Ensure that all Connections to Branches has been made.

16.4 Ensure that mains have been connected to the respective pumps, underground and overhead tanks or as per requirements.

16.5 All main line Valves should be closed.

17.0 **COMMISSIONING**

17.1 Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.

17.2 Start Water Supply Tubewell / Municipal flow and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.

17.3 Run the Pumps with all water treatment accessories or Bypass.

17.4 Fill the domestic water tanks and run main supply pumps.

17.5 Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or garden hydrant in lower regions. Ensure clean water is now coming out of the system.

- 17.6 Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.
- 17.7 Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.
- 17.8 The entire water supply system should be disinfected with bleaching powder and system flush cleaned.
- 17.9 Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).
- 18. RESPONSIBILITY
Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

RAGE / DRAINAGE SYSTEM

1.0 SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all Labour, Materials, Equipments and Appliances necessary and required to completely finish Sewerage/Drainage system as required by the drawings and specified hereinafter.

1.2 Without restricting to the generality of the foregoing, the sewerage system shall include:

- Installation of all sewer lines around the buildings and connection to the existing main sewer system.
- Installation of pre-engineered Grease trap and Grease pumping system for Kitchen waste
- Installation of Neutralization tank for pretreatment of Laundry waste
- Installation of all storm water drainage lines around the buildings and connection to the main drain.
- Construction of all catch basins, chambers, manholes, grease traps & other related civil works etc. around the buildings

2.0 GENERAL REQUIREMENTS

2.1 All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge / Owner.

2.2 Drainage lines 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 Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge / Owner before the actual execution of work at site.

2.5 All works shall be executed as directed by Engineer-in-Charge / Owner.

3.0 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 / Owner 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 / Owner.

4.0 HIGH DENSITY POLYTHENE PIPES FOR SEWERAGE LINE

4.1 HDPE (High density polythene black) pipes conforming IS: 14333, for Sewerage effluents with material grade PE-80 with working pressure 4 Kg / Cm².

4.2 Laying and Jointing of HDPE Pipes

Laying and jointing of the pipes shall be done as specified in IS: 14333

While laying the pipe in trenches the bed of the trench should be level and free from sharp edged stones. While lying in rocky areas suitable bed of sand or gravel should be provided. The initial back fill about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete M-100, 15 cm shall be provided, before putting in the soft sand/gravel. Jointing of two pipes shall be done through BUTT-Welding. The method of butt-welding shall be as below:

- a) The ends of the pipes to be joined are cut vertically at right angles with a fine toothed saw and trimmed with a file to make both ends smooth so that the pipes when pressed together are without leaving any gap.
- b) Both the inside and outside surfaces of the ends of the pipes are scraped (up to about 1/2" from the end) with a sharp scraper to remove the thin oxidized layer.
- c) It is necessary to see that there are no extraneous particles of dust, mud, grease, polyethylene powder etc. at the joining portion of the pipes.

An electrical HEAT MIRROR (Hot Plate) is used for heating the ends of the pipes. The pipes are pressed flush against the flat surface of the Heat Mirror, one on each side horizontally, and held in that position under slight pressure. The Heat Mirror is maintained at a steady temperature of 200 deg C. with the help of THERMOSTAT. After a while, a slight rim is formed at the ends of the pipes both inside and outside. When a rim of about 1/10" to 1/8" is formed, the pipes are pulled apart and the Heat Mirror is quickly withdrawn. Then the two ends of the pipes are brought together face to face so that the molten portions come into contact with each other. Then the pipes are drawn back very slightly (without separating the joined molten portion) and then again the pipes are pressed together with a moderate pressure of about (1 to 1.5 kg/cm sq). This ensures that any air bubbles are squeezed out. The pipes are held in that position until the pipe-joint cools off naturally in atmospheric air. When a perfect joint is made, the rims cohere in such a way that there is only a very fine slight depression between the two rims. If the top surface of the rim is too flat, it will be because the pipe is overheated. If there is too much of depression (groove) between the rims, the pipe is under-heated. The rims should not be cut off or erased from the joints. Also, correct alignment of the pipes will help in joining the pipes perfectly, as otherwise there will be reduction in the area of the joining surface rendering the joint weak and imperfect.

5.0 DWC PIPES FOR SEWERAGE LINE

- 5.1 DWC Pipes shall confirm IS 16098 (Part-2) and of SN8 class, have a smooth internal surface and corrugated external surface. The corrugated external surface provides greater stiffness, withstands soil movement & takes higher loads (static & dynamic), whereas the internal surface helps in smooth flow of sewerage. DWC Pipes are manufactured using HDPE polymer. These pipes are resistant to various

types of gases & chemicals which are generated due to purification of various ingredients flowing in the system.

5.2 All the pipes shall be jointed Socket & Spigot joint with elastomeric sealing ring.

6.0 **GULLY TRAPS**

6.1 Gully traps shall conform to IS 651. These shall be sound, free from visible defects

such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing.

They shall give a sharp clear tone when struck with light hammer. There shall be no broken blisters.

6.2 Gully traps shall be fixed in cement concrete 1:5:10 mix (1 cement: 5 coarse sand: 10 stone aggregate 40mm nominal size) and a brick masonry chamber 30x30 cms or 45x45 cms inside whatever required in cement mortar 1:3 with grating as per requirements and 30x30 cms or 45x45 cms C.I. sealed cover as per requirements and frame weighting not less than 14 kg to be constructed as per standard drawing. Where necessary, sealed cover shall be replaced with C.I. grating of the same size.

7.0 **GREASE SEPARATOR FOR KITCHEN**

Grease Trap shall be provided on Kitchen waste lines before discharging the waste into the main sewer line. Grease trap shall be NS10 Grease separator, size as per the drawings made of polyethylene as per DIN EN 1988 and DIN4040-100; for below ground installation with integrated sludge trap and top cover having nominal diameter 600 mm with load class B125 (EN 124); Ventilation provision; Draining connection, Discharge pipe work OD 160 mm Compression fittings and connection pipe with coupling ; Standard odour tight top 2 nos. cover of 600 mm dia. clear opening, load class B125 according to EN 124 including related Civil works as per preliminary details given in the above mentioned drawings complete in all respects.

7.1 **SCREW SLUDGE PUMP FOR REMOVAL OF GREASE**

Screw Sludge pump for removal of grease waste, mounted on SS Mover Trolley with Control Panels, Storage Tanks accordingly complete in all respects to handle grease from grease trap in Environment Friendly way with following specifications:

Grease Waste Mover Trolley Heavy-duty waste mover trolley designed to carry and transport grease waste efficiently made of Stainless steel for durability and corrosion resistance. Load capacity: Minimum 1500 kg with Locking wheels as per manufacturer's specifications to fit securely on top of the screw sludge pump with control unit & storage tank 500 liters Electric motor with adequate power rating

for efficient pumping. Standard connections for seamless integration with the system with an electrical control panel to operate and manage the screw sludge pump and related equipment safely.

8.0 **REINFORCED CEMENT CONCRETE PIPES FOR STORM WATER SYSTEM**

8.1 All underground storm water drainage pipes where specified shall be centrifugally spun RCC pipes NP3 of specified class above 200 mm dia. Up to 200 mm dia HDPE pipes conforming to IS: 14333 shall be used. 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.

8.2 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 12mm 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 / Owner.

8.3 Jointing

After setting out the pipes the collars 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 degree to the longitudinal axis of the pipe on both side of the collars neatly.

9. **TESTING**

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. All pipes shall be subjected to a test pressure of at least 1.5 meter head of water. The test pressure shall, however, not exceed 1.5 meter head at any point. The pipes shall be plugged preferably with standard design rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head. The tolerance figure of two liters per centimeter of dia per kilometer may be allowed during a period of

ten minutes. Subsidence of the test water may be due to one or more of the following causes:

- Absorption by pipes and joints
- Sweating of pipe or joints
- Leakage at joints or from defective pipes

(a) Trapped Air

Allowance shall be made for (i) by adding water until absorption has ceased after which the test proper should commence. Any leakage will be visible and the defective part of the work should be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

(b) Sewer and Drain Pipelines shall be tested for straightness by:

- Inserting a smooth ball 12mm 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.
- Means of a mirror at one end 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 / Owner.

(d) A test register shall be maintained which shall be signed and dated by Contractor, Engineer-in-Charge / Owner and representative of Architects/ Consultants.

10.0 **CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.**

10.1 Materials

(a) Water

Acidity, Alkalinity and percentage of Solids shall be in accordance with IS: 3025. The Ph value shall generally be not less than 6. In general potable water is considered satisfactory for use. Sea water shall not be used.

Testing shall be done individually for different source points before the start of the work and there after once in every three months.

(b) Aggregate for Concrete

It shall be strong, durable and free from adherent coatings, sea shell, organic impurities, disintegrated pieces.

If dirty, shall be washed with water before actual use. Flaky and elongated piece shall be avoided. It shall conform to IS: 383 and IS: 2386.

(c) Sand

It shall be hard, durable, chemically inert, clean and free from adherent coatings, organic matter etc. and shall not contain any appreciable amount of clay bald harmful impurities and shall confirm IS: 231 or pellets an86. It shall not contain more than 8 % of silt as per the field test.

Grading for masonry, plaster and concrete shall be as per IS: 2116, IS: 1542, IS: 383 respectively, Sea sand shall not be used.

Testing for bulkage to be done and allowance be made at the time of use.

(d) Cement

The cement used for all the constructional purposes shall be Portland pozzolana cement confirming to I.S. 1489 OR rapid hardening, Portland cement conforming to I.S. 269.

Different types of Cement shall not be mixed together, shall be stacked and stored separately. Cement Bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received.

The site where it is stored shall be dry, leak proof and as far as possible moisture proof.

Necessary precautions to be taken to avoid dampness through floor and walls. Stacking shall not be more than 10 bags high.

(e) Mild Steel Reinforcement

The mild steel for the reinforcement bars shall be in the form of round/ twisted/deformed bars conforming to all requirements of I.S. 432 (Grade I).

(f) Bricks

Brick shall have uniform color, thoroughly burnt, smooth rectangular faces, with parallel slab, sharp and right angled edges, but not over-burnt.

When struck should give clear ringing sound.

The maximum permissible area of perceptible deposit of efflorescence shall be 50% of the surface area of the Bricks. The affected bricks should not be more than 80% of the lot. There shall be no powdering or flaking of the surface.

The average water absorption shall not exceed 22% by weight after 24 hours immersion in water.

The average minimum compressive strength for bricks of class designation 75 shall not be less than 75 kg / cm².

(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 / Owner before use.

10.2 Cement Concrete (Plain or Reinforced)

- (a) Cement concrete pipes bedding, cradles, foundations and RCC 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 / Owner. 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 per requirement.
- (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 pipe trenches and foundations shall be kept dry during the curing period.

10.3 Masonry Work

Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks in cement mortar 1:4 mix (1 cement: 4 coarse sand). All joints shall be properly raked to receive plaster.

10.4 Cement Concrete for Pipe Support

- (a) Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be as per requirement. Type of the bedding is as described as follows:
- (b) Unless otherwise directed by the Engineer-in-Charge / Owner cement concrete for bed, all round or in haunches shall be laid as follows:-

Description	Upto 3 M depth
Pipes in open ground (No sub soil water)	All round (1:5:10)
Pipes (all) in sub soil water condition	All round (1:3:6)
Pipes under the building or at road crossing or under public places	All round (1:2:4)

(1=1 =1 cement, 2-3-5 coarse sand, 4-6-10) stone aggregate 20 / 40mm nominal size)

- (c) R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.
- (d) Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

11.0 MANHOLES AND CHAMBERS

11.1 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).

11.2 All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix as shown on the drawings.

Where not specified, Manholes may be constructed as follows:-

(All dimensions internal clear in cms) (As / BMC Regulation)

Size of Manhole Type	90x80 Rect.	120X90 Rect.	91 dia Circular	122 dia Circular	152 dia Circular
Maximum depth	90	250	167	230	Any depth beyond 230
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia)	61x45.5	560 dia.	56 dia	56 dia	56 dia
Weight of cover and frame not less than	38 Kg. or as specified	208 Kg. or as specified	116 Kg. or 170 Kg. or 208 Kg.	116 Kg. or 170 Kg. or 208 Kg.	116 Kg. or 170 Kg. or 208 Kg.
Type of Cover & Frame	C.I., D.I. or SFRC	C.I., D.I. or SFRC	D.I. or SFRC	D.I. or SFRC	D.I. or SFRC

11.3 All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm 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.

11.4 All manholes shall be plastered with 12/15mm 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.

11.5 All manholes with depths greater than 1 M. shall be provided with plastic encapsulated 20mm square or 25mm round rods foot rungs set in cement concrete blocks 30 x 20 x 15cms in 1:3:6 mix 30 cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.

- 11.6 All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab or SFRC precast concrete covers as per instructions of the Engineer-in-Charge / Owner. Weight of cover, frame and thickness of slab shall be as specified or as given above.
- 11.7 All catch basins shall be having C.I. grating or SFRC precast Gully Grating as per instructions of Engineer-in-Charge / Owner. The grating along with frame shall be of approved design and quality as per instruction of Engineer-in-Charge/ Owner.
- 12.0 **MAKING CONNECTIONS**
Contractor shall connect the new sewer line to the existing manhole by cutting the, 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.
- 13.0 **COMMISSIONING**
- 13.1 After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary pipings, labours, tools and equipments etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, whenever and as may be required. Generally, the following test/inspection has to be carried out:-
- (a) For any Leakages/seepages in the external sewerage and drainage pipes.
 - (b) For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
 - (c) For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

EXCAVATION FOR PIPE LINE

1.0 EXCAVATION

The excavation for pipe 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 stacked sufficiently away from the edge of Trenches & then brought back later on for refilling the trenches or tunnel.

Regarding Items of Archaeological interest such as relics of antiquity, coins, fossils etc. found at the site or obtained during excavation, the Engineer-in-charge shall be informed and items delivered immediately. Any other material obtained in such manner which in the opinion of the Engineer-in-charge is useful, shall be stocked properly as per the direction of the Engineer-in-charge.

1.1 Opening out Trenches.

In excavation the trenches, etc. the solid road metalling, pavement, curbing 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 shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-charge and the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence or 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 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 at his own cost.

1.2 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.

1.3 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.

- 1.4 **Excavation to be Taken to Proper Depths**
The trenches shall be excavated to such a depth that the pipes shall rest on concrete or on firm bedding as described in the several clauses relating to these 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, gravel or other materials.
- 1.5 **Refilling**
After the pipes 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 upto 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 20 mm layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer-in-charge shall otherwise direct.
- 1.6 **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 held responsible for any accidents caused thereby. He shall also, at his own expenses and charges, repair and make good any damage done to buildings and other property. In case if he fails to make good such damages inspite of repeated instructions of the Engineer-in-charge, the Engineer-in-charge will be at liberty to get the damaged work done by any other agency at the risk and cost of the contractor and recover such amount from him from him running payments of the bills or by any other manner according to the law of the land.
- 1.7 **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.
- 1.8 **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 close, timbered in loose or sandy strata and below the surface of the sub soil water level.
 - (b) All timbering, sheeting and piling with their waling 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 efficiency of all timbering, branches, 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.

1.9 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. For which nothing extra will be paid.

1.10 Removal of Water from Sewer, Trench etc.

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed off 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.

1.11 Width and Depth of Trench

Up to one metre depth the authorized width of trench for excavation shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on concrete bed/ cushioning layer, the authorized width shall be the external diameter of pipe (not socket/ collar) plus 25 cm or the width of concrete bed/ cushioning layer whichever is more.

- (a) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical up to depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom.
- (b) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.
- (c) Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding increase in the width of trench. Sloping or shoring to be done for excavation in soft, loose or slushy soils.

WATER SUPPLY PUMPS, EQUIPMENTS, WATER TREATMENT UNITS

1.0 SCOPE

1.1 Pumps & Water Treatment Equipment

Work under this sub-head consists of furnishing all labour, with appropriate T&P scaffolding & staging as required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter and given in the Indicative list of items.

Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include the followings:

- Filter Feed/ Raw Water pumps at water treatment plant
- Domestic water hydro-pneumatic pump for supplying water to Over head tank of Hostel blocks from WTP.
- Water treatment units consisting of Pressure Sand Filters, Softener, chemical dosing pumps, and related equipment and accessories etc at water treatment plant (WTP)
- Sump pumps for disposal of Drainage from WTP
- Centralized drinking RO system for each block
- PLC based Controller & Indication System for Tanks & Pumps at Centralized WTP.
- Electrical panels, cables, trays and related accessories at WTP.
- Flow meter at the Inlet and outlet water supply lines.
- Butterfly motorized valve at the inlet line for control of water into tanks.
- Pipes, valves, accessories, hangers, supports, delivery and suction feeders and connection to proposed pipe work at WTP.

Successful Bidder should submit water test quality report before designing the WTP shall accommodate without any price implication.

Successful Bidder shall submit warrantee & guarantee certificates of WTP Electro – mechanical equipments.

2.0 MATERIAL

2.1 Clear water pump

2.1.1 Water supply pumps shall be suitable for clean water. Pumps shall be multistage, Inline vertical, centrifugal pumps with SS casing, stainless steel impeller, stainless steel shaft, CI base with CED coating and directly coupled with TEFC induction motor of class "F" insulation & efficiency class IE-5, 2900 RPM, IP 55 enclosure, suitable for operation on 415 volts $\pm 10\%$, 3 phase, 50 Hz, A.C. supply. Each pump should operate at specific duty point of max. efficiency. Tenderers shall select their drivers within 10% to 15% in excess of the maximum B.H.P of the pump plus transmission losses if any.

2.1.2 Pump and motor shall be mounted on a common M.S. structural or C.I. base plate or as required as per site conditions.

- 2.1.3 Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal "Burden" type pressure gauge with gunmetal isolation cock and connecting piping.
- 2.1.4 Provide vibration-eliminating pads appropriate for each pump.
- 2.1.5 Provide vibration eliminators/expansion joints on suction and Discharge side of the Pump and wherever required.
- 2.1.6 Provide rate of flow measuring meter with bypass arrangement with every set of pumps as shown on the drawings and given in the Indicative list of items.
- 2.1.7 All water supply pumps shall be provided with mechanical seals of required specifications.

3.0 **HYDRO-PNEUMATIC SYSTEMS**

3.1 Hydro pneumatic systems (With Variable Frequency Drive)

3.1.1 The scope of this section covers supply, installation, testing and commissioning of compact packaged type skid mounted, self-contained variable frequency drive hydro pneumatic system. The skid mounted, factory assembled hydro-pneumatic system shall be provided with pressure transmitters, frequency convertor for noiseless operation of the pump at varying duty point. The convertor shall be provided with short circuit safety, earthing, over current, under voltage protection. The pump shall be complete with suction and delivery pipe. The system shall comprise of multiple pumps working and one stand-by to meet the system discharge requirements.

3.1.2 It shall conform to the following specifications:

- (a) Pumps shall be vertical, inline multistage centrifugal and fulfills all specifications as specified in the Clear water pump section.
- (b) Pressure vessel shall be of non corrosive FRP composite construction lined with NSF and /or FDA listed material, like high density polyethylene with fully replaceable polyurethane. Air cell burst pressure of minimum of five times the vessel operating pressure and cycle tested for 80,000 cycles with charging connections to discharge pipe line with necessary flanges, gaskets, isolating valve, nuts/ bolts etc. with suitable foundation bolts & other accessories, complete. Capacity provided shall be as per manufacture specifications.
- (c) Panel mounted microprocessor multi pump controller with large graphical display and variable frequency drive (VFD) mounted inside a panel complete with pressure sensor transmitter. The graphical display is capable to show number of pumps running & also communicate with other controllers following with open protocol through RS485 port. System should be capable to compensate for frictional losses at lower flows. All alarms should be displayed in the controller. The panel should also have provision for manual / automatic alternate (cyclic)

operation of pumps, ON/OFF switch, dry run protection, inter connecting power and control cabling etc complete.

3.1.3 CONTROL PANEL (FOR HYDRO-PNEUMATIC SYSTEMS)

The control panel shall have terminals for:

- (d) Remote monitoring.
- (e) Pump fault.
- (f) Analog output signal for frequency convertor
(In case of VFD operated Hydro-pneumatic systems).
- (g) Pressure sensor / Pressure switches as per system requirement.

3.1.4 GENERAL

The hydro pneumatic system shall be capable of maintaining a constant pressure at varied consumption. The hydro pneumatic system shall be complete with pressure sensor and microprocessor based controller for flow control by means of frequency variation (in case of VFD operated system). The controller should have time control switch to adapt pump operation to actual requirement in peak load situation. The control panel should also have manual operation.

The pumping system shall perform the following functions:

- a) Shut off the pump at zero demand.
- b) Shut off the pump at zero suction (Dry Run protection)
- c) Protect the pump from overvoltage, under voltage, overload & earth fault.
- d) Vary the time of pump speed acceleration and deceleration
(For VFD operated Hydro pneumatic system).
- e) Compensate for higher friction losses at high flow rates.
- f) Send out a signal for remote monitoring of flow as well as pressure.
- g) Conduct automatic test run of pumps at set times.
- h) Keep track of run time for pumps.
- i) Perform run time equalization of all pumps in system.

3.1.5 INSTALLATION

Hydro pneumatic systems shall be mounted on a common base frame & installed as per manufacturer's recommendations. Pump sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. The vibration isolation pads, foundation bolts etc. shall be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump-sets shall be factory aligned, wherever necessary, site alignment shall be done by competent persons. The entire system along with pumps & control panel must be sourced from single manufacturer only for unit responsibility.

4.0 **Pressure Sand Filters**

- 4.1 Water filter shall be of dual media pressure filter (comprising of minimum 300mm bed depth of Anthracite and support media and minimum Height on Straight 1500mm) of downward or upward flow type suitable for a rate of filtration given in drawings and in indicative list of item.
- 4.2 Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure of 3 Kg/cm². The minimum thickness of shell will be 10 mm and dished ends shall be 12 mm. The quality of Steel shall be as per IS:2062 Grade B, thickness as per ASME Section 8. The filter shall have at least one pressure tight manhole cover.

4.3 **Accessories**

Each filter shall be provided with following accessories: -

- a) Air release valve with connecting piping.
- b) 150mm dia dial burden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- c) SS Sampling cocks on raw water inlet and filtered water outlet.
- d) Individual drain connection with gunmetal full way valve should be piped through a properly sized G.I. pipe to nearest drain point.

5.0 **Water Softener for WTP**

- 5.1 Softener shall be designed to give zero commercial hardness. Softener shall be with "cation" ION exchange resins.
- 5.2 Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a minimum working pressure of 3 Kg/Sq. cm. The vessel shall be tested at 1.5 times the working pressure. The shell shall be designed to allow a minimum free board space at 50% of the mineral bed depth for adequate expansion during back washing. The shell shall have a minimum thickness of 10mm and dished ends 12mm. The quality of Steel shall be as per IS:2062 Grade B, thickness as per ASME Section 8. All internal parts of the softener shall be rubber lined as per approved specifications rubber lined and externally with one coat of red oxide and two or more coats of synthetic enamel paint of approved shade.
- 5.3 The vessel shall have an internal collecting and distribution system of manufacturer's design.
- 5.4 The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be G.I heavy duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves with C.I. body and Neoprene rubber

diaphragm. Individual drain connection with gunmetal full way valve should be piped through a properly sized G.I. pipe to nearest drain point.

- 5.5 The brine injection system consists of hydraulic ejector with control valve, brine delivery pipes with adjustable indicator.
- 5.6 One measuring tank (Brine Tank) having a capacity of minimum one regenerations or as specified in Indicative list of items.
- 5.7 One orifice board for indicating wash and rinse rate to be fitted in drain sump.
- 5.8 One initial charge of supporting gravel, sand and "cation" ION exchange resin in requisite quantity.
- 5.9 One water testing kit with instructions for testing water samples.
- 5.10 One rotameter to indicate flow rate.
- 5.11 Inlet & outlet pressure gauges.

6.0 Plant room drainage Sump Pumps

- 6.1 Sump pump set shall be compact, mono-block, submersible type with class "F" insulation of suitable capacity & RPM operating on 415volt $\pm$ 10%, 3 phase, 50Hz AC supply, with non-clog free flow open CI impellers, CI casing (Pump & Motor) and having solid handling capacity of 28 mm for lifting domestic sewage or muddy water/drainage as specified in drawings and in indicative list of item.
- 6.2 Pump shall inclusive of all necessary accessories like valves, piping, Control Panel and Cabling, Level Controllers, Test and/or air vent cocks, gland drain etc. as required within the quoted cost. The Contractor has to ensure for smooth and trouble free operation after the commissioning of the entire system. Nothing shall be paid extra on this account. Below are the functions of panel

- (1) All the working and standby pumps shall start/stop automatically and alternatively.
- (2) Each pump shall start/stop automatically at pre-set levels and work alternatively in cyclic operation.
- (3) In case of pump getting overloaded, indication shall come on the panel and hooter will give sound non-operation of pump.
- (4) In case of emergency due to high volume flow of incoming sewer all pumps shall start operating simultaneously

7.0 Chlorinator

Chemical dosing should consist of electronic / electro mechanical metering pump with suction and delivery flexible connections and fittings. The pump shall be mounted on FRP tank of 200 litre capacity. The system should be completed with electrically operated single phase motor driven stirrer having stainless steel shaft. This should be suitable for working against a pressure of 1.5 kg/Sq.cm and should be capable of ejecting Sodium Hypo-chloride solution / suitable alternate chemicals with a dose of 1 ppm.

PARTS	MATERIAL
Head	CF8M
Suction & Discharge Valve Plug	SS-316
Ball	Ceramic
Ring Seal	PTFE
Diaphragm	Teflon Faced Hypalon
Pressure Relief Valve	SS-316
Anti-syphon Valve	SS-316
Suction Strainer	CF8M Y-Type

8.0 SALT SATURATOR ASSEMBLY

- 8.1 Tanks shall in High density Polyethylene (HDPE) construction of required capacity. The assembly shall be suitable for holding and supplying salt for softener with inlet & outlet piping with valves and accessories complete as per requirement.
- 8.2 The assembly shall be provided with an automatic agitator. The automatic agitator shall be motorized (motor of suitable rating operating on single phase, 50 Hz, AC supply) having Stainless steel shaft with fan blade, coupled with suitable gear box duly mounted MS Frame with Epoxy Coating.
- 8.3 The transfer Pump for supplying salt solution to softener shall be of multistage, Inline vertical, centrifugal pumps with cast iron/cast steel body, SS316L stage casing, SS316L impeller, stainless steel shaft, and directly coupled with TEFC induction motor of class "F" insulation & efficiency class EFF-1, 2900 RPM, IP 55 enclosure, suitable for operation on 415 volts $\pm 10\%$, 3 phase, 50 Hz, A.C. supply.

- 8.4 The contractor has to ensure that the effective capacity of the system shall be of minimum 10% greater than actual salt required for approx. 3 Days with complete structural arrangement including suitable foundation bolts & other accessories etc.
- 8.5 Material of Construction

PARTS	MATERIAL
Head	CF8M
Suction & Discharge Valve Plug	SS-316
Ball	Ceramic
Ring Seal	PTFE
Diaphragm	Teflon Faced Hypalon
Pressure Relief Valve	SS-316
Anti-syphon Valve	SS-316
Suction Strainer	CF8M Y-Type

9.0 ELECTRICAL CONTROL PANEL

9.1 Motor Control System

The main switchboard shall be floor mounted, free standing, cubical type, compartmentalized and shall be factory built fabricated by CPRI approved fabricators. The board shall be fabricated from 2mm thick CRCA sheet and powder coated after seven tank process. The board shall be fabricated with IP 54 degree of protection suitable for operation of 415 volt $\pm$ 10%, 3 phase, 4 wire, 50Hz, AC supply. The switch board shall have provision for termination of cables from top as well as bottom with suitable knockouts. The layout shall be designed for convenient connections and inter-connections with various switchgears. Connections from individual compartments to cable alleys shall be such as not to shut down healthy circuits in the event of maintenance work becoming necessary on a defective circuit. A base channel of 75mm x 5mm thick shall be provided at the bottom. A maximum of 200mm space between the floor and bottom most panel of unit shall be provided. The bus bar shall be of aluminium complete with heat shrinkable PVC sleeves. The fabrication of switch board shall be taken up only after the drawings for the fabrication of the same are approved by the Engineer –in – charge.

Control panel shall contain starters and safety protection for different types of pump motors & various feeders along with its controls. It shall also house the switchgears for incoming as well for outgoings supply. Provision of voltmeter (for incomer) & ammeter for incomer as well as for other feeders with selector switch, a set of LED indicating light

for incoming phases as well as status indication of each equipment. The voltmeter & indication lamps shall be protected by MCBs.

The feeders for all those motors having more than 7.5 HP capacity shall be provided with fully automatic Star Delta starters with motor duty MCCBs for short circuit protection only (ICS = 100% ICU)& Overload Relays with contactors of suitable range & ratings, for overload protection, while less than or equal to 7.5 HP motor shall have Motor protection circuit breaker(MPCB) with suitable rating contactor. Single phase preventers shall be provided for all 3 phase motors. Single phase preventer shall be in conformity with relevant ISI standards. Single phase preventers shall act when the supply voltage drops down to 90 % of the rated voltage or failure of one or more phases. Single phase preventer shall be voltage operated and of approved make.

Other feeders of the panel which don't require starter shall be housed with:

MCCB with Thermal magnetic release & should provide adjustable setting for overload and short circuit protection with ICS = 100% ICU.

MCB used for controlling shall be with tripping characteristics of C curve. The miniature circuit breakers shall be 1/2/3/4 pole as per requirement. The breaking capacity of MCBs shall have minimum 10KA.

ON-OFF switches for each motor / equipment should not be provided on the cover of the control panel. But at the same time interlocking shall be provided between switch and the door in such a way that the door of the panel cannot be opened when the supply is ON.

The panel shall be provided all identification tags, danger board etc as per IS standard.

All control panels shall be provided with detailed control circuit diagram indicating the terminal numbers and color coding of the wires used in the panels. This diagram shall be pasted on the inner side of the cover and protected with PVC transparent lamination.

All MCCBs / MPCB's shall be equipped with extended front operated rotary handles on the doors. Rotary handle should have provision for pad lock.

Outgoing from each of the MCCB shall be extended to the cable alley by providing necessary busbar of suitable rating and supports etc. for terminating the outgoing feeders.

The detailed specification of switch gears and other accessories shall follow as described in electrical package of tender specifications.

All dosing tanks and process tanks/sumps shall be provided with level indicators/switches for low and high level alarm as well as for dry run protection, indications of which shall be provided in the main Electrical Control Panel.

10.0 PUMP MOTOR CONTROLLER CUM WATER LEVEL INDICATING PANEL

The Pressure Transducers shall be used for water level measurement, and it shall be convenient to mount on the water tanks. Hydrostatic pressure level sensors shall be submersible or externally mounted pressure sensors suitable for measuring the level of liquids in deep tanks or water in reservoirs. Level measurement shall be based on the pressure measurement principal, also referred to as hydrostatic tank gauging (HTG). It shall work on the principle that the difference between the two pressures (d/p) is equal to the height of the liquid (h, in inches) multiplied by the specific gravity (SG) of the fluid.

$$d/p=h(SG)$$

Therefore, the Transducers reading will represent the tank level. These sensors sense increasing pressure with depth and because depth is proportional to Volume for a regular tank, the Volume of Water can be easily calculated using a PLC.

The Centralized PLC control panel shall be front operated, cubicle construction, wall mounted type, fabricated out of 1.6 mm thick CRCA Sheet, with hinged lockable doors, dust and vermin proof, powder coated of approved shade, inter-connections, having, internal wiring, earth terminals, Top / Bottom control cable entry, numberings etc. comprises of touch-screen display board (Minimum Diagonal size 8") along with all accessories for complete Programmable logical controls & indications, having necessary interlocks, Inputs/Outputs, required number of repeater amplifiers, all audio-visual alarms as per the requirements listed below i/c emergency stop push button on the panel etc. The panel shall have BMS compatible with open protocol.

Water level indicators and controllers: The hydrostatic pressure sensor (Water level indicator) is working on hydrostatic pressure measurement principle made of Stainless Steel for installation in storage tanks, and capable of providing 4 to 20 mA analog signal compatible with PLC signal inputs and all control outputs to MCC panel (Plumbing/Water supply), for various water tanks as per the indicative list of items.

10.1 Power / Control Cabling

Contractor shall provide all power /control cables from the motor control centre to various motors, level controllers and other control devices.

Cables and wires in conduits shall be laid on the metallic trays.

10.2 Earthing

Main Electrical power upto the Electrical panel(s) in Pump Room shall be provided by other agency.

All three phase motors / equipment shall be earthed with two independent earth conductors as per the requirement of Indian Electricity Rules and Regulation - 1956.

10.3 Commissioning

After successful testing of the different items in parts, the Contractor shall provide all facilities including necessary piping, labour, tools and equipments etc. for carrying out final commissioning of the entire water treatment plant complete as per requirement in the presence of Engineer-In-charge or his representative whenever and as may be required. Generally, the following test/inspection has to be carried out:

11.0 PIPES & JOINTING

Pipes for suction and delivery shall be galvanized steel pipes (heavy duty) conforming to I.S:1239 upto 150mm dia and as per I.S:3589 for dia 200mm and above or as specified in Indicative list of items.

11.1 Valves & Accessories

Sluice / Gate Valves

Sluice Valves above 65 mm (inside screw and non raising screw type) shall be of Cast Iron body and Gunmetal seat with double flanged ends and valve wheel. They shall conform to type PN 1.6 of IS:14846. Sluice valves upto 65mm (outside screw raising spindle type) shall be of Gunmetal Full Way Valve with wheel tested to 20 Kg. /cm² class-II as per I.S: 778 with female screwed ends. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and close.

Butterfly Valves

The Butterfly Valve shall be suitable for waterworks. The Valves conforming to IS : 13095 shall be provided. All valves shall be suitable to withstand the pressure in the system and rating shall be PN 1.6. All valves shall be right handed (i.e. handle or key shall be rotated clock wise to close the valve).

The direction of opening and closing shall be marked and an open / shut indicator fitted.

The material of valves shall be as under: -

Body	-	Cast iron
Disc	-	Ductile Iron
Seat	-	EPDM / nitrile rubber
Shaft	-	Stainless Steel

The Valve shall be fitted between two flanges on either side of pipe flanges. The Valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

Non-Return Valve

Non-return valves shall be of Cast Iron body and Stainless Steel seat. They shall conform to API 594 and have companion flanges. They shall be Dual Plate Type suitable for both horizontal and vertical installation. An arrow mark in the direction of flow shall be marked on the body of the valve.

Ball Valve

The Ball Valve shall be made from forged brass and tested to 16 Kg/ cm² pressure. The valve shall be internally threaded to receive pipe connections.

The Ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body bonnet gasket and gland packing shall be of Teflon.

The handle shall be of chrome plated steel with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping upto 14 Kg / cm² pressure.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90 degrees.

Strainer

Strainers shall be preferably of the approved type with fabricated steel bodies designed to the test pressure of 16 Kg/cm². Strainers shall be fabricated by minimum 1.2 mm thick stainless steel sheet with 3 mm dia. perforation holes. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.

Pressure Gauges

Pressure gauges shall be of 150mm dia. dial and of appropriate range and be complete with shut off valve etc. duly calibrated before installation. Care shall be taken to protect pressure gauges during pressure testing.

Flexible Connection for Pumps

All suction and delivery lines shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturer's details.

11.2 Jointing

Galvanising shall conform to IS 4736. Pipes and fittings shall be jointed with screwed/flanged joints, flanges either screwed or welded complete and flanged joints with 3mm thick rubber gasket as per requirements complete with nuts, bolts and washers etc.

All Fittings shall be new and from reputed manufacturers, Fittings shall be of malleable iron galvanized of pressure ratings suitable for the piping system. Fitting for G.I. pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes.

11.3 Installation Piping layout shall take due care for expansion and contraction in pipes.

All pipes using screwed fittings shall be accurately cut to the required sizes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. Genuine red lead with grumet and a few strands of fine hemp shall be applied and threaded in accordance with IS: 554. Open ends of the piping shall be locked as the pipe is installed to avoid entrance of foreign matter. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.

Drain shall be provided at all low points in the piping system and shall be of the following sizes:

Mains	Drains
Upto 300mm dia	25mm dia
Over 300mm dia	40mm dia

Drains shall be provided with forged brass ball valve of equal size. Drains shall be piped through equal size G.I. pipe to the nearest drain or floor waste or as shown on the drawings. Piping shall be pitched towards drain points.

Piping installation shall be carried out with vibration elimination fittings wherever required.

12.0 TESTING

12.1 Pumps & Water Treatment Equipment

Tenderers shall submit the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match his own piping and equipment layout. On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, B.H.P. Where it is not possible at least the discharge, head and B.H.P. (as measured on the input side) shall be field tested. Test results shall correspond to the performance curves.

12.1.1 Painting

After complete installation and testing, pumps accessories and fittings shall be given two coats, three mils each of approved finishing paint.

12.2 Piping

All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 10 kg/cm² in any case and with the consent of Project-in-Charge.

Pressure shall be maintained for a period of at least two hours without appreciable drop in the pressure after fixing at site. A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.

12.2.1 Painting

After the piping has been installed, tested and run for at least ten days. The piping shall be given two finish coats, 3 mils each of approved color. The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Engineer-in-charge.

13.0 RO Drinking Water Treatment Unit

The Centralized R.O. Drinking Water Treatment Plant shall generate water of required quality and shall be supplied by gravity to all user points. Centralized RO drinking water system shall be installed at the terrace of each block of the hostel building and the Kitchen Block.

The RO system shall be provided with latest and with approved complete accessories including pre-treatment, cartridge filter, high pressure feed pumps, RO membrane and casing, chemical dosing systems, SS storage tanks and other necessary equipments with as per approved technical submittals.

TECHNICAL SPECIFICATIONS (FIRE FIGHTING WORKS)

1. GENERAL REQUIREMENTS

1.1 All materials shall be of the best quality conforming to the Specifications and subject to the approval of the Engineer-in-Charge/ Project Manager/ Owner.

1.2 Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workman like manner.

1.3 Pipes shall be fixed in such a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in Shaft, Passage etc.

1.4 Pipes shall be securely fixed to walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings.

1.5 Valves and other appurtenance shall be suitably located so that they are easily accessible for operation, repairs and maintenance.

2. PIPES

2.1 All pipes within and outside the building in exposed locations and shafts shall be as follows:

Pipe 150mm dia and below IS: 1239 heavy class.

The pipes shall be Mild Steel (M.S.) manufactured by electric resistant welded (ERW)/ High Frequency induction welding or hot finished welded process. The sulphur and phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps/ strips conforming to IS: 10748.

The following manufacturing tolerances shall be permitted on the tubes and sockets:

Thickness: shall not be less than 10 percent.

Weight: shall not vary by more than 10 percent either way.

The pipes shall satisfy the following table with regards to diameter, thickness and weight of tube.

Screwed tubes shall be supplied with threads as per IS:554. Each tube shall be tested for hydrostatic test for leak-tightness as an in-process test at the manufacturer's works. The finished pipe shall be tested for tensile strength, elongation, bend test and flattening test.

Pipe 200 mm dia and above IS 3589 of thickness specified.

The pipes shall be manufactured by electric resistant welding (ERW)/ High Frequency induction welding or hot finished welded process. The sulphur and

phosphorus requirements in steel shall not be more than 0.05 percent each. The tubes shall be manufactured from hot rolled steel skelps/strips conforming to IS: 10748.

The pipes shall conform to the tensile test, hydraulic pressure test and mechanical tests as per IS:3589. The pipe shall also conform to the requirements of as per IS: 3589. The tolerance shall as per IS: 3589. All pipes shall be of minimum 6 mm wall thickness. Pipes shall be supplied with bevel edging.

3. PIPE FITTINGS

3.1 Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are need to complete the piping work in its totality.

3.2 Fabricated fittings shall not be permitted for MS pipe diameters 50 mm and below only screwed jointing shall be adopted, while for pipes above 50 mm dia welded or flanged connection shall be used. Only electro galvanized nuts/ bolts shall be used.

3.3 When used, they shall be fabricated, welded and inspected in workshops under supervision of Project Managers whose welding procedures have been approved by the TAC as per TAC rule 4102 for applicable to hydrant. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

3.4 M.S Pipe up to 150 mm dia shall have all fittings as per IS: 1239, part II, (heavy grade) while pipes above 150 mm dia shall be as per IS: 3589 inclusive of IS marking.

4. JOINTING

4.1 Screwed

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. (With screwed M.S. forged fittings)

4.2 Welded

Joints between M.S. and pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor. (With welded M.S. fittings heavy class with V-Groove). The welding machine shall be 3 Phase of required current and capacity.

All welding shall be carried out by a certified welder only. The contractor must produce the welder's certificate.

All pipe edges shall be bevel finished to a clean edge by a electric grinder. A requisite gap determined by the thickness of the weld electrode shall be given between the joints before start of welding.

Weld electrodes shall be of approved make of grade and type as suitable for the job. This shall be satisfied by the Project Manager before start of work.

Joints shall be given a first weld in the full width on the full dia of the pipe. Welding shall be carried out vertically from the surface.

After application of first coat the weld shall be cleaned by electric grinder and then another layer of welding shall be done. The weld shall also be cleaned by grinding. Similarly, a third weld shall also be applied.

4.6 All pipe cutting shall be by oxy-acetylene gas flame cutter only. The cut surface shall be cleaned by electric grinder before further welding.

4.7 Flanges

Flanged joints where specified shall be as follows:

Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.

For jointing all types of flanged valves, vessels appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.

d) Flanges shall be as per I.S.6392-1971, Table 17/18 with appropriate number of G.I. Washers, Nuts and Bolts, half threaded of GKW make or equivalent with 3 mm insertion neoprene gasket complete.

4.8 Unions

Provide approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges.

5.0 PIPE PROTECTION

5.1 All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer immediately after bringing the pipes to site and shall be painted with one coat of red oxide primer after erection and proper hydraulic testing, and two or more coats of Synthetic Enamel Paint of approved shade on finishing.

5.2 All black steel pipes under floors or below ground shall be provided with protection against corrosion after proper hydraulic testing by application of 100mm wide and 4mm thick layer of anti-corrosive protection tape over the pipe, with overlap of 25mm minimum as per manufacturers specifications.

6.0 PIPE SUPPORTS

6.1 All pipes shall be adequately supported from ceiling or walls from existing/new inserts by Structural clamps fabricated from M.S. Structural works e.g. Rods, Channels, Angles and Flats as per details given in drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.

6.2 Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and ceilings by drilling holes with Electrical drill in an approved manner as recommended by the manufacturer of the fasteners. Load bearing capacity of Anchor Fastener will be checked at site and then approved for implementation.

Hangers/ supports for all the piping shall be approved by the Project Manger before installation. Anchoring fasteners shall be rated to take minimum 0.4-ton load and shall be as per approved make. Additional supports shall be provided at bends etc. Angles for pipe supports shall not be less than 50x50x6mm size. cutting shall be by gas cutter. All cut edges and weld surfaces shall be ground to a smooth finish.

6.3 The supports/ angle pieces shall be cut by oxy-acetylene gas and cleaned by electric grinder. All cutting for bolt inserts shall be by electric drill.

6.4 Hangers for fire hydrant pipes shall be at 30m intervals

7.0 TESTING

7.1 All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure subject to a min of 15 kg/cm² including water hammer effects without drop in the pressure for at least 24 hours.

7.2 In case of any detected drop in pressure, leakages are to be rectified and the pipes re-tested as required.

8.0 ANCHOR BLOCK

Contractor shall provide suitable cement concrete, anchor blocks of adequate dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes wherever pipes are installed on-ground/underground/terraces. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

9.0 VALVES

9.1 Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1980, valves upto 65mm shall be of Gunmetal Full way Valve with wheel tested to 20 Kg./cm² class-II as per I.S: 778-1971. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.

9.2 Butterfly Valves-

Butterfly valves of approved quality for pressure rating of PN16 with locking arrangement with handle operated with lid shall be provided.

Butterfly valves shall be of specified conforming to IS: 13095 or BS: 5155.

Joints for butterfly valves shall be made with suitable tail /socket pieces on the pipe line and flanged joints made with 3mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.

Butterfly valves shall be provided on all branches as shown in the drawings or as specified.

9.3 Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS:5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type. An arrow mark in the direction of flow shall be marked on the body of the valve.

9.4 Valves below 50mm size shall have screwed ends while those of 50mm and higher sizes shall have flanged connections.

10.0 **INTERNAL HYDRANTS**

10.1 The Internal Hydrant outlet shall comprise "Single Headed Single Outlet Gunmetal Landing Valve" conforming to type 'A' of IS: 5290-1977. Separate valve on the head shall form part of the landing valve construction.

10.2 A cap with chain is provided on one head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.

10.3 The Landing Valve shall be fitted to a Tee connection on the Down Comer at the landing.

11. **FIRST-AID HOSE REEL EQUIPMENT**

11.1 First aid hose reel equipment shall comprise reel, drum which can swing upto 170 degrees, with hose, guide fixing wall bracket, hose tubing, globe valve, stopcock and nozzle. This shall conform to IS: 884 - 1969. The hose tubing shall confirm to IS: 444-1980 or IS: 12585 (Thermoplastic). The drum shall be fabricated from GI sheet of minimum 18-gauge thickness.

11.2 The hose tubing shall be 20 mm dia and 36.5m long. The G.M nozzle 5mm and globe valve shall be of 20 mm size to shut off the water supply to the Hose Reel.

11.3 The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the M.S. pipe riser through a 25mm dia pipe.

11.4 A MS bracket shall be fixed on the wall to which the first aid hose reel shall be bolted. The bracket shall be of 40x40x5mm thick MS angle to form a square of

400x400 approx. This shall be fixed on the wall. After approval of sample by Project Manager further units shall be fabricated in factory and all joints shall be finished with grinder and shall be spray painted after single coat of primer.

12. HOSE PIPES, BRANCH PIPES AND NOZZLES

12.1 Hose pipes

Two numbers Hose Pipes shall be rubber lined woven jacketed (RRL) and 63mm dia. 15m long, conforming to type A (Reinforced rubber lined) of IS:636 – 1979. The hose shall be sufficiently flexible and capable of being rolled.

Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

12.2 Branch Pipes

Standard short sized Branch pipe shall be of Copper, Gunmetal, Aluminum alloy, or Stainless steel and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle. The branch pipe shall to be tested to 20 kg/ cm² pressure.

12.3 Nozzles

The nozzle shall be of Copper or Gunmetal, 20 mm internal diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

12.4 End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.

12.5 Two RRL hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

13. HOSE CABINET (INTERNAL)

13.1 The internal hose cabinet shall accommodate the Hose Pipes, Branch Pipe, Nozzle and Hydrant Outlets and shall be fabricated from SS 316. The overall size shall be as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for Down Comer is provided with shutters, separate hose cabinet as above may be dispensed with. Sample of the fire door shall be approved by Project Manager.

13.2 The hose cabinet shall be painted red and stove enameled.

14. FIRE BRIGADE INLET CONNECTIONS

14.1 Fire Brigade Inlet connection shall be provided, for the following purposes:

- i) Fire brigade inlet connection to the Internal Hydrant Line.
- ii) Fire brigade inlet connection to the Down Comer system. Each connection shall be in accordance with similar dia of Sluice valve and Non return valve.

14.2 The locations of these fire brigade connections shall be suitably decided with the approval of Consultant/ Project Manager and with a view that these are easily accessible to the fire brigade, without any possible hindrance.

15. VALVE CHAMBERS

15.1 Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick 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.

16. PORTABLE FIRE EXTINGUISHER

Portable fire extinguishers shall be provided conforming to IS: 2190-1979.

17.0 FIRE FIGHTING PUMPS

17.1 Terrace Fire Pumps

Pumping sets shall be single/multi stage horizontal centrifugal single or multi outlet with cast iron body and bronze dynamically balanced impellers.

Connecting shaft shall be stainless steel with bronze sleeve and grease lubricated bearings.

Pumps shall be connected to the drive by means of spacer type love-joy coupling, which shall be individually balanced dynamically and statically.

The coupling joins the prime mover with the pump shall be provided with a sheet metal guard.

Pumps shall be provided with approved type of mechanical seals.

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.

The pump shall meet the requirements of the Tariff Advisory Committee (TAC) and unit shall be design proven in fire protection services.

17.2 Motors for Electric Driven Pumps

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.

Motors for fire protection pumps shall be at least 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.

Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.

Motors shall be suitable for 415 volts, 3 Phase, 50 cycles A.C supply and shall be designed for 33o C ambient temperature. Motors shall conform to IS: 325.

Motors shall be designed for two start system.

Motors shall be capable of handling the required starting torque of the pumps.

Contractor shall provide heating arrangements for the fire pump motor to ensure that motor windings shall remain dry.

17.3 Air Vessel for Fire Pumps

Provide an air vessel fabricated from 10mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. the vessel shall be 250mmx1200mm dia high and tested to 1.5 times of the working pressure or 20 Kg/Cm², whichever is greater.

18.0 CABLES

18.1 Contractor shall provide all power control cables from the motor control centre to various motors, level controllers and other control devices.

18.2 Cables shall conform to IS: 1554 and carry ISI mark.

18.3 Wiring cables shall conform to IS 694.

18.4 All power and wiring cables shall be aluminium conductor PVC insulated armored and PVC sheathed of 1100 volts grade.

18.5 All control cables shall be copper conductor PVC insulated armored and PVC sheathed 1100 Volt grade.

18.6 All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

18.7 All cables joints shall be made in approved manner as per standard practice.

18.8 The cable jointing shall be Crimping type.

18.9 The cable shall satisfy the following tests as per relevant IS codes:

Insulation Resistance test sectional and overall.

Continuity Resistance test.

Earth continuity test.

All tests shall be carried out in accordance with relevant standard code of practice and Indian electricity rules. The contractor shall provide necessary instruments, equipments and labour for conducting the above tests and shall bear all expenses of conducting such tests.

19.0 CABLE TRAYS

19.1 Contractor shall provide G.I. perforated cable trays at locations as shown on the drawings and of sizes as given, with G.I. sheet thickness of 2.0mm.

19.2 Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by welding support rods with insert plates OR Anchor fasteners.

19.3 Cost of clips, bolts, nuts, support rods and any other materials required to fix the trays in proper manner shall be included in the rate for trays.

19.4 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8 mm dia round headed bolts, nuts and washers.

19.5 Factory fabricated bends, reducers, tee/ cross junctions etc shall be provided as per good engineering practice. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending the largest size of cable to be carried by the cable tray.

20.0 EARTHING

20.1 There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sweated.

20.2 Earth plates shall be buried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

20.3 A brick masonry manhole 30x30x30xcm size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated, in this manhole for testing.

20.4 All equipments installed shall be properly earthed to the main earthing station.

21.0 MOTOR CONTROL CENTRES

21.1 MCC shall be cubical type i.e. one motor feeder completely in one cubicle, and shall be fabricated from 14 gauge CRC sheet with dust & vermin proof construction. It shall have Powder Coated finish and shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following: -

Incoming main MCCB of required capacity.

Fully automatic as specified D.O.L/ Star delta starters suitable for motor H.P. with push buttons one for each motor and ON/OFF indicating LED type lamps.

Single phasing preventor of appropriate rating for each motor.

Rotary duty selector switch.

Panel type ampere meters one for each motor.

Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.

LED type-indicating lamps for in incoming main and ON/OFF indicating lamps for each motor.

Rotary switch for manual or auto operation for each pump (manual/auto/off).

Fully taped separate aluminium bus bars of required capacity.

Space for liquid level controllers as specified.

The panel shall be prewired with colour-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.

& Power wiring and Control wiring in MCC to be of Copper only and minimum size 4 1.5 Sqr.mm respectively.

Provided with a degree of protection of IP-52 and of uniform height of not more than 2450mm

21.2 All switchgears and accessories shall be of approved make such as "Siemens, English Electric, Larsen & Toubro" or equivalent.

21.3 Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers.

22.0 VIBRATION ELIMINATORS

All suction and delivery lines shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturer's details. Flexible connectors shall be as manufactured by Relay Corp., New Delhi /Resistoflex.

23.0 MEASUREMENTS

23.1 Pumps and equipment shall be measured by numbers and shall include all items.

23.2 Motor control panel and level controllers shall be measured by numbers.

23.3 All pipes including hydrant lines, headers and branches for risers, suction and delivery header and mains etc. shall be measured per linear meter along the centre line of the pipe and shall be inclusive of all fittings and structural supports, clamps, anchor fasteners etc.

23.4 Only if as per the approval by the engineer – in – charge in writing, any additional structural clamps are instructed to be provided by the contractor, the necessary structural supports item shall be used as per the designated BOQ item. This shall be including hangers and shall be measured by weight calculated from sections used. No separate payment shall be admissible for bolts, anchor bolts, raw plugs etc.

23.5 Cable trays and cables shall be measured per linear meter.

23.6 No separate payment shall be made for making connections of the existing service lines to the pumps. Vibration eliminator pads are included in the scope of this work.

24.0 COMMISSIONING

24.1 After successful testing of the different items in parts, the Contractor shall provide all facilities including necessary piping, labor, tools and equipments etc. for carrying out testing and commissioning of the entire fire fighting system complete as per requirement in the presence of Client's representative and during the visit of the Fire Officer whenever and as may be required. Generally, the following test/inspection has to be carried out:

(a) For the automatic operation of the fire pump as per the sequences required.

(b) For checking the pressure available at the farthest and highest point in the fire system.

TECHNICAL SPECIFICATIONS FOR STP WORKS

SECTION – I PREAMBLE

1. The job of STP for 160 m³/day capacity has to be done on a Turnkey basis, therefore the contractor shall be fully responsible for designing, preparation of drawings and calculations, supply of material, installation, testing and commissioning, getting final certifications related to the final quality of treated effluent, from all the concerned Pollution & Environmental Authorities & Operation and Maintenance of the STP for the mentioned period.
2. All the main STP components shall be pre-fabricated and installed on the Ground for which space has already been provided.
3. Treated water of the STP shall be utilized for Horticulture purposes inside the site and periphery of the site or may be disposed as per site.
4. Generally but not limited to the following main activities are expected from the Executing Agency in a sequential manner.
 - (d) Study of existing site conditions.
 - (e) Measuring/taking levels and conducting survey as required for verification of the existing systems at site.
 - (f) Preparation of scheme based on the design data & guidelines given in the documents and getting it approved from the Engineer in charge.
 - (g) Preparation of detailed Shop drawings for: -
 - 3 All the fabricated/civil components sizing, Detailing Works including all structural details, cutouts, sleeves and puddle flanges, as per architectural/Client requirements If needed.
 - 4 Pumping System and Pipelines as may be required
 - 5 For Mechanical, Electrical & all relevant piping work and as may be required.
 - (h) Execution of works: The STP contractor shall be completely responsible for the design of all components, structural details & supervision of works at no extra cost, fabricated components, platforms, foundations etc.

- vi) Supply, Installation, Testing of the civil, fabricated storage, mechanical, electrical pipes, fittings & other accessories.
 - vii) Getting of successful test results & obtaining approval from authorized Lab / Agency of the Pollution Control Board and relevant Authorities.
 - viii) Initial commissioning and handing over along with complete operation and maintenance documents shall be the responsibility of the Vendor.
5. The STP Vendor shall execute all elements of the plant as specified.
 6. The STP Vendor shall be fully responsible for Supply, Installation, Testing of all fabricated storage items, Mechanical & Electrical components and all other accessories.
 7. The STP Vendor shall be fully responsible for collecting the samples & getting the test results within the approved limit of the Pollution Control Board or as mentioned from a authorized Lab / agency of Pollution Control Board or relevant authorities.
 8. For sludge handling a filter press shall be provided, and it is recommended to collect the de-watered compressed sludge into HDPE bags for re-use as manure / disposal to the final destination as per the approval of the Pollution Authorities.

SECTION – II DETAILED SCOPE OF WORK

1. SCOPE OF WORK

- 1.1 The contractor will execute the entire work on a turnkey basis including designing of all elements, supply & installation of all electro-mechanical components, design all fabrication works, commissioning, start-up and obtaining satisfactory results from approved testing agencies, as per norms of the Environmental Authorities, based on accepted shop drawings & detailed calculations. The STP contractor shall be completely responsible for the design and execution of all components, structural details & supervision of any related civil works at no extra cost.
- 1.2 The contractor shall bear responsibility for the characteristics of the final effluent and shall make any addition/alterations to the equipment or plant, if the same fails to meet the required standard, without any extra cost.
- 1.3 Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required together with shop drawings and required details to construct, erect and commission, a Sewage Treatment Plant, completely in accordance with the specifications and drawings enclosed with this document generally comprising but not limited to the items mentioned in the following sections.
 - 1.3.1 Detailed engineering and preparation of all working drawings as per design data given in the document and actual site conditions to be determined by the contractor.
 - 1.3.2 Construction of all elements of the plant including minor civil works as specified.
 - 1.3.3 Interconnecting piping between all units, valves, gates and all other appurtenances and devices as required.
 - 1.3.4 All mechanical equipments duly protected against corrosion.
 - 1.3.5 All electric drives, motor control centers, power and control cables (except main incoming feeder and yard lighting).
 - 1.3.6 All instrumentation, control cabling, panels complete in all respects.
 - 1.3.7 All units are shown on the contract drawings. These drawings are enclosed for guidance of the contractor. The contractor shall work out detailed layout and flow scheme with levels. The contractor may suggest minor changes in the proposed flow scheme, ensuring that the basic design data conforms to as given as Section- II of this contract documents.
 - 1.3.8 Start-up and obtaining satisfactory results from approved testing agencies, as per norms of the Environmental Authorities.
 - 1.3.9 The bearing capacity of soil should be ascertained after proper soil investigation for design of different structures, and to know the influent quality of effluent conduct proper tests, as may be required for successful execution and commissioning.
2. Contractor shall verify/check all levels and other information given in the tender/drawings. No extra payment shall be admissible for any variation in levels or other site data.

SECTION III- DESIGN DATA & PROCESS DESCRIPTIONS

DESIGN DATA

(The data as provided below are only for guideline purposes and are to be verified by the Executing Agency)

1. Influent Characteristics

1.1 Type of Waste Water: The influent is the product of the wastewaters from different activities such as:

(a) Domestic sewage from the toilets & bathrooms.

(b) Oil, Grease and food waste from Pantries etc.

The influent characteristics indicated are only for guideline purpose.

1.2	flow	:	160 Cum. /day.
1.3	Duration of flow to STP	:	24 hours
1.4	Temperature	:	Maximum 32.8OC
1.5	pH	:	7.15 to 8.2
1.6	Color	:	Mild
1.7	T.S.S (mg/l)	:	250 to 350
1.8	BOD (mg/l)	:	200 to 250
1.9	COD (mg/l)	:	300 to 400
1.10	Oil & Grease	:	10 - 50 mg/lit.

2. Treated Effluent Characteristics after Secondary treatment

2.1	pH	:	7.2 to 7.8
2.2	Oil & Grease	:	< 10 mg/l
2.3	B.O.D	:	20 to 30 mg/l
2.4	C.O.D	:	50 to 100 mg/l
2.5	Total suspended solids	:	25 to 30 mg/l

3. Final Effluent Characteristics after Tertiary Treatment

3.1	pH	:	7.1 to 7.3
3.2	Oil & Grease	:	< 2 mg/l
3.3	B.O.D	:	Less than 10 mg/l

3.4	C.O.D	:	Less than 50 mg/l
3.5	Total suspended solids	:	< 20 mg/l
3.6	NH4-N	:	5 mg/l
3.7	N- total	:	10 mg/l
3.8	Fecal Coliform	:	<100 (MPN/1000ml)
- 3.9 It may clearly be understood that the client wants to make re-use of treated effluent. The water after above treatment shall go for flushing, and horticulture purposes. The water from the tertiary treatment shall be re-used. Hence, it is imperative that the contractor ensures that the effluent is usable for above purposes. The treated effluent should also be suitable for re-use for construction purposes to meet the requirements of I.S. 456.

4. Space Availability & Proposed Height

The following provisions are presently proposed for the construction of the Sewage Treatment Plant. However the details are subject to change as per the final planning, architectural approval and coordination, and at present should only be considered for guidance purpose. At the time of detailing, the contractor shall get approved the exact space and location from all concerned. The STP shall have to be accommodated as per the finally designated area.

Total Area required -- 240 Sq. Mtr. Approx.

5. Proposed Location of STP

The proposed location of the plant shall be as shown in the drawing. Please refer attached sketches for further details.

6. Influent Levels

Influent levels given on the tender drawings are approximate and no extra payment shall be admissible for any change in the same. The influent will be received from the gravity outfall from the plant. For the purpose of preparation and submission of tender the level of incoming effluent may be taken as approx. 2.0 meter below the mean ground level of STP. The contractor may however be permitted to revise levels of his plants to suit the new levels without any change in quoted price.

6. Site Information

The entire STP shall be installed above ground area. Proper ventilation and lighting arrangements shall have to be provided accordingly.

DISCRIPTION OF TREATMENT PROCESS AND UNITS

1. SCOPE OF WORK

1.1 Without restricting to the generality of the foregoing, the work shall consist of:-

1.2 Design & construction of all Prefabricated works, to consist of:-

- a) Equalization tank with Screen chamber, Oil and grease trap as per the last manhole sewage invert level.(RCC)
- b) Anoxic tank (MS Prefabricated)
- c) MBBR tank (MS Prefabricated)
- d) Tube settler (MS Prefabricated)
- e) Clarified/Chlorinated water tank (MS Prefabricated)
- f) Treated Water tank (MS Prefabricated)
- g) Sludge holding tank & loading arrangements (MS Prefabricated)
- h) Any other etc.

1.3 Mechanical Equipment

All mechanical equipments, as discussed in the proceeding sections, generally comprising of:

- Bar Screen
- Air blowers with motor and related accessories.
- Air distribution assembly.
- Raw sewage re-lift pumps, Sludge return pump, filter feed pump.
- Agitator for anoxic tank
- Centrifuge & Sludge handling arrangements
- All Pipe-line and valves
- Dosing system
- Dual media Filter
- Activated carbon Filter
- Any other equipment required for functioning of STP or as per Clients' requirements.
- Bio-media for MBBR Tank & Tube settler
- Hydro-pneumatic Flushing water supply pump
- Hydro-pneumatic garden/irrigation water supply pump

1.4. Electrical Equipment

All Electrical equipment generally comprising of:

- Electric motors for all equipments as required.
- Motor control center completes with all internal wiring and accessories.
- Electrical cables from M.C.C panel to all electric motors and units.
- Electric earthing stations as per I.E.E. rules.

- All internal lighting & exhaust system etc.

1.5 Piping Work

Laying of all piping work as per detailed designs and generally for:

- (a) All above mentioned civil structure and pre fabricated tanks.
- (b) For the interconnection of the various equipments, sludge sump, pump house and control room.
- (c) All interconnecting piping between various units bypass etc.
- (d) Effluent piping within limits as shown on the drawings.
- (e) Piping required for providing water supply & drainage for the Testing Laboratory.

1.6 Instrumentation & Laboratory Equipment

All Instrumentation & Testing equipments, as discussed and detailed in the proceeding sections.

2. TREATMENT PROCESS

2.1 The treatment process is aimed to convert the influent quality as mentioned in the above sections, into the required quality standards so that the treated effluent can be re-used for non-potable uses such as Horticulture. It is proposed to perform the treatment of the effluent by the biological aerobic process. The process is designed to induce the growth of bacteria, which by physical and physio-chemical action retain the organic pollution and live on it. This growth is obtained by putting a bacterial culture disposal as a flock in suspension in the effluent inside a stirrer, i.e. aeration tank.

2.2 To have an efficient treatment system, MBBR System (Moving bed bio film reactor) is proposed using submerged fine bubble diffusers, along with Bio-media, to reduce the HRT (Hydraulic Retention time) and storage capacity for MBBR Tanks.

3. PROCESS DESCRIPTION

3.1 The effluent from all the contributing units shall be brought by pipe to the Equalization tank. From the equalization tank the wastewater will be pumped via the submersible solids handling pumps into an adjoining Anoxic tank.

3.2 The waste water from the Oil & Grease trap (OGT) should then pass into the Equalization Tank.

The design of Equalization tank should cater for the condition that the waste water generation may not be uniform and higher quantity may come out during peak hours. There may be very low flow condition for few hours. To optimize the size of the plant, the plant design should cater for continuous operation and hence a buffer should be provided to store the waste water during its peak hour generation and supply the same during lean or no flow hours. The equalization tank is provided to homogenize the waste water quality and also even out flow fluctuations and feed waste water of uniform quality at constant rate to subsequent treatment units. Air mixing should be provided to mix the contents of the equalization tank. An aeration grid should be provided to mix the contents of the equalization tank and also to avoid septic conditions in the tank.

From the equalization tank the wastewater will be pumped into Anoxic tank for removal of nitrogen & phosphorous in the absence of oxygen by denitrification process. By-pass line shall be provided from the pumping system which shall only be provisional for disposal of sewage to mobile sewage tanker for emergency purposes.

From the Anoxic tank the wastewater will be overflowed into MBBR Tank.

- 3.3 In the MBBR tanks, the wastewater will be mixed with microorganisms in the presence of dissolved oxygen. Microorganisms will assimilate organic impurities. The mixed liquor suspended solids (MLSS) will be maintained at levels of 3500 mg/lit to 4000 mg/lit. The bottom of the MBBR tank has provision of aeration grid which receive air from positive displacements (roots type) air blowers located outside the tank. Submerged air diffusers will provide mixing and oxygen for the needs of microorganisms. The blowers will be sized to maintain dissolved oxygen level in the MBBR tank of approximately 2 mg/lit.
- 3.3 From the MBBR tank mixed liquor will flow by gravity into adjoining settling tank. The solids will settle in the tube settler/settling tank. A sludge return pump is provided for pumping the settled sludge from the settling tank back to the MBBR tank.
- 3.4 An overflow weir with scum baffle will be provided in the settler to take treated wastewater out of the settling tank.
- 3.5 From the Tube settler, treated wastewater will flow by gravity into adjoining chlorine contact tank/clarified water tank. In this tank chlorine will be added in the form of calcium or sodium hypochlorite solution by a suitable chlorinator.
- 3.6 Treated water after chlorine contact tank will be clear, odorless, low BOD, low suspended solids and meets the minimum standards as per Environmental norms to be disposed directly to public/natural drain.

- 3.7 It is further filtered through Dual media filter and an activated carbon filter to make it suitable for recycling for irrigation purpose. Filtered water shall be stored in a separate tank for supply to the garden hydrant system.
- 3.9 According to the guidelines of Ministry of Environment and Forest the online disinfection system will be provided on the discharge point.
- 3.10 Excess sludge from the tube settler /secondary settling tank will be taken periodically into sludge holding tank. In this tank sludge will be aerated for self-stabilization. Air will be shut off periodically and superannuate water will be transferred to the aeration tank creating stabilized sludge. The final sludge may be de-watered / dried and shall be collected in HDPE bags and disposed off profitably by selling in the market or using as manure for horticultural purposes. Sludge loading arrangements shall also be provided for direct disposal of sludge to sludge tankers/trolleys.

14. **Specifications for Modular Aluminium Formwork Shuttering System (MAFSS):**

1.0 SCOPE OF WORK

- 1.1 The project has two high rise towers of H shape of ground with 12 upper floors and lifts & stair case core in each tower. The contractor has to go through the available architecture and structure drawings to decide the number of shuttering set required w.r.t to the design & time allotted to complete the work .
- 1.2 The Contractor shall be responsible for the design, supply, installation, supervision, and dismantling of the modular aluminium formwork (shuttering) system (MAFSS) for all structural members (foundation, walls, columns, beams, slabs, staircases) in accordance with the project drawings and the specification. The system shall ensure high dimensional accuracy, rapid construction, and a superior surface finish.
- 1.3 The Cost includes supply, packaging, design installations, supervision, transportation, shuttering and de shuttering, maintenance and rectifying the material of a modular aluminium formwork (shuttering) system with no escalation. It includes all the applicable taxes. It also includes-
 - i. Data entry of all shuttering items in the excel format will be covered by contractor.
 - ii. Labour and gas material charges for MIG (Metal inert gas) welding.

- iii. Labour & consumable charges of cutting, drilling & filling of aluminium panel.
- iv. Recoating & cleaning of panels.
- v. Transportation of material to the site.
- vi. Arrangement of wooden pallets & all required accessories for aluminium shuttering will be provided by contractor.

1.4 Reference codes to be followed are as under:

- i. IS 456:2000 - Code of Practice for plain and reinforced concrete.
- ii. IS 8147:1976- Code of practice for use of Aluminium alloys in structures.
- iii. IS : 14987-1999 - Guidelines for falsework for concrete structures
- iv. IS 733 : 1983 - Wrought Aluminium and Aluminum Alloy Bars, Rods and Sections (for General Engineering Purposes)
- v. IS 1786:2008 - High strength deformed steel bars and wires for concrete reinforcement.

2.0 MATERIAL SPECIFICATIONS

2.1 Aluminium Alloy, Panel Thickness Average Weight: The Aluminium shuttering shall be made of extrusions of high grade aluminium 6061 T6. The standard panels of formwork shall be MIG welded. The aluminium sheets forming parts of the shuttering shall be of Aluminium grade 5052. The minimum weight of shuttering shall be 22 kg/Sqm.. The gauge of formwork shall be Minimum 4mm. All wall tie holes shall have to be plugged with tie rods/ pins as per manufacturer's specification, no holes shall be kept open while concreting. Contractor shall provide enough wall pins/ tie rods to close all holes in shuttering. The stacking of formwork shall be on fairly leveled surface.

2.2 Steel Accessories: All props, pins, wedges, and wall ties etc. shall be made high grade hot-dip galvanized high strength steel for corrosion resistance.

2.3 Approved Manufacturers/Vendors:

All following manufacturers are approved for supply of aluminium shuttering systems, subject to compliance with the above specifications and prior approval by the Engineer-in-Charge:

- i. Maini Construction Equipment's Pvt. Ltd.-Delhi
- ii. Unimax International – Sonapat (Haryana)

iii. Wintus Aluminium Formwork- Delhi

iv. MFE (MIVAN)

Any manufacturer or supplier of aluminium shuttering systems holding a valid ISO 9001:2008 certification is Eligible.

3.0 SYSTEM COMPONENTS-The MAFSS should have the following components-

3.1 Panels: Modular wall, slab and column panels with interlocking features for rapid assembly and dismantling.

3.2 Beams and Decks: Beam side panels, soffit panels, and deck panels designed for monolithic or staged casting.

3.3 Props and Bracing: Adjustable steel props (GI/MS, 40 mm dia.), 'Z' shaped brackets, and MS angle iron for support and alignment.

3.4 Connectors: Pins and wedges (hot-dip galvanized) for all inter-panel connections, supplied with 20% extra quantity.

3.5 Accessories: Wall ties, working brackets, slings for staircases, cross bars for alignment, corrugated polypropylene sheet, polythene tube, tie puller, panel puller, wedges, stub pin & wing nut etc.

4.0 DESIGN & ASSEMBLY REQUIREMENTS

All work must comply with IS 8147:1976 and relevant Indian & International standards.

4.1 It shall be strong enough to withstand the Self weight of structure, dead and live loads, wind loads & forces caused by ramming and vibrations of concrete and any other incidental loads, imposed upon it during and after casting of concrete. The system must be designed for high recycling value, and minimal site waste. Load bearing capacity of MFASS should be 70 KN/sqm (minimum).

4.2 It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard bond wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

- 4.3** Forms shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections. Care shall be taken to see that no piece is keyed into the concrete.
- 4.4. Supports: To avoid the bulging of vertical members the tie rods shall be fitted at every 1 meter (maximum) span of member and To avoid sagging/hogging of horizontal members the support from bottom shall be at every 0.6 meter span of member. All the vertical supports shall rest on firm bases and shall be tied to each other to avoid dislocation of support.
- 4.5** Wall hung brackets to be designed, fabricated, and erected in such a way that it forms complete ring around the building and there are no gaps.
- 4.6** The Contractor will provide Cantilever Bracket width will be 1.2 meter and Railing height will be upto above floor level in the same cost. Bracket will be designed to take load of MAFSS plates and Workers.
- 4.7** In all situations centering/shuttering/staging & aluminium shuttering should be designed by a qualified & experienced person/agency having past experience in design of MFASS for RCC structures and should be part proof checked by similar experienced person/agency and it should be approved by the Engineer-In-Charge.
- 5.0 STIFFENERS & SPECIAL FEATURES:**
- 5.1 Stiffener shall be at the back of the plate and sufficient stiffeners per vertical or horizontal plate should be provided as per design. Every Vertical plate shall have min. 9 stiffeners at 200mm c/c
- 5.2 Special Features such as Triangular corner plates, special kickers for sunken areas, and cross bars for lift and staircase alignment. Sling shall be provided to hold deck at level in the staircase portion. Support of kicker at top with cleat at every joint age at back with soldier rod. Sunken area shall have special kickers. Cross bars shall be used for maintaining alignment of lift and staircase. Special cut out for lifting material and malba chute should be provided.
- 5.3 All the designed wall tie holes to be placed with wall ties. All the holes for interlocking of plates to be 100% fixed with pin and wedge. All the wallers / alignment pipe to be fixed on both sides, both internally and external faces with German clamps.

- 5.4 Each AFS set will contain 2 set of deck prop (DP) with adjustable prop jacks, Kicker, Brackets etc. If required adequate no of turn buckles wire rope will be provided positioning of AFS. All brackets shall be fixed in proper line and level and each bracket will be bolted with 2 nos tie rods.

6.0 **PERFORMANCE & REUSE**

- 6.1 Surface Preparation: All formwork surfaces shall be cleaned and oiled before each use; gaps between kicker plates and wall panels shall be sealed; holes from keys/pins shall be filled with an approved compound.
- 6.2 Cycle Life: Each panel must be reusable under normal& adverse site conditions without affecting performance& quality.
- 6.3 Early Stripping: subject to concrete strength and approval of the Engineer-in-Charge.
- i. For vertical (wall) formwork: 12 hours after concreting or when concrete strength has reached 2 N/sqmm.
 - ii. For horizontal (deck) formwork: 36 hours after concreting or when concrete strength has reached 10 N/sqmm.
- 6.4 Monolithic Casting: The system must support one-time casting of walls, beams, and slabs, or staged casting as required.

7.0 **TOLERANCES**

- 7.1 Accuracy: The system must allow for precise construction with minimal measurement error; all elements shall be custom fabricated to project dimensions. The tolerance of finished panel should be as per IS : 14987-1999
- i. Vertical members-Within 3 mm over 2 m height, maximum displacement not exceeding 6 mm over the full height
 - ii. Beams- Should not exceed 5 mm
- 7.2 Design & construction of formwork :
- Form work shall be designed & constructed to the shapes, lines and dimensions shown on the drawings as given in Article 11 page 25 of IS 456 : 2000.

(Note- Tolerance apply to concrete dimensions only, and not to positioning of vertical steel or dowels.)

8.0 QUALITY ASSURANCE

8.1 Testing: All raw materials must be tested for chemical composition at an approved laboratory (contractor's cost).

8.2 Certificates: Material test certificates must accompany every dispatch.

8.3 Rejection: Full rejection and replacement at contractor's cost if materials fail testing or do not meet specification.

8.4 Minimum Weights: Recovery charges will apply for aluminium supplied below 22 kg/m² and MS below 9 kg/m².

9.0 PACKAGING, COLOR CODING DELIVERY& STACKING

9.1 Packaging: Contractor to dispatch the AFS material room wise (all wall panels, deck panels, all corner / jointing members, props, accessories etc. packed together) with drawing indicating location of each member. In case of any missing member, it has to be provided on immediate basis. Materials shall be dispatched room-wise with location-specific drawings. Any missing parts must be supplied immediately. Contractor have to provide a detailed packaging list with each delivery.

9.2 Color Coding: All panels and members shall be color-coded before erection for identification. Contractor will ensure Colour coding to be done for each panel / member of AFS before or after complete erection at site. Kicker members to be properly erected so that there is no dislocation. Each member to be marked with paint so that it is placed above at the same location

9.3 Delivery: Aluminium form work system shall be supplied with all accessories, such as pins, wedges and wall ties; Two of more set of adjustable GI props to be provided, MS working bracket of two levels to be provided. Contractor to provide Manufacturers certificate of raw Materials shall be sent for external laboratory testing at the approved labs for the chemical analysis – no extra shall be payable

on this account. In case the material fails the above-mentioned test, the entire material shall be rejected.

- 9.4 Stacking: Aluminium shuttering shall be stacked properly to avoid dents, unwanted bents, curves, undulations. The shuttering with objectionable dents, rough surfaces shall be rejected. Surface Finish should be as specified by the Architects.

10.0 TERMS AND CONDITIONS:

10.1 Accessories

- a)** Accessories such as Pins, Wedges & Wall ties etc. shall be provided and supplied 20% extra.
- b)** Two sets of Props (Adjustable & made out of M.S. Pipe) shall be provided as per design and Technical requirements. Specific props/supports will be provided for openings such as windows, doors and other locations as per drawings.
- c)** Test Certificates: Material test certificate will be accompanied with every truck.
- d)** Shell Drawings Shell drawings/shop drawings will be prepared by Contractor and shall be submitted within for approval 7 working days from the date of receipt of GFC drawings.

10.2 Mode of Measurement

Formwork quantity shall be measured based upon the contact area of the formwork supplied corresponding to the contact concrete area of structure.

10.3 Technical Support

Manufacturer of aluminium form work will provide adequate supervisors/shuttering experts to execute the work under supervision, provide training and assistant to workers for entire period of RCC casting. The supervisors will provide training to workers in regard of erection of shuttering, conduiting, plumbing, casting of RCC, de-shuttering, stacking of de shuttering materials, oiling and lubricating etc.

10.4 Quality

- i. Minimum 22 kg of aluminium per sqm is required in AFS system. Weight less than specified will attract recovery based on Market rates.
- ii. Minimum 9 kg of MS material per sqm is required in AFS system. Weight less than specified will attract recovery based on Market rates.

10.5 Delivery

Complete supply of the material will be delivered in 30 days from date of approval of shell plan. Delivery beyond 30th day will attract penalty of 2 % per week.

10.6 Special Conditions-

The Contractor shall, at no additional cost to the Owner, provide a complete sample assembly of the aluminium formwork shuttering system. This assembly shall include all integrated finishing works such as electrical, plumbing, sanitary fittings, switches, appliances, windows, doors, hardware, flooring, and partitions, as specified in the contract documents. The sample assembly shall be submitted for inspection and written approval by the Engineer-in-Charge prior to commencement of bulk works. No extra payment shall be made for the provision, installation, or removal of the sample assembly. Work on the main project shall proceed only after the sample has been approved.

LIST OF PREFERRED MAKES OF MATERIALS (CIVIL WORKS)

Preferred makes of materials to be used in the work is given below and Contractor shall procure the material mentioned in the list from any one of the preferred makes only. The Engineer in charge reserves the right to select any of the makes/brands indicated in the list of approved brand/make. The tenderers shall quote his rates on the basis of the price for the best quality product of the brand/make stipulated for the item of work in the schedule of quantity/specification/list of preferred brand/ make. In case of non availability of these makes, the Engineer-in-charge may allow use of alternative BIS marked materials/makes in the work. Non BIS marked materials may be permitted by the Engineer-in-charge only when BIS marked materials are not manufactured.

S. No.	ITEM DESCRIPTION	BRAND/ MANUFACTURER
1	CEMENT	
a	Ordinary Portland Cement 43 Grade	Ultratech , Ambuja, ACC, L&T, J.K.Laxmi
b	Pozzolona Portland Cement 43 and 53 MPA	Ultratech , ACC, Birla, Ambuja, JK Lakshmi
c	White cement	Birla White, J.K. White
d	Ready Mix Concrete (RMC)	Ultratech, ACC, RMC Ready Mix (India)
2	STEEL	
a	Reinforcement Steel	SAIL, TATA, JSW, RINL, JSPL
b	Structural Steel Sections: Beams, Channels, Tees, Flats, Angles Bars (Round, Square, Hexagonal).	TATA, SAIL, JSW, RINL, JSPL
c	Structural Hollow steel sections	TATA , SAIL, JSW, RINL, JSPL
d	Structural Tubular Sections / M.S. Pipe	TATA , SAIL, Jindal, Prakash, Surya
e	Stainless Steel	Salem Steel, Jindal stainless steel.

f	Welding Electrodes	Advani, Oerlikon or approved equivalent
g	Admixture/Plasticizer	Fosroc, Sika, BASF, Dr.Fixit
h	Factory made cover block of required grade	A.S.R Cover block, J.K,Conbextra, KGM, KK,Manhole
i	Binding wire	Tata, JSW or approved equivalent
3	Expansion Joints	
a	Expansion Joint filler	Durafill (Armour Board) Supreme Industries , Paramount or approved equivalent
b	Expansion Joint System 100mm thick for floor with Provision of Moisture/water Barrier Membrane	Migua FSL 113/35 & Migua FSL 113/35 corner , Vexcolt Megatec 300-A01-100 & 300-A02-100 or approved equivalent
c	Expansion Joint System 100 mm thick for internal wall & ceiling	Migua WJC 100 & Migua WJC 100 Corner, Vexcolt Megatec 360-A07-100 & 360-A09-100 or approved equivalent
d	Expansion Joint System 100 mm thick for external wall with Provision of Moisture/water Barrier Membrane	Migua WJC 100 & Migua WJC 100 Corner, Vexcolt Megatec 360-A07-100 & 360-A09-100 or approved equivalent
4	BRICKS	
a	First class burnt clay bricks	1st Quality Locally best available as approved
b	First class Cement based Fly ash bricks	1st Quality Locally best available as approved
5	TILES / FLOORING	

a	Ceramic Tiles /Glazed Tiles	Kajaria , H& R Johnson (India) Ltd, Somany, or approved equivalent	
b	Antiskid full bodyVitrified floor tiles 9 mm(+/- 1 mm) thick of size 60 X 30 cm / 60 X 60 cm	Kajaria - Eternity series / Somany : Durastone (geostone or Techstone series)/Johnson : Endura series / Restile - Original collection Granamite / Simpolo or approved equivalent	
c	Matt / polished Vitrified wall tiles 9 mm (+/- 1 mm) thick of size 60 X 30 cm / 60 X 60 cm	Kajaria - The Trend Eternity series / Somany : Duragress / Johnson - Porcelano series / Restile Granamite series / Simpolo or approved equivalent	
d	Matt / polished / semi polished Vitrified floor tiles 10 mm (+/- 1 mm) thick of size 60 X 30 cm / 60 X 60 cm	Kajaria - Stonegress / Somany : Tesoro /duragress series /Johnson endura - Sandex plus series / Restile - Original collection Granamite / Simpolo or approved equivalent	
e	Tile Admixture	Laticrete 3642 of Laticrete or admixture E 135 of Ardex Endura or approved equivalent	
f	High polymer fix set cementitious Tile Adhesive	Ardex Endura, Laticrete, Fosroc, Pidilite	
g	Tile Grout for internal floor & wall	SP-100 Epoxy grout of Laticrete or epoxy grout of Ardex Endura or approved equivalent	
h	Tile Grout for External floor & wall	Laticrete (500 Series grout + 1776 grout admix plus) or Cement polymer grout of Ardex Endura + admix GT1 or approved equivalent	
i	Heat resistant tiles	Johnson ,Kajaria, Somany or approved equivalent	
j	Pavers / Inter locking Pavers	Koncrete, Pavit , Nitco Tiles, Unitile. or approved equivalent	
6	WATERPROOFING		
a	Acrylic Modified Cementitious Water Proofing Compound	Tapecrete P151	CICO Tech. Ltd
		Armourcrete	Structural Water Proofing Company Pvt. Ltd.
b	Construction Chemical Waterproofing	Fosroc Chemicals (India) Ltd., Sika India Pvt. Ltd., CICO Tec. Ltd, pidilite,	

		Ardex endura
c	Acrylic cementitious modified two component waterproofing	Fosroc, Ardex Endura , Pidilite, Cico
d	Polyurea polyurethane Waterproofing	Fosroc, Ardex Endura , Pidilite, Cico
e	Thermal Insulation with Polyurethane Foam	Fosroc , Pidilite , BASF or approved equivalent make
f	Self-adhesive 1.5 mm thick HDPE membrane	Fosroc, Ardex Endura , Pidilite, Cico
g	Self adhesive 1.5 mm thick SBS modified membrane	Fosroc, Ardex Endura , Pidilite, Cico
7	WOODWORK	
a	Commercial Board	Greenply/ Duro / Century/ or approved equivalent
b	Flush door shutters	Greenply/ Duro / Century / Merino or approved equivalent
c	Marine Plywood	Greenply/ Duro / Century or approved equivalent
d	BWP Ply	Greenply/ Duro / Century or approved equivalent
e	Laminate	Greenlam (Greenply Industries Ltd.), Merino, Century Laminating Co. Ltd, Formica India Division. Sunmica
f	Natural veneer	Century Ply boards (India) Ltd., Greenply Industries Ltd., Sarda Plywood Industries, Merino
g	Teak Wood / Cedar	1st quality Nagpur Teak or Cedar
8	GLASS	
a	Float Glass	Saint- Gobain , Modi Float, Asahi, . or approved equivalent make
b	Mirror Glass	Modi Float, Asahi. or approved equivalent make
c	6mm / 10 mm / 12 mm thick toughened glass	Saint- Gobain , Asahi, Sisecam flat glass india,
d	6 mm thick High performance toughened glass	ST 467 toughened of saint Gobain / AIS or approved equivalent
e	24 mm thick Double glazed insulating glass	6mm PLTT toughened +12mm airgap+6 mm clear toughened of saint Gobain / AIS or approved equivalent

f	13.52 mm thick Laminated,glass	Saint- Gobain , Asahi, Sisecam flat glass india
9	FALSE CEILING	
a	Gypsum Board	Saint Gobain Gyproc, USG Boral, Knauff or approved equivalent
b	Aluminium Lay in tile False ceiling / Aluminium Micro Perforated ceiling	ArmStrong, Hunter Douglas, Durlum or approved equivalent make
c	POP / White cement putty	Birla, JK or approved equivalent make
d	Calcium silicate boards & tiles, & Calcium silicate perforated tiles	Ramco, Promat or approved equivalent make
e	White cement based, water resistant, polymer modified self curing ready mix Levelplast plaster	Level Plast of Birla white or approved equivalent make
10	WEATHER SEALS	
a	Rubber seals	Enviroseals, Anand Reddiplex or approved equivalent make
b	Brush Strips	Enviroseals, Anand Reddiplex or approved equivalent make
c	Expansion Joint Filler	Dow Corning, GE Silicon, Fosroc Chemicals(India) Ltd. or approved equivalent make
d	Silicon Structural Sealant & Weather Sealant	Dow Corning, G.E., Wacker or approved equivalent make
e	Polysulphide Sealant	Fosroc, Pidilite, Roff, MC Bauchemie, or approved equivalent make
11	ALUMINIUM	
a	Aluminium	Hindalco , Jindal or approved equivalent make
b	Curtain Glazing	Hindalco, Jindal. Indal, or approved equivalent make
c	Adhesive tape	Norton ,3D or approved equivalent make
d	EPDM Gasket	Anand Reddiplex, Enviroseals or approved equivalent

e	Aluminium spacers	Lisec / Alupro or equivalent
f	uPVC Doors & Windows	Kommerling / Fenesta / Deceuninck india or approved equivalent make
g	Screw	Nettlefold, Paragon. or approved equivalent make
h	Fasteners	Hilti India Pvt. Ltd , Fischer or equivalent
12	HARDWARE	
a	Floor Spring	Dorma BTS 65 , GEZE 1740004 (TS 500 NV), Hafele 932.79.040
b	Surface mounted door closer	DormaKaba TS Kompakt Door Closer with Std Arm, Kich DC512S & Hafele or approved equivalent)
c	Stainless steel grade 304 satin finish tower bolts 150mm	DormaKaba :9117696, Kich TBF36S & Hafele or approved equivalent)
d	Stainless steel grade 304 satin finish tower bolts 300mm	DormaKaba : 9117713, Kich TBF312S & Hafele or approved equivalent)
e	Stainless steel grade 304 satin finish pull handle 19 mm dia x 150 mm long	DormaKaba : TGDI-D 150, kich PRDH1906S & Hafele or approved equivalent
f	Stainless steel grade 304 satin finish pull handle 19 mm dia x 200 mm long	DormaKaba : TGDI-D 200 , Kich PRDH1908S & Hafele or approved equivalent
g	Stainless steel grade 304 satin finish pull handle 22 mm dia x 300 mm long	DormaKaba : TGDI-D 300 , Kich PRDH2212S & Hafele or approved equivalent
h	Stainless steel grade 304 satin finish pull handle 25 mm dia x 450 mm long	DormaKaba : TGDI-H 450 , Kich PRDH2518S & Hafele or approved equivalent
i	Satin stainless steel Foot operated	DormaKaba : 9112195 , Kich DSTRS & Hafele or approved equivalent

	Door Stopper with rubber buffer	
j	Satin stainless steel wall mounted Door Stopper with rubber buffer	DormaKaba : 4012, Kich DST75S & Hafele or approved equivalent
k	Single point locking handles without Key for window	PL 205H of PULSE (LGF Sysmac (I) Pvt Ltd / HD 03 of PEGO or approved equivalent
l	Stainless steel grade 304 sliding door bolt	300 x 16 mm. Hafele 911.81.881, Kich PRAD12612C or approved equivalent
m	Mortise lock with one side thumb turn & one side Key & pairs of lever handle with rose & escutcheons.	Dormakaba Pure Lever Handle 8906 + Mortice sash lock 271a + 3016 / Kich PRLH223S+MLB96S+PRPCKNS60 & Hafele or approved equivalent
n	Mortice bathroom lock	DormaKaba : Pure 8906 WC lever handle + 275a WC lock / Kich, Hafele or approved equivalent
o	Backset mortice dead lock, 20 mm square forend with 6 pin Euro Profile Cylinder with both side Key operation	Dormakaba Mortice dead lock 706 dead lock + 3026 / KichMDB96S+PRPCBSKS60+PREEP50S / Hafele or approved equivalent
p	SS grade 316 Grab bar 25 mm dia * 625 mm length	Dorma : GBD1, D-600 / Hafele / GEZE or approved equivalent
q	Stainless Steel Ball bearing hinges (4" x 3" x 3mm thick).	Dormakaba 3043FWD , Kich PRBHT2B34S & Hafele or approved equivalent
r	Friction Stay	Hettich, Hafele, Geze, Ingersoll Rand or approved equivalent
s	Shaft dead bolt with allen-key	Dorma : 8681 , Kich SDBA, Hafele or approved equivalent
t	Wardrobe Handle	CHA56S of Kich , 115.68.004 of Hafele or approved equivalent
u	Magnetic Catcher	Kich AWM13 / 246.84.713 of Hafele /

		or approved equivalent
v	Wardrobe Lock 22 mm	DL111S of Kich / 232.01.250 of Hafele or approved equivalent
13	PAINTS & DISTEMPERS	
a	Acrylic Distemper	Asian, Nerolac, Berger, I.C.I.
b	Synthetic Enamel	Asian, Nerolac, Berger, I.C.I.
c	Acrylic/ Plastic Emulsion	Asian, Nerolac, Berger, I.C.I.
d	Cement Paint	Snowcem, Durocem or approved equivalent
e	Premium Acrylic smooth Exterior Paint with silicon Additive	Asian paint Apex Ultima / Nerolac : XL total / Berger ;Weather coat all guard / ICI Dulux :Weather Shield max
f	Red oxide	Asian, Shalimar, Acroprime or approved equivalent
g	Silicon paint	Nerolac, Asian, ICI or approved equivalent
h	DUCO, Paint.	ICI, DUCO or approved equivalent
i	Putty	Goldsize, Shalimar Paints Ltd or approved equivalent
j	Polish	First Quality as per approved sample.
k	White cement putty	Birla, JK, Asian paint or approved equivalent make
l	EXTERNAL GRADE TEXTURE PAINTS	Asian Paint / Berger Paint / I.C.I. as per approved sample
14	STONES	
a	Granite stone 18 mm thick /	First Quality as per approved sample/ approved quarries
b	Marble	First Quality as per approved sample/ approved quarries
c	Kotah Stone	First Quality as per approved sample/ approved quarries
d	Red Mandana Stone	First Quality as per approved sample/ approved quarries
e	Chunar stone	First Quality as per approved sample/ approved quarries
f	Red sand stone	First Quality as per approved sample/ approved quarries

g	Katni stone	First Quality as per approved sample/ approved quarries
h	Stone finish	Leather finish, Flamed , sand blasted & Leathered finish , Honed finish, natural Polished etc.
15	FIRE & ACOUSTIC DOORS	
a	Fire door & Fire rated hardware	Shakti Hormann Ltd, Navair or approved equivalent
b	Fire Glass	Borosilicate clear toughened Fire Glass minimum 6 mm thick of Schott or Saint Gobain.
16	MISCELLANEOUS	
a	Adhesive	Fevicol (Pidilite Ind. Ltd), Vamicol, Century SH, Araldite, Mansonite.
b	Pigments	Tata chemicals, Sudershan Chemical Industries.
c	Anti-termite.	Indo Gulf Pest Control, Montari Industries.
d	Norton Tape (Double sided) Adhesive tape	Norton, Supreme
e	S.S. Railings 316 grade with 50.8 mm dia tube top Handrail ,42.4 mm dia tube single baluster, 4 Nos. mid rail of S.S. tube 16 mm dia	Kich / Rinox / or approved equivalent
f	S.S. Railings 316 grade with 50.8mm dia tube top Handrail & SS flat single baluster 50mmx10mm, 5 nos. mid rail of SS tube 16 mm dia	Kich / Rinox / or approved equivalent
g	Bonding Agent	Nitobond EP of Fosroc / Sikadur 32LP of Sika / Concrese 1414 of BASF
h	Floor hardner	Nitoflor hard top of Fosroc / Chapdur of Sika / Master top hardner of BASF
i	GRC (Glass Reinforced Concrete) Jali	Unistone Product India Pvt. Ltd., Sanderson Theme Construction , Can Build Group

NOTE: All the Materials/Makes listed above and other than as specified above shall be used after obtaining prior approval from the Architect/Engineer-in-charge/Owner. Sample duly approved by Engineer-in-charge shall be kept in safe custody of contractor and displayed in board properly till completion of the project.

Not with standing any interim or final approval the contractor remains responsible for satisfactory performance of all fittings & fixtures. The liability of the contractor is not limited by any approval of the maker of materials.

The contractor shall organize to submit following samples for the project.

Aluminium & UPVC Doors & Windows profiles with accessories and hardware
 All types of stone / Tiles and floorings
 All types of Stone/tiles used for Dry Cladding and Internal Wall cladding
 All types of Hardwares as mentioned in BOQ
 All types of Waterproofing samples as mentioned in BOQ
 Any other material as required as mentioned in the BOQ
 Glass Reinforced Concrete (G.R.C) Screens
 Nothing extra shall be payable for the samples.

LIST OF MOCKUPS / SAMPLES

The contractor shall organize to prepare following mock-ups / prototypes for the project or as called for by the Engineer-in-Charge / Architect.

Aluminium Door & Window

UPVC Door & Window

Stainless steel grade 304 doors & frame (Fire door)

Stainless steel grade 316 Railings

6. EXTERNAL GRADE SMOOTH / TEXTURE PAINTS

7. Glass Reinforced Concrete (G.R.C) Screens

LIST OF SHOP DRAWINGS TO BE PREPARED BY THE CONTRACTOR

The contractor shall organize to prepare & submit shop drawings as instructed by the Engineer-in-Charge / Architect for all specialized items. Below is a list which is indicative but not complete.

All doors / Windows drawings and details

SS Railing

Expansion joints

Water proofing

Glass Reinforced Concrete (G.R.C) Screens

LIST OF APPROVED MAKES OF MATERIALS (PLUMBING WORKS)

S.No	Materials	Brand & Manufacturer
1.	Sanitary Fixtures & fittings	As per the Model no. & make given in BOQ items
2.	G.I. pipes	TATA/JINDAL HISSAR/SURYA ROSHNI
3.	G.I. Fittings for Water Supply (Malleable)	UNIK/JAINSONS/ZOLOTO/DRP
4.	SS Pipes 316	ALPHA PRESS/VIEGA/VSH SUDOPRESS
6.	uPVC pipes	PRINCE/ SUPREME/ ASHIRWAD/JAIN IRRIGATION
8.	CPVC pipes	ASTRAL/ASHIRVAD FLOWGUARD/JAIN IRRIGATION
9.	Centrifugal Cast Iron Hubless Pipes & fittings	NECO/HEPCO
10.	Gully Trap	ANAND/BK CERAMICS INDUSTRY
12.	RCC PIPES	PRAGATI/ KRISHNA SPUN PIPES/ OM SPUN PIPE

S.No	Materials	Brand & Manufacturer
13.	HDPE pipe for sewerage system (IS 14333)	ORIPLAST/ JAIN IRRIGATION/SUPREME
14.	Insulation For Pipes	THERMAFLEX
15.	Insulation For External / Exposed Pipes	THERMAFLEX
16.	Pipe protection For External Water Supply Pipes	PYPKOTE/MAKPOLYKOTE/ARMAFLEX
17.	Pre-Fabricated Structural supports and clamps	CHILLY/EASYFLEX/CAMRY
18.	Paints	ASIAN PAINTS/BERGER/SHALIMAR
19.	C.I Manholes cover	NECO/HEPCO
20.	SFRC Manhole Cover & Gratings	ABC-ACCURATE BUILDCON
21.	Plastic Encapsulated Foot Rest	KGM
22.	Ball valves	LEHRY/SKS/CASTLE
23.	Butterfly valve	LEHRY/SKS
24.	Motorized butterfly valve with controller for OHT	LEHRY/SKS
25.	Air Release Valve	LEHRY/LEADER/SKS
26.	C.I double flanged sluice valve	KIRLOSKAR/LEADER/SKS
27.	C.I Strainer more than 65mm dia.	LEADER/SANT/AIP
28.	Solenoid valve	DANFOSS/HONEYWELL
29.	PVC Water storage tank	SINTEX/SHEETAL/SUPREME
30.	Prefabricated Grease separator	KESSEL/ACO
31.	Hot water Geyser	VENUS/AOSMITH

LIST OF APPROVED MAKES OF MATERIALS (WATER SUPPLY PUMPS AND EQUIPMENTS)

S. No.	Material / Item	Makes
1	Clear water pump	KSB/GRUNDFOS/XYLEM
2	Hydro-pneumatic Pumping System	KSB/GRUNDFOS/XYLEM
3	Submersible Sump Pumps	KSB/GRUNDFOS
4	Water Level Control & Indication System Integrators	ADVANCE AUTOMATION/TRICOLITE/DIAMOND
5	Electrical Panels	ADVANCE AUTOMATION/TRICOLITE/DIAMOND
6	Pressure Gauges	FIEBIG / H. GURU / DANFOSS
7	Dosing System	MILTON ROY/ ASIALMI / GRUNDFOS
8	Pump Vibration Pads & Suction & Delivery Flexible Connectors	EASYFLEX / RESISTOFLEX / DUNLOP
9	Power Cables and control cable	UNIVERSAL / POLY CAB / HAVELS
10	Cable Trays	MEK / STEELWALYS / PILCO
11	Filter & Softner	SIMA/ASTHA/WATCON
12	Electromagnetic flow Meters	IOTA / FORBES MARSHALL / ASTER
13	Switches, MPCB , MCB and MCCB,	Siemens / Schneider / Legrand
14	Contactors	Siemens / Schneider / Legrand
15	Push Button element/ Indicating Lamp	L&T / BCH / KAYCEE
16	Protective Relay	GECA / ABB / SIEMENS
17	G.I. pipes	TATA / JINDAL HISSAR / SURYA ROSHNI
18	G.I. Fittings	UNIK/JAINSONS/ZOLOTO/DRP
19	Ball valve	LEHRY/SKS/CASTLE
20	Butterfly Valve	LEHRY/SKS
21	C.I double flanged sluice valve	KIRLOSKAR/LEADER/SKS
22	Non return valves	KIRLOSKAR/LEADER/SKS
23	Motorized butterfly valve with controller for OHT	LEHRY/CASTLE/AIP
24.	Pressure reducing valve	RBM/TIMME/SKS
25	Strainer	ZOLOTO / SANT / CASTLE
26	Float switch	NOLTA / DANFOSS / HONEY WELL
27.	Pre-Fabricated Structural supports and clamps	CHILLY/MUPRO/CAMRY
28.	Paints	ASIAN PAINTS/BERGER/SHALIMAR
29.	C.I Manholes cover	NECO/KARTAR/RIF
30.	SFRC Manhole Cover & Gratings	KK/ABC-ACCURATE BUILDCON/SURABH

S. No.	Material / Item	Makes
31.	Plastic Encapsulated Foot Rest	KGM/KK/ABC

LIST OF APPROVED MAKES OF MATERIALS (RO SYSTEMS)

S. No.	Material / Item	Makes
1	R.O. Membranes	HYDRANAUTICS/DOW/PAINTAIR
2	Micro Cartridge Filters	PENTAIR/AMETEK/THERMAX
3	Activated Carbon Filters	PENTAIR/AMETEK/THERMAX
4	Dosing System	ASIA LMI/GRUNDFOS/MILTON ROY
5	R.O. Raw water Low pressure feed Pumps, High pressure feed pumps	GRUNDFOS/DP HOLLAND/FRANKLIN ELECTRIC
6	Hydropneumatic R.O. water supply pump	GRUNDFOS/DP HOLLAND/FRANKLIN ELECTRIC
7	CIP pump	GRUNDFOS/DP HOLLAND
8	PLC Control Panel	ALLEN BRADLEY/DELTA PLC/HONEYWELL
9	UPVC Pipes	SUPREME/JAIN PIPES/FINOLEX
10	SS Pipe	JINDAL STAINLESS/VSH/VIEGA
11	HDPE Treated water storage tank	SINTEX
12	Flow Meter	FORBES MARSHAL/ASTER/ EEE
13	Digital conductivity meter	FORBES MARSHAL/ASTER/ EEE
14	Pressure Gauge	DANFOSS/H.GURU/FIEBIG
15	Pressure switch	DANFOSS/HONEY WELL/SWITZER
16	ORP METRE	ASTER/ FORBES MARSHAL/EEE

LIST OF APPROVED MAKES OF MATERIALS (FIRE FIGHTING WORKS)

S.No	Materials	Brand &Manufacturer
1.	M.S Pipes	TATA/JINDALHISSAR/SURYA ROSHNI
2.	Butt Welded fittings	TRUE FORGE/DRP/SS
3.	D.I. Fittings	JAINSONS/ANVIL/SMITH COPPER
4.	D.I. Grooved Coupling Fittings	JAINSONS/VICTAULIC/JACKSON
4.	Ball valve	JAINSON/CIM/RB
6.	Butterfly Valve (upto PN 16)	JAINSON/KIRLOSKAR/SKS
7.	Air Release Valve	SKS/CIM/LEADER
8.	C.I Double flanged sluice valves	JAINSON/KIRLOSKAR/SKS
9.	C.I Double Flanged Non-return valve	JAINSON/KIRLOSKAR/SKS
10.	Dual Plate / Wafer Type Non-return valves (upto PN 16)	JAINSON/KIRLOSKAR/SKS
13.	Fire Extinguishers	SAFEGUARD/MINIMAX/LIFEGUARD
14.	First-aid Hose Reel Drum	SAFEGUARD/SUPEREX/LIFEGUARD
15.	Rubber Hose Reels for Drums	SAFEGUARD/SUPEREX/LIFEGUARD
16.	Thermo Plastic Hose Reels for Drums	SAFEGUARD/SUPEREX/LIFEGUARD
17.	R.R.L. Hose &C.P. Hose	SAFEGUARD/SUPEREX/LIFEGUARD
18.	Branch Pipe, Nozzle, Coupling etc.	SAFEGUARD/SUPEREX/LIFEGUARD
19.	Landing Valves	SAFEGUARD/ LIFEGUARD/ SUPEREX
20.	Fire Brigade Connections	SAFEGUARD/LIFEGUARD/SUPEREX
21.	Fire Fighting Equipment not covered else where	SAFEGUARD/LIFEGUARD/SUPEREX
22.	Hose Box	Reputed make as per IS: specification subject to approval of Samples/Technical Details.
23.	Sprinklers & Rosette Plates (All Types)	TYCO/VIKING/HD
24.	Motors for Fire Pumps	KIRLOSKAR/ABB/CROMPTON GREAVES
25.	Fire Pumps	KIRLOSKAR /MATHER PLATT/WILO/HBD
26.	Diesel Engine	KIRLOSKAR/ EICHER / MAHINDER
27.	Electrical Switch Gear	SIEMENS/L&T
28.	Cables	GRANDLAY/POLYCAB/HAVELLS
29.	Main Control panel (Power coated)	DIAMOND / ADVANCE AUTOMATION
30.	Voltmeter &Ammeter	AE/DUCATI
31	Y-Type / Pot / Suction Strainer	JAINSON/KIRLOSKAR/SANT

32	Foot valve with Strainer	KIRLOSKAR/KARTAR/LEADER
33	Batteries	EXIDE/AMCO-YUSSA/STANDARD
34	Flexible Connectors (Drop) for Sprinklers	SAFEGUARD/VIKING/FLEXDROP
36	Flow Switches /Monitor Modules	HONEYWELL/SYSTEM SENSOR/POTTER
38	Inspector Test Valves	JAINSON/GIACOMINI/BANCHANG
39	Pre-Fabricated Structural supports and clamps	INDTECH/CHILLY/CAMRY
40	Pressure Gauge	FIEBIG/H.GURU
41	Alarm Valve	NEW AGE / HD / MONSHER
42	Pipe Coat Material (Pipe Protection)	PYPKOTE/SHALIMAR/POLYCHEM
43	Dash fasteners	HILTI/FISHER
44	Paint / Primers	ASIAN/JENSON NICHOLSON/BERGER
45	Weld. Electrodes	ADVANI/ESSAB
46	Anti-vibration Pads & suction & delivery flexible connectors	EASYFLEX/RESISTOFLEX
47	Nuts/ Bolts	LAKSHMI/UNBRAKO
48	Contactors & overload relays, fuse links and indicating lamps	L&T/SIEMENS/GE POWER
49	CT/PT Transformer	AE/KAPPA/C&S

LIST OF APPROVED MAKES OF MATERIALS (STP WORKS)

1	G.I. pipes	TATA /JINDAL HISSAR
2	G.I. Fittings for Water Supply (Malleable)	UNIK/ZOLOTO/SS
3	M.S Forged Steel fittings	VS/DRP/SS
4	UPVC pipes	SUPREME/JAIN PIPES/AKG
5	Pre-Fabricated Structural supports and clamps	CHILLY/EASYFLEX/CAMRY
6	Paints	ASIAN PAINTS/BERGER
7	Gunmetal Fullway Valve	ZOLOTO/LEADER/SANT
8	Gunmetal Fullway Valve	LEADER/SANT/ZOLOTO
9	Ball valve	ARCO/CIM./TIMME
10	Butterfly Valve	KSB/SKS/AIP
11	Air Release Valve	RBM/TIMME/SKS
12	C.I double flanged sluice valve	KIRLOSKAR/LEADER/AIP
13	C.I Disk Type non return valves (65mm dia and above – Dual plate type)	KIRLOSKAR/LEADER/AIP
18	Clear Water Pumps	KSB/GRUNDFOS

19	Hydro-Pneumatic Pumping Systems	KSB/GRUNDFOS
20	Electrical Panels	ADVANCE AUTOMATION
21	Pressure Gauges	FIEBIG/ H. GURU
22	Dosing System	PENTAIR/ASIA LMI
23	Pump Vibration Pads & Suction & Delivery Flexible Connectors	EASYFLEX/ RESISTOFLEX
24	Cables	Gloster/CCI/NICCO
25	Cable Trays	MEK/STEELWALYS/PILCO
26	Water Meters	KENT/MARSHALL/IOTA
27	Switches and Fuses	Siemens/ GFC Alsthom
28	Contactors	Siemens/ L&T
29	Push Button element/ Indicating Lamp	L&T / L&T
30	Protective Relay	GECA/ L&T
31	Lighting distribution board	Controls & Switchgear
32	MCB	Indo Asian/ L&T
33	FRP/GRP Vessels	PENTAIR/THERMAX/STRUCTURAL
34	Air Blowers	EVEREST/BETA/ELGI
35	Ultra Violet Disinfection for Treated Effluent	ALPHA UV/SUKRUT
36	Air Diffusors	BOBKAY/REHAU/MM AQUA
37	Submerged/Floating Media	MM AQUA/PP Aquatech/Tube Deck
38	Dosing Pumps	MILTON ROY/ASIA LMI/GRUNDFOS
39	Sludge Pumps (Centrifugal)	KSB/JOHNSON/KIRLOSKAR
40	Sludge Pumps (Screw)	ROTO/UT PUMPS/MYTO
41	Testing Meters	ABB/SIEMENS
42	Centrifuge	APOLLO/ BA ENGINEERING

PART-B3

Proforma (Water Proofing, Aluminium & Bank Guarantee)

T O B E E X E C U T E D B Y C O N T R A C T O R F O R R E M O V A L O F D E F E C T S A F T E R

C O M P L E T I O N I N R E S P E C T O F W A T E R P R O O F I N G W O R K S

**G U A R A N T E E B O N D F O R R E M O V A L O F D E F E C T S A F T E R C O M P L E T I O N I N R E S P E C T
O F W A T E R P R O O F I N G W O R K S**

(TOILETS & BATHROOMS/HAND WASH AREA/UNDER GROUND TANK/OVERHEAD
TANKS/ROOF)

The Agreement made this _____ day of _____ Two thousand and _____ between
_____ son of _____ (hereinafter
called the Guarantor on the one part) and the PRESIDENT OF INDIA (hereinafter called the
Government on the other part).

WHEREAS THIS agreement is supplementary to a contract (hereinafter called the
contract) dated _____ and made between the GUARANTOR OF THE
ONE part and the Government of the other part, whereby the contractor, inter alia,
undertook to render the buildings and structures in the contract recited completely water
and leak-proof.

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the
said structures will remain water and leak-proof for 10 (Ten) years to be reckoned from
the date Completion of the building.

NOW THE GUARANTOR hereby guarantees that water proofing treatment given
by him will render the structures completely leak proof and the minimum life of such
water proofing treatment shall be ten years to be reckoned from the date Completion of
the building.

Provided that the Guarantor will not be responsible for the leakage caused by
earthquake or structural defects or misuse of roof or alteration and for such purpose:

- (a) Misuse of roof shall mean any operation which will damage proofing treatment,
like chopping of firewood and things of the same nature which might cause
damage to the roof.
- (b) Alteration shall mean construction of an additional storey or a part of the roof or
construction adjoining to existing roof whereby proofing treatment is removed
in parts.
- (c) The decision of the Engineer-in –charge with regard to cause of leakage/seepage
shall be final.

During this period of guarantee the guarantor shall make good all defects and in
case of any defect being found, render the building water proof to the satisfaction of the
Engineer-in– charge at his cost and shall commence the work for the rectification within
seven days from the date of issue of the notice from the Engineer-in–charge calling upon
him to rectify the defects failing which the work shall be done by the department by some
other agency contractor at the GUARANTOR's risk and cost. The decision of the Engineer-
in–charge as to the cost payable by the Guarantor shall be final and binding.

That if guarantor fails to make good all defects or commits breach there under

then the Guarantor will indemnify the principal and his successors against all loss, damage, cost expense otherwise which may be incurred by him by reason of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the Government the decision of the Engineer-in-Charge will be final and binding on the parties.

IN WITNESS WHEREOF these presents have been executed by the Obliger_____and by_____and for and on behalf of the PRESIDENT OF INDIA on the day, month and year first above written SIGNED, SEALED AND delivered by OBLIGOR in the presence of :

1.
2.

SIGNED FOR AND ON BEHALF OF THE PRESIDENT OF INDIA BY _____in the presence of:

1.
2.

G UARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR REMOVAL

O F DEFECTS AFTER COMPLETION IN RESPECT OF ALUMINIUM DOORS,

WINDOWS, VENTILATORS & STRUCTURAL GLAZING WORKS

The agreement made this _____ day of _____ Two Thousand and _____ between _____ son of _____ (hereinafter called the GURANTOR on the one part) and the PRESIDENT OF INDIA (hereinafter called the Government on the other part.)

WHEREAS THIS agreement is supplementary to a contract (Hereinafter called the Contract) dated _____ and made between the GUARANTOR OF THE ONE PART AND the Government of the other part, whereby the contractor inter alia, undertook to render the work in the said contract recited structurally stable, leak proof and sound material, workmanship, anodizing, colouring, sealing.

AND WHEREAS THE GURANTOR agreed to give a guarantee to the affect that the said work will remain structurally stable, leak proof and guaranteed against faulty material and workmanship, defective anodizing, colouring, sealing and finishing for 3 (Three) years to be reckoned from the date Completion of the building prescribed in the contract.

NOW THE GUARANTOR hereby guarantee that work executed by him will remain structurally stable, leak proof and guaranteed against faulty material and workmanship, defective anodizing, colouring, sealing and finishing for 3 (Tthree) years to be reckoned from the date Completion of the building.

The decision of the Engineer-in-charge with regard to nature and cause of defects shall be final.

During this period of guarantee, the guarantor shall make good all defects to the satisfaction of the Engineer-in-charge at his cost and shall commence the work for such rectification within seven days from the date of issue of the notice from the Engineer-in-charge calling upon him to rectify the defects failing which the work shall be got done by the Department by some other contractor at the Guarantor's risk and cost. The decision of the Engineer-in-Charge as to the cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to make good all the defects or commits breach thereunder, then the guarantor will indemnify the principal and his successor against all loss, damage, cost expense or otherwise which may be incurred by him by reason of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the Government, the decision of the Engineer-in-charge will be final and binding on both the parties.

IN WITNESS WHEREOF these presents, have been executed by the obligator _____ and _____ by _____ for and on behalf of the PRESIDENT OF INDIA on the day, month and year first above written.

SIGNED, sealed and delivered by OBLIGATOR in the presence

of: 1. _____
2. _____

SIGNED FOR AND ON BEHALF OF THE PRESIDENT OF INDIA BY
_____in the presence of :

1. _____
2. _____

Form of Performance Security (Guarantee)

BANK GUARANTEE BOND

In consideration of the President of India (hereinafter called "the Government") having agreed under the terms and conditions of agreement No. _____ dated - _____ made between _____ and _____ (hereinafter called "the contractor(s)") _____ for the work _____ (hereinafter called "the said agreement") having agreed to production of a irrevocable Bank Guarantee for

_____ (Rupees _____ only) as a security/guarantee from the contractor(s) for compliance of his obligations in accordance with the terms and conditions in the said agreement, we

(hereinafter referred to as "the Bank") hereby undertake to pay to the

(Indicate the name of the Bank)

Government an amount not exceeding ₹ _____ (only) on demand by the Government.

2. We _____ do hereby undertake to pay the amounts due and payable

(Indicate the name of the Bank)

under this Guarantee without any demure, merely on a demand from the Government stating that the amount claimed is required to meet the recoveries due or likely to be due from the said contractor(s). Any such demand made on the bank shall be conclusive as regards the amount due and payable by the bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding _____ (Rupees

3. only). We, the said bank further undertake to pay to the government any money so demanded notwithstanding any dispute or disputes raised by the contractor(s) in any suit or proceeding pending before any court or tribunal relating thereto, our liability under this present being absolute and unequivocal.

The payment so made by us under this bond shall be a valid discharge of our liability for payment thereunder and the contractor(s) shall have no claim against us for making such payment.

4. We _____ further agree that the guarantee herein

contained shall (Indicate the name of the Bank)

remain in full force and effect during the period that would be taken for performance of the said agreement and that it shall continue to be enforceable till all the dues of the Government under or by virtue of the said agreement have been fully paid and its claims satisfied or discharged or till Engineer-in-charge on behalf of the government certified that the terms and conditions of the said agreement have been fully and properly carried out by the said contractor(s) and accordingly discharges this guarantee.

5. We _____ further agree with the Government that
the Government

(Indicate the name of the Bank)

shall have the fullest liberty without our consent and without effecting in any manner our obligations hereunder to vary any of the terms and conditions of the said agreement or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the government against the said contractor(s) and to forebear or enforce any of the terms and conditions relating to the said agreement and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said contractor(s) or for any forbearance, act of omission on the part of the government or any indulgence by the Government to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would, but for this provision, have effect of so relieving us.

6. This guarantee will not be discharged due to the change in the constitution of the Bank or the contractor(s).

7. We _____ lastly undertake not to revoke this guarantee
except with

(Indicate the name of the
Bank)

the previous consent of the Government in writing.

8. This guarantee shall be valid up to _____, unless extended on demand by Government. Notwithstanding anything mentioned above, our liability against this guarantee is restricted to ₹ _____ (₹ _____ only) and unless a claim in writing is lodged with us within six months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharged.

Dated _____ the _____ day of _____
for _____

(Indicate the name of the Bank)

This Guarantee will remain in force up to and including the date* after the deadline for submission of tender as such deadline is stated in the Instructions to contractor or as it may be extended by the Engineer-in-Charge, 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.

DATE

SIGNATURE OF THE BANK

WITNESS

SEAL

(SIGNATURE, NAME AND ADDRESS)

*Date to be worked out on the basis of validity period of 6 months from last date of receipt of tender.

Part C

**ELECTRICAL
TENDER
DOCUMENT**

Eligibility criteria for associate contractor (SH: SITC of ELECTRICAL Works)

Name of work:-

Construction of Hall of Residence No.15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & multipurpose Hall and facilities block including Internal & External Electrification Works, Plumbing, Fire Fighting, Fire Alarm System, Lifts, water tank, landscape, roads HVAC(Low side) etc. at IIT Kanpur (U.P.)

Eligibility conditions for Associate agency for work of SITC of ELECTRICAL Works.

The associate agency shall be registered / enlisted in any of CPWD, BSNL, MES, PWD, Railways, Central PSUs/ State PSUs in the appropriate class.

The associate agency having valid "A" class electrical license.

The associate agency should have successfully completed works, as mentioned under during last 7 years ending previous day of last date of submission of tender.

(i) Three similar works each of value not less than Rs. 600 lakhs

OR

(ii) Two similar works each of value not less than Rs. 901 lakhs

OR

(iii) One similar work each of value not less than Rs. 1201 lakhs

Similar works means SITC of internal ELECTRICAL Works with LT panels/cables etc.

The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of tenders.

The main contractor / agency has to submit details of such associate agency to Engineer-In charge (Internal Electrical Installation works) within one month from the start of work. (The associate agency shall be approved by Executive Engineer (Elect.)). In case the main contractor intends to change any of the above agency / agencies during the operation of the contract, he shall obtain the prior approval of Executive Engineer (Elect.). The new agency / agencies shall also have to satisfy the laid down eligibility criteria. In case Executive Engineer (Elect.) is not satisfied with the performance of any agency, he can direct the main contractor to change the agency executing such items of work and this shall be binding on the contractor.

The Composite category contractor shall also be eligible to carry out himself the work without associating with any specialized agency provided:

He fulfills the prescribed eligibility criteria respectively for this work.

Associate Agency shall enclose self-attested copies of the following documents.

- a. The contractor should be registered in any department of CPWD, BSNL, MES, PWD, Railways, Central PSUs/ State PSUs in the appropriate class.
- b. Valid Electrical License in appropriate class.
- c. The firm should be registered with GST and shall submit the copies of upto date GST filed return.
- d. Self attested copies of completion certificate(s) issued by the officer of the client department, not below the rank of Executive Engineer or equivalent, for works executed in Government and in cases of private works certificates signed by the Consultant / Engineer/ Architect In charge and counter-signed by the owner of the building for whom the work has been carried out, will have to be furnished along with the application. The completion certificate must have the following details: -

Stipulated date of start and actual date of completion.

Attested copy of the final bill with matching 26AS downloaded from website (TDS) for accessing the Value of & SITC of ELECTRICAL Works.

That the work has been completed satisfactorily.

Full address of the client, officer issuing certificate and location, where work is executed.

MEMORANDUM OF UNDERSTANDING [M.O.U] BETWEEN

1] M/S [Name of the firm with full address]

Enlistment Status

Valid Upto:

[Henceforth called the main contractor]

And

2] M/S [Name of the firm with full address]

Enlistment Status

Valid Up to:

[Henceforth, called Associated Contractor]

Name of work:- Construction of Hall of Residence No.15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & multipurpose Hall and facilities block including Internal & External Electrification Works, Plumbing, Fire Fighting, Fire Alarm System, Lifts, water tank, landscape, roads HVAC(Low side) etc. at IIT Kanpur (U.P.)

[Electrical component only] as per schedule, specifications, terms and conditions of the tender.

We state that M.O.U. between us will be treated as an agreement and has legality as per Indian Contract Act (amended up to date) and the department (IWD) can enforce all the terms and conditions of the agreement for execution of the above work. Both of us shall be responsible for the execution of work as per the agreement to the extent of this MOU allows. Both the parties shall be paid consequent to the execution as per agreement to the extent this MOU permits.

We have agreed as under :

- 1- The associated contractor shall be liable for disciplinary action if he fails to discharge the action(s) and other legal action as per agreement besides forfeiture of the security deposit.
- 2- All the material, machinery and equipments, tools and tackles required for execution of the electrical works. As per agreement shall be the responsibility of the associated contractor.
- 3- The site staff required for the electrical work shall be arranged by the associated contractor as per terms and conditions of the agreement.

SIGNATURE OF MAIN CONTRACTOR

SIGNATURE OF ASSOCIATED CONTRACTOR

Date :

Date:

Place:

Place:

**COUNTERSIGNED
EXECUTIVE ENGINEER (Elec)**

WILLINGNESS CERTIFICATE

Name of work:- Construction of Hall of Residence No.15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & multipurpose Hall and facilities block including Internal & External Electrification Works, Plumbing, Fire Fighting, Fire Alarm System, Lifts, water tank, landscape, roads HVAC(Low side) etc. at IIT Kanpur (U.P.)

I will execute the work as per specifications and conditions for the agreement and as per direction of the Executive Engineer(Elec). Also, I will employ full time technically qualified supervisor for the works. I will attend an inspection of officers of the department as and when required.

"I/We undertake and confirm that eligible similar work(s) has /have not been got executed through another contractor on back-to-back basis. Further that, if such a violation comes to the notice of Department, then I/We shall be debarred for tendering in IWD contracts in future forever."

"I have also read the complete tender conditions, and I am aware that PART-A of this tender document is applicable to me also"

Date:

Signature of Contractor

PROFORMA OF SCHEDULES

(SH: Internal Electrical Installation works)

(Operative schedules shall be supplied separately to each intending tenderer)

SCHEDULE 'A' Internal Electrical Installation works

Schedule of Quantities (as per CPWD-3) As per separate sheet attached for electrical items of works.

SCHEDULE 'B'

Schedule of materials to be issued to the contractor:

S.No	Description of item	Quantity	Rates in figure & words at which the material will be charged to the contractor.	
	place of issue			
1	2	3	4	5
..... NIL.....				

SCHEDULE 'C'

Tools and plants to be hired to the contractor

S.No	Description	Hire charges per day	Place of issue
1	2	3	4
..... NIL.....			

SCHEDULE 'D'

Schedule for specific requirement / document for the work if any: As attached in tender form

SCHEDULE 'E'

Reference to General condition of contract- GCC 2023, CPWD form 7 modified and corrected up to last date of receipt of tender. Moreover, any modifications in clauses of GCC-2023 issued by CPWD on account of GST regime in future i.e after the receipt of tender and upto the actual date of completion of the work of the present contract shall also be applicable for this contract.

Name of work:

Construction of Hall of Residence No.15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & multipurpose Hall and facilities block including Internal & External Electrification Works, Plumbing, Fire Fighting, Fire Alarm System, Lifts, water tank, landscape, roads HVAC(Low side) etc. at IIT Kanpur (U.P.)

**Estimated cost of work: Electrical Items of works Rs. 15,01,04,195/-
(Excluding applicable GST@ 18%)**

Earnest Money Included on schedules of civil components

ii) Performance Guarantee: As per major components

iii) Security deposit

General Rules of & Directions: Officer inviting tender;
Maximum percentage for quantity of items of work to be executed beyond which rates are to be determined in accordance with major component.

SCHEDULE 'F'

Definitions:

2 (v) Engineer-in-charge Executive Engineer (Elect), IIT Kanpur

2 (vii) Accepting Authority As per major component

2 (x) Percentage on cost of materials and labour 15%
to cover all overheads and profits

2(xi) Standard schedule of Rates: Schedule of rates-2022 & MR

2 (xii) Department: Institute Works Department

9(ii) Standard CPWD contract form: As per Major Components

Remaining applicable clauses are as per major component.

Annexure-1 (Internal Electrical Installation works)

Clause- 10 –A & 18

List of mandatory machinery, tools and plants & testing Equipment to be deployed by the contractor at site.

1. Steel/Aluminium Ladder 1.5 m to 8 m.	2 Nos.
2. Chase cutting machines.	2 Nos.
3. Electrical wire drawing equipment.	2 Set.
4. Torque wrench for nut/bolt/screws.	2 Nos.
5. Conduit die set.	2 Set.
6. Pipe vice.	1 No.
7. Bench vice.	1 No.
8. L.T.Megger 500/1000 volts.	1 No.
9. Tong Tester.	1 No.
10. Multimeter.	1 No.
11. Hydraulically operated & hand operated crimping machine.	1 No.
12. Earth tester.	1 No.
13. Portable Ordinary drilling machine.	2 Nos.
14. Portable Hammer drilling machine.	2 Nos.
15. Overhead conduit puller.	1 No.
16. welding machine	1 No
17. Metal Grinding machine (Hand held)	1 No
18. Drill machine	1 No

Additional conditions for Internal Electrical Installation works

Name of work:-

Construction of Hall of Residence No.15 for Girls consisting of four blocks of (G+12) storied including their connecting corridors, Admin block & multipurpose Hall and facilities block including Internal & External Electrification Works, Plumbing, Fire Fighting, Fire Alarm System, Lifts, water tank, landscape, roads HVAC(Low side) etc. at IIT Kanpur (U.P.)

1. Specification :- The work shall be executed as per CPWD General Specifications for Electrical Works Part I Internal – 2023 & Part II – External 2023, CPWD General Specifications for Electrical Works Part IV Sub Station – 2013 with correction slips upto last date of receipt of tender (Hereinafter called CPWD specifications also), Indian Standards amended upto last date of receipt of tenders, NBC 2016, IE Rules, and as per direction of Engineer-in-Charge. However, if the specification detailed herein is not manufactured, the standard practice for reputed manufacturers shall be adopted.
2. Test Certificate :- Test certificate for the work carried out shall also be submitted.
3. The makes of material have been indicated in the list of acceptable makes. No other make will be acceptable. The contractor shall have to prove bonafides of the make of materials by producing necessary documentary evidence. The material to be used in the work shall be got approved from the Engineer-in-Charge before use at site. The Engineer-in-Charge shall reserve the right to instruct the contractor to remove the rejected material and material which, in his opinion, is not as per specifications.
4. Contractor shall preserve the copies of invoices, test certificates, gate passes etc.
5. Materials, equipments, manufacturing process, documents etc for the work may be inspected by the departmental officers/Engineers at various stages (manufacturing, assembling, storage/ godown, transportation, etc) to ensure proper quality of the material. However the final responsibility of quality shall rest with the contractor. All the test reports shall be submitted before the dispatch of equipment. If desired by the engineer-in-charge, inspection at factory or at godown of the manufacturer, as required, shall be arranged by the firm for a mutually agreed date.
6. Agency will be required to procure all materials directly from the manufacturer/ authorized dealers / distributors to ensure genuineness & quality and as per the approved makes only. Proof in this regard shall be submitted by the contractor by the department.
7. No inspection outside the country is permissible. If required so, the same will be

deemed to be waived off and necessary test reports shall be submitted before the dispatch of equipment. The contractor shall be fully responsible for such items of materials.

8. Works to be done by the contractor:- Complete work including testing and commissioning etc. as per drawings and additional technical specification for ELECTRICAL works and ancillary works related to make the item functional and as per manufacturer specification and related document.

1. Drawings:-

- a) After award of the work, the contractor will be required to submit the design and shop/execution drawings for the proposed work including layout plan, conduit routes etc. Work will be carried out as per the approved shop/execution drawings.
- b) All circuits shall be indicated and numbered in the lay out plan with mentioning their respective distribution board and circuit number from which they are electrically connected.
- c) Position of all points with their control switch boards indicating their number shall be marked in wiring lay out plan.
- d) All the electrical panel boards, distribution boards duly numbered shall be marked in wiring lay out plan.
- e) For fabricated equipments, the contractor will first submit dimensional detailed G.A. drawings for approval before fabrication is taken up in the factory.

- 2. Defect Liability:-** The defect liability period for the work is 36 months from the date of completion of the building. Following conditions are elaborated as follows.

- a) Repair/replacement of defective wire cables, switches, sockets, ACB'S, MCB'S, MCCB'S, contactor, relay, meters, batteries, earth pits, etc. within 48 Hrs on receipt of complaint from operational staff.
- b) Replacement of items against any manufacturing defects noticed during defect liability period.

- 3. The bidder shall submit the Three year onsite replacement warranty of defective LED luminaries from OEM.**

- 4. Interchangeability:-** Similar parts of all switches, lamp holders, distribution fuse boards, Switch gears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

5. Workmanship:-

a) Good workmanship is an essential requirement to be complied with. The entire work of manufacture / fabrication, assembly and installation shall conform to sound engineering practice.

b) The working contractor shall be a licensed electrical contractor of appropriate class suitable for execution of the electrical work. He shall engage suitably skilled/licensed workmen of various categories for execution of work supervised by supervisors / Engineer of appropriate qualification and experience to ensure proper execution of work. They will carry out instruction of Engineer-in-charge and other senior officers of the Department during the progress of work.

- 6. Main Board and Main Distribution Board:-** The design and GA drawings of all Main/Distribution panels shall be prepared by panels manufacture and got approved by Engineer in-charge before fabrication. The panels shall be fabricated according to approved GA drawings/ details. Factory inspection of panels of engineer in-charge shall be planned before dispatch at site. All main panels/Distribution panels shall be provided with MCCB of appropriate capacity as per single line diagram The panels shall be fabricated according to the drawings / details are as approved by the Engineer-in-Charge. All termination of electrical cables in panel / feeder pillars DB's, cable-looping box etc. shall have to be done with proper thimbles / lugs using crimping process. Copper thimbles / reducer shall be used for copper cable, GI earth wire, aluminum thimbles/reducer for aluminum cable and nothing extra will be paid for the same. All multi-stranded/stranded copper wires shall be terminated through copper lugs.
- 7.** All panels, DB's, cable-looping boxes will be numbered and marked with paint / name plate and nothing extra will be payable on this amount.
- 8.** "Modular Switch, Socket, plate, box, Computer outlet, Telephone outlet, accessories" shall be of the same make in one board. The contractor shall have to make the edges around the boxes wherever required shall have to be made by the contractor for which nothing extra shall be paid.
- 9.** All items of interrelated works considered necessary to make the installation complete and operative are deemed to be included shall be provided by the contractor at no extra cost.
- 10.** Wherever ceiling roses are not required to be provided in the light/fan/exhaust fan points, due to site conditions, the contractor shall use suitable three pin connectors for which nothing extra shall be paid.

- 11.** Contractor shall provide polythene / PVC plastic cover for all MDB's/SDB's/DB's, panels, feeder pillars etc. to protect them from rust /damages, during execution of work till the work is actually completed and handed over to the department.
- 12.** The MCB and MCCB should be of the same make as that of DB in all DBs items.
- 13.** 36 months onsite warranty shall be provided to all items except the items of LED fittings and fixtures. For the LED lighting fixtures 60 months onsite replacement warranty shall be provided. Such replacement shall be done within a reasonable period, failing which suitable penalty will be imposed as detailed in part-A of the tender documents (Major component).

ADDITIONAL TECHNICAL SPECIFICATION FOR INTERNAL ELECTRICAL INSTALATION WORKS

Name of work:- Construction of Hall of Residence No.15 for Girls consisting of flour blocks of (G+12) storied including their connecting corridors, Admin block & multipurpose Hall and facilities block including Internal & External Electrification Works, Plumbing, Fire Fighting, Fire Alarm System, Lifts, water tank, landscape, roads HVAC(Low side) etc. at IIT Kanpur (U.P.)

1. SCOPE OF WORK

1.1 The general character and the scope of work to be carried out under the contract are illustrated in Drawings. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Executive engineer (Elec). The contractor shall furnish all labour, materials and equipment to complete the work as per additional conditions for ELECTRICAL works, drawings and specifications enclosed. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract.

Complete building to be designed but execution shall be done only in finished areas of ground floor and complete area in first floor of building as shown in shaded areas of drawings. In Unfinished areas in the building the contractor will not provide wrings, Light fixtures, fans, power point outlets and final MCB distribution boards.

The brief of the works to be executed by the contractor and the system shall include:

- a) Wiring for Normal electric supply & Emergency supply shall be done in metallic steel rigid conduit / Cable tray/ O. H. Raceway system as per drawings.
- b) Switches, plug sockets, cover plates and other wiring accessories.
- c) CPRI approved Main L.T. panel, Non metered Sub distribution board panel 1 & 2 and UPS output panel 1 & 2 at ground floor, Metered Main distribution panels on each floor and final MCB distribution boards as per SLD, BOQ and DB detail and plan layout drawings.
- d) Cables from Main L.T. Panel to all respective floor Metering main distribution panels/ Common areas sub distribution panels on cable trays / surface including installation, cable trays, hangers, supports, cable terminations i/c all fixing accessories.
- e) Finishing of available RCC floor level below and around the floor mounted Metered Main L.T. panel, Non metered Sub distribution board panels and UPS output panels suitable to their installation and operation.
- f) Cables/Sub main from Metering main distribution panels boards / Common areas sub distribution panel boards to final DBs in ground and first floors on cable trays / surface including installation, cable trays, hangers, supports, cable terminations and i/c fixing accessories.

- g) Earthing (Grounding) System and Lightning Protection System as per NBC-2016.
- h) Cable connections from substations panel to main Building panel and UPS shall not be in scope.
- i) LED Lighting Fixtures, Fans and power point outlets in finished areas of ground floor and complete area in first floor of building as shown in shaded areas of drawings .

1.2 RELATED DOCUMENTS

More particularly following documents should be strictly followed.

1. All Drawings.
2. Additional conditions and additional technical specification for ELECTRICAL works in this tender.
3. CPWD General Specification for Electrical work Part-1 Internal (2023)
4. CPWD General Specification for Electrical work Part-2 External (2023)
5. Relevant Bureau of Indian Standard codes as more particularly stated herein and broadly to all the codes, status and regulations as applicable shall be strictly enforced and adhered to. Manufactures specification
6. National Building Code – 2016
7. National Electrical Code – 2008
8. Indian Electricity Act 2003
9. The Electricity Rule 1956

2. SUB MAINS AND POINT WIRING

2.1 Scope

The scope of this section comprises the supply, installation, testing and commissioning of following as per drawings:

1. Wiring for power and UPS outlets, heavy duty sockets/industrial sockets.
2. Wiring from distribution boards to different switchboards and from there onwards to individual points like light points, Bell Buzzers, Fan points and small exhaust fan points etc for all internal areas.
3. Switchboards, power plugs and its accessories like gang box, front plate, switch etc.
4. Wires and its accessories like conduits, Outlet boxes, junction boxes, pull-through boxes etc.
5. Ceiling rose, Connectors etc. for light points, Fan points, small exhaust fan points etc for all internal areas.
6. Conduit/channel, accessories for the same and wiring cables between the switch box and the point outlet, loop protective earthing of each fan/ light fixture.
7. All fixing accessories such as clips, screws, raw plug etc. as required.

8. Metal switch boxes (as specified) for control switches, regulators, sockets etc, recessed or surface type, and phenolic laminated sheet covers over the same.
9. Control switch or MCB, as specified in drawings.
10. Connections to ceiling rose, connector, socket outlet, switch etc.
11. Flexible conduits from ceiling junction box to the fittings shall be provided duly coupled at both ends where false ceiling is coming. This shall be included within the scope of point wiring.)
12. Interconnecting wiring between switches within the switch box on the same circuit.
13. For any other Items drawings shall be refer.

2.2 Specifications

2.2.1 Wires:

The wires shall be PVC Insulated Copper Conductor multi strained FRLS confirming to IS: 694 and amendment up to date.

- a. Wires for all electric supply for light/Fan circuit wiring and point wiring (along with internal loop earthing) shall be of as per CPWD Specification/approved drawings.
- b. Wires from DB to 6A Socket outlet (along with internal loop earthing) shall be of 2.5 sq.mm size.
- c. Wires from DB to 6/16A Socket outlet (along with internal loop earthing) shall be as per CPWD Specification.
- d. Wires from DB to socket outlets more than 1 KW, Split AC, Geyser, Industrial sockets and Sheet steel MCB/MCCB box shall be as per drawings.

2.2.2 Thimbles/lugs:

The wires shall be terminated with the help of crimping lugs at both the terminals. The lugs shall be suitable for 1100V and the min temperature rating for these lugs shall be 150 degree Celsius. The lugs shall be pin/Hole type with pin designed in such a fashion to prevent damage to the wire from over tightening and ensure a reliable electrical connection. If Aluminum cable is used, aluminum lugs shall be used, for copper cables, copper lugs shall be used and if cable termination is of aluminum conductor and main bus bar is copper than tinned copper or bi-metallic lugs shall be used.

2.2.3 Metallic conduits, Fittings and accessories:

Wiring for Light/ Fan/Call Bell/Exhaust Fan point and circuit wiring and power wiring shall be done in Metallic rigid steel conduit confirming to IS 9537 with conduit fittings confirming to IS 14768 and conduit accessories confirming to IS 3837 amendment up to date.

2.2.4 Modular GI Box:

The switch box for mounting modular switches and sockets shall be made out from pre galvanized sheet. The modular GI box having wall thickness not less than 1.2mm for boxes up to size of 20 cm X 30 cm and above this size of 1.6 mm thick shall be used.

2.2.5 Modular Base and cover plate:

The front plate shall have smooth surface from both the side and shall be properly matching the fixing alignment. Perfect alignment shall be maintained while fixing of the back boxes. The color shall be as per the engineer in-charge.

2.2.6 Switch - Socket Outlets:

The switch sockets shall be modular type of reputed make mentioned in preferred approved make list.

2.2.7 Blanking Plate:

Spare space in modular switch box shall be covered by blanking plate.

2.2.8 Electronic fan regulator:

Step Type two module modular Electronic regulators should be used.

3. DISTRIBUTION BOARD:

3.1 The distribution board shall be made out of CRCA sheet steel with powder coated double metallic door with minimum IP: 42 protection compliance to IS: 8623-1 and 3 and IEC 61439-1 & 3 and amendment up to the last date of receipt of tender.

4. CABLES TRAYS AND RACEWAYS:

4.1 CABLE TRAY

Cable tray system shall comprise of perforated painted with powder coating M.S. cable trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with M.S. suspenders including bolts& nuts, painting suspenders including bends, Tee joints, Cross member and reducers etc as required.

4.2 RACEWAY

1. Material Pre galvanized sheet raceway trunking system with openable cover confirming to EN 50 085 - 2 – 2 shall be used
2. Metal raceways combines with Junction Boxes, back Boxes for wiring devices, fixing and coupler accessories shall be of same manufacture of raceway selected.

3. Standard Thickness: 1.5mm for Body and Cover / 1 mm for divider.

4. LIGHTNING PROTECTION AND EARTHING SYSTEM:

The buildings specified are to be provided Class-II mesh type lightning protection system with Type-B Earthing protection confirming to national building code 2016, Part-8, Section-

5. In case NBC does not elaborate a particular parameter, IEC-62305 may be referred.

5. LED LIGHTING FIXTURES:

The contractor shall submit LM 79 report of the LED Luminaries & LM 80 report from LED manufacture before fixture supplied at site. The make of LED used shall be CGL/Philips/Havells/ Wipro / Decon.

All lighting fixtures shall comply with the following specifications.

Lumens $\geq$ certain value as specified in drawings.

Efficacy ≥ 100 for indoor lighting fixtures and > 120 for highway and outdoor

luminaries.

CRI ≥ 80 for indoor lighting and 70 for external lighting.

Power Factor ≥ 0.95

THD $\leq 10 \%$

Surge Protection 2.50KV for indoor and 5 KV for outdoor lighting fixtures.

Operating voltage 150-270 volt.

Useful life of LED's 50000 hours @ L70.

7. MAIN LT Panels/DISTRIBUTION PANELS:

Distribution Panels and Final Distribution Boards shall be covered under this section. Panels/Boards shall be suitable for operation on 3 Phase 4 wire system 415 volts/single phase 2 wire system 240 volts, 50 cycles, with neutral grounded at transformer. All Distribution panels shall be CPRI tested design and manufactured by an approved manufacturer. Distribution panels shall comply with the latest Relevant Indian Standards, National building code-2016 and Electricity Rules and Regulations and general construction as per IS-8623-1993 as amended up to date and degree of protection shall be IP 42 as per 13947 Part- I.

7.1 Construction Features:

Distribution panels shall be fabricated out 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. 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. 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. Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. 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.

7.1.1 Bus Bar Connections:

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminum/electric grade copper 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 / aluminum strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum allowable temperature for the Bus bar to be restricted to 85 deg C.

7.1.2 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.

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.LT Switchgears:

7.2. Standards and Codes:

The latest amended up to last date of submission of bid Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 2003 and Indian Electricity Rules 1956 as amended up to date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

7.3. Air Circuit Breaker:

The ACB shall conform to the requirements of IS/IEC 60947-2 and shall be type tested & certified for compliance to standards from–CPRI, ERDA/ any accredited international lab.

The circuit breaker shall be suitable for 433 V, 3 phase, 50 Hz supply system. Air Circuit Breakers shall be with molded 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" "CIRCUIT HEALTHY" "SPRINK CHARGE "indications.

ACB should be able to carry Rated current as required in the SLD at the yearly maximum ambient temperature applicable for 50 degree centigrade and as per site condition whichever is higher.

ACB should have an operational designed voltage of 690 V for $I_{cs}=100\%$ I_{cu} for $I_{cw}=1$ Sec.

The ACB shall be 3/4 pole with modular construction, draw out, manually or electrically operated version as specified in SLD. 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).

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. Mechanical Contact wear indicator shall be mounted directly on the moving contacts to indicate the degree of erosion of the contacts. 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 open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts or as per BOQ requirement w.r.t Manufacturer shall be provided on each breaker. Rated insulation voltage shall be 1000 volts AC.

7.3.1 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 Pin & Cam type/steel balls/rollers and not on flat surfaces.

There shall be 3 distinct and separate position of the circuit breaker on the cradle. Racking Interlock in Connected / Test / Disconnected Position.

Connected Position: Main isolating contacts & 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 & control contacts of the breaker 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.

f) Actual Contact Inspection should be possible by removing Breaker from the panel – with mechanism connected to moving contacts of ACB.

7.3.2 Protections:

The breaker should be equipped within built battery backup microprocessor LCD display based release to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following five zones:

Long time protection.

Short time protection with intentional delay. Instantaneous protection.

Ground fault protection.

Neutral protection for 4 pole ACBs.

The protection release shall have following features and settings:

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.

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. ACB should display last 20 trip history with date time stamping.

e. The release shall meet the EMI / EMC requirements.

f. The setting range of release shall confirm to IEC- 60947 and its applicable sub-parts. All ACBs shall have over temperature protection of release.

All Incomer ACBs shall have temperature rise monitoring at cradle terminals and display thru protection release, LED/LCD display showing all Power & Energy Parameters (Currents, %loading, Voltages, Frequency, PF, Power & Energy (active, reactive & apparent) etc. All incomer ACBs shall have following additional protections other than mentioned above:-

Under and over voltage

Under and over frequency

Restricted Earth Fault protection

Trip Circuit supervision with PS class CT's.

Undercurrent, (for DG set only)

Reverse power (for DG set only)

Phase sequence reversal

Load shedding and reconnection thru programmable contacts.

Release should have LCD display for Power parameters.

Release should be able to capture short circuit current on which ACB has tripped. The trip and alarm shall be stored in memory with the date & time stamping along with type of fault and alarm.

Release should be self-powered.

Integral Test facility to test healthiness of release and the trip circuitry shall be provided on the Release.

Programmable digital contact shall be provided with possibility to configure for pre alarm like over load, over temperature etc, and trip functions like OL/SC/EF/OT etc.

7.3.3 Safety Features:

The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

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.

Draw out breakers should not close unless in distinct service/Test/Isolated positions.

The insulation material used shall conform to Glow wire test as per IEC60695.

The ACB shall provide in built electrical and mechanical anti-pumping.

7.4. Molded Case Circuit Breaker (MCCB):

7.4.1 General:

Molded-Case Circuit Breakers (MCCB) shall comply with IEC 60947-1 & 2 standards.

Earth Leakage Relay (30-3000mA) with CBCT shall be used for all outgoing MCCB.

Earth Fault shall be provided for all incoming MCCB.

MCCB shall be of category A with a rated service breaking capacity (I_{cs}) equal to the ultimate breaking capacity (ICU) on all the ratings.

MCCB shall have designed operational voltage upto 690 V AC (50/60 Hz).

MCCB shall have a rated insulation voltage of 690 V AC (50/60 Hz)

Indication lamp ON, OFF, TRIP shall be provided in MCCBs and ACB.

MCCB must be available in Microprocessor (250A and above) / Thermal Magnetic (Up to 200 Amp.) type release.

All MCCB should be fully rated up to 50 Deg C.

All thermal magnetic MCCBs up to 160A shall be adjustable thermal and fixed magnetic type and 200A shall be adjustable thermal and adjustable magnetic type ($I_r = 0.8 \times I_n$ to 1.0).

For microprocessor shall have following characteristics:-

MCCBs shall be permissible for mounting in all 3 axes (Vertical Wall, Laterally Rotated Wall and Ceiling & Floor mounting) without any adverse effect on electrical performance. It shall have line load reversibility.

7.4.2 Construction and operation:

For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries.

MCCBs shall be actuated by a toggle or handle that clearly indicates the three positions: ON, OFF and TRIPPED.

The operating mechanism shall be designed such that the toggle or handle can only be in OFF position (O) if the power contacts are all actually separated & in OFF position, the toggle or handle shall indicate the isolation position.

MCCBs shall be equipped with a "push to trip" button in front to test operation and the opening of the poles.

The MCCB should be have a trip-free mechanism that ensures the trip process is not prevented even if the operating mechanism is blocked or manually held in the "ON" position.

The Microprocessor Release MCCBs should be equipped with non-saturable type CTs for reliable & accurate protection.

All microprocessor based MCCBs should have display with battery back-up.

All microprocessor based MCCBs should have precise current setting in one step.

7.4.3 Current Limit & Selectivity:

MCCBs shall be Current Limiting type.

MCCBs, the current ratings of which are identical with the ratings of their trip units, shall ensure selectivity in rated current interval 1:1.6

-MCCBs shall be equipped with a test facility of the Release by a hand-held device.

7.4.5 Accessories:

MCCBs shall have uniform Internal Accessories platform across the range

MCCBs Door Mounted Extendible Rotary Handle shall have an option of Illumination Kit to indicate three stable mechanism positions (ON, OFF and TRIPPED).

MCCBs with TMTU Release should have provision for separate Short Circuit Signal facility.

MCCBs shall be snap fit type to enable safe on-site installation of auxiliaries, voltage releases, signal contacts etc.

MCCBs should have symbols engraved in the lid of the accessories compartment to indicate possible mounting position of internal accessories.

The addition of a motor module or manual rotary handle etc. shall not block device settings.

MCCB shall be equipped with Phase barrier, tinned copper spreaders.

7.4.6 Communications:

All incomers ACBs & MCCBs in main LT panel and distribution panel shall be BMS compatible in open protocol.

7.5. Moulded Case Circuit Breaker (MCB):

Miniature Circuit Breaker shall comply with IS/IEC 60898-1:2002 & EN 60947-2 or IEC-60947-2. 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 C curves. 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.

7.6. Meters:

7.6.1 The digital meters shall conform in all respects to International standards –IEC 62053-21-22 or the relevant Indian standards, RoHs compliance with latest amendments thereof.

All voltmeters and indicating lamps shall be through Control MCB's.

Meters and indicating instruments shall be flush type.

All CT's connection for meters shall be through Test Terminal Block (TTB).

CT ratio and burdens shall be according to connected instrument and load.

7.6.2 Digital Multi-Function meter shall be provided in all incomers in main LT panels and distribution panels as shown in SLD, having following characteristics:-

Digital Electronic multi-function meter with RS-485 port with THD with individual harmonics up-to 31st order and THDi to measure and display the following electrical parameters:-

Total active energy(KWH/MWH),

Maximum demand(KVA/MVA)(KW/MW),

Maximum demand reset count,

Instantaneous power factor,

High/Low recording of VLL, VNL, A, Hz, PF, Var, with time stamp.

K factor V & A to keep check on the losses due to harmonic load current and their effects of transformer heating.

Load Manager with Demand monitoring and RTC based demand manager.

Export/Import Net monitoring of Wh, VAH, VARh, inductive/capacitive load hours.

Auto Scaling Capability in variance of Kilo, Mega, Giga.

Positive energy accumulation even with CT polarity reversal with reverse lock programmable.

Byte order option-Field Programmable float/Little Endian/Big Endian data formats.

7.6.3 Energy meter shall be provided in all outgoing in main LT panels and Metering main distribution panels having following characteristics:-

Monitors electrical parameters : Amps, W/VA, LLV, LNV, Hz, PF

Integrated Parameters :KWh /KVah, PF/Watt anyone programmable.

Old Energy register for back-up of last cleared energy values.

True RMS measurement with simulations sampling of current and voltage.

Color coded analog load bar indicators

CT Reversal : Auto correction of energy integration in Star (WYE) mode

Password protection for tamer proofing.

Site Selectable CT/PT.

Pulse output for integration into a process through PLC/DCS for online energy management.

Auto& Manual Scaling Capability in variance of Kilo, Mega, Giga

Seamless integration into any mod bus compatible SCADA- Energy Management System (EMS)

7.6.4 General Requirements:

CT polarity correction should be possible through Energy Meter for each phase.

Import/ Export measurement for KWH/ KVARH is required.

The current inputs shall be configurable at site for measuring x/5/1 A current transformers

The meters shall be suitable for operation with AC auxiliary power and shall have wide tolerance band of 70V to 300V, 40-70Hz

The multifunction meters shall have backlit LCD display with power saving mode/ adjustable contrast.

7.7. Current Transformer:

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5/ 1 amps secondary 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 as per SLD.

7.8 Residual Current Circuit Breaker (RCCB)

7.8.1 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 electromotive 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 20,000 electrical operations.

RCCBs should have a rated conditional short-circuit current of 10 kA.

7.8.2 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.

7.8.3 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.

7.8.4 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.

7.9 bus bar and internal wiring

Incomer switchgear shall be TP 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 up to 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.

Wiring of the control circuit shall be done by using 1.5 sq.mm, 1100 V grade, PVC insulated, multi-stranded copper control wire.

Suitable bus links for input supply cable termination shall be provided.

7.10 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).

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

8. 00 **Cable laying:**

8.01 Cables shall generally be installed in cable trays except for some short runs in buried formation or in conduit / pipe for protection or crossing. Multi core power cable laid on trays & riser shall be neatly dressed & clamped with fabricated 25 x 3 mm G.S flat or cable tray at an interval of maximum 1 meter for vertical / inclined run & 1.50 meter for horizontal run. Control cables may be laid in single layer with touching formation. Power &

control cables shall be claimed in separate group. Power & control cables shall be no be laid in a common tray excepting in very special case where a gap of 150 mm shall be maintained between power & control cables.

8.02 H.T & L.T power cables shall be laid in cable trays in single layer & with spacing equal to the diameter of cable.

8.03 Control cable can be laid upto a maximum of three layers in each tray.

8.04 Both power & control cables shall be clamped to the trays rungs by means of clamp made up to 25 x 3 mm fabricated G.S flat at an interval of 1500 mm for horizontal run & 1000 mm for vertical / inclined cable run.

8.05 The cable trays shall be run with a vertical spacing of 300 mm cable trenches. A minimum of 300 mm clearance shall be provided between the top of tray & beams, cold piping, 500 mm clearance for hot piping / object to facilitate installation of cables in tray.

8.06 Adequate pull boxes shall be provided in conduit run to facilitate. Cable pulling in long runs & also to ensure that there will be no more than 270 degree bend between the pull points.

8.07 Cable tray shall be installed to accommodate cable manufacture's recommended maximum pulling tension & minimum bending radius.

8.08 All opening in the floor & wall for cable access shall be sealed after installation of the cable system with non-inflammable materials.

8.09 All floor/ wall for cable entry to the electrical equipment & accessories shall be sealed with non- inflammable material, after completion of cable installation. Thickness of such materials shall be equal to the thickness of floor / wall.

9.00 Cable power & control:

9.01 The tender shall install & connect all power & control cable required for complete installation with in his scope of work. Type and size of power & control cable shall be as specified & as supplied under a separate sub section for power and control cable.

9.02 In general all power and control cable shall be run in cable trays in cable trenches. Isolated runs of control cables shall be run in rigid conduit.

9.03 Jointing of power cable should be avoided as per as possible. However, if any splicing of control cable is required to carry out interlock it will be done junction boxes not in the

conduit or in the trays. Such junction boxes shall be in scope of tenderer.

9.04 The contractor shall not install cables with different voltage in the same cable tray.

9.05 During cable installation care shall be taken so that actual bending radius of each cable is not less than the one recommended by the cable manufacturer.

9.06 For cable buried directly underground there shall be a stone free sand cushion both above and below the cable run being held by brick wall support on two (2) sides. The excavated portion above the top sand cushion shall be covered by concrete precast slab supported on the side walls & finally filled up with standard back fill.

9.07 Cables shall be pulled into the trenches in strict accordance with the cable manufacturer's instruction.

9.08 Tender shall furnish & install suitable solderless crimping type cable lugs at the termination of all wires & cables if not already furnished with the equipment.

9.09 All exposed conduits & armoured cables shall be tagged with numbers that appear in the conduit & cable schedules as prepared by the tenderer. All conduits & armoured cable shall be tagged at their entrance and / or exist from any piece of apparatus, junction box or pull box. Aluminum tags shall be used with the number engraved / punched on the tag. Tag shall be suitably secured to the conduit or armoured cable.

The cable tags shall also be provided at all bends and at interval of 30 M on straight run of cable in order to facilitate the identification.

9.10 Laying termination & connection of all control cables for interlock, protection, indication & annunciation.

The tender shall prepare cable schedule & interconnection diagram & submit the same for approval of the Authority. Cable laying shall be started with the approved cable schedule & interconnection diagrams. Separate cables for each type of following services/ functions as applicable shall be used & laid along the run for each feeders.

- a) Power - designate as 'P'
- b) Control protection interlock, metering, indication & annunciation designate as "C".

10.00.00 Field Testing:

10.01.00 Field testing shall be required for all the equipment & accessories furnished, installed or connected by the tenderer to ensure proper installation, setting, connection & in accordance with the plans, specification and manufacturer's recommendations.

Testing shall be conducted in presence of Owner's engineer with prior notice at least 2

weeks before commencement of any test.

10.02.00 Filed testing work shall be done as per the latest edition of the relevant standards. All tests recommended by the equipment manufacturer shall be conducted. The tenderer shall submit the list of all filed tests to be conducted for all equipment & accessories for review / approval by the owner.

10.03.00 Testing shall include any additional tests suggested by the owner that the deems necessary because of filed condition to determine that equipment, materials & system meet requirements of the specification.

10.04.00 The tender shall depute qualified personal to conduit all testing & shall provide all labour and testing equipment required for & incidental to testing.

10.05.00 The tender shall be responsible for any damage to equipment & material due to improper test procedure or test apparatus & shall replace to original condition of any damaged equipment or material.

10.06.00 The tender shall maintain in quadruplicate a written record of all tests showing date, personal making the tests, equipment or material tested performed & result. Two copies of test records shall be given to the authority.

11.00.00 **Commissioning:**

After the satisfactory test are performed the equipment & material shall be put non trial operation by the tenderer. After successful trial operation, the equipment shall be put on performance tests initially at no load condition & finally with different loading conditions.

12.00.00 Land escaping works:

The pole should be as per drawing with 40 watt post top lantern LED lights.

13.00.00 **Drawings/ Data required prior to commencement of electrical works:**

13.01.00 The following drawings shall be provided by the Architect/ Engineer-In-Charge of the works:-

13.01.01 Conduit layout for lights, fans, socket outlets, telephone outlets, networks & fire alarm system and sub mains showing size of conduit, no. of wires and size of wires in each run, location and size of accessories like junction boxes, ceiling boxes for hooks, draw boxes and switch boxed etc.

13.01.02 Cable routing drawings showing details of size, type and no. of cables and mode of installation.

13.02.00 following drawing shall be furnished by the contractor for the approval of the Engineer-In-Charge.

13.02.01 G.A and schematic drawing of MV switchgear/ distribution / plant/AHU/FCU/Fire Alarm panel showing material and size of sheet steel / bus bars / inter connections and make and ratings of switchgear i/c details of protection, metering, indicating and inter lock etc.

13.03.00 Completion Drawings:

13.03.01 On completion of work and before issuance of completion certificate, the contractor submit completion drawings in the form of three complete set of originals (reproducible)

13.03.02 As built G.A and schematic drawings of MV panels, distribution boards, fire alarm panels, etc., showing material size of sheet steel / bus bars/ connections and make and rating of switchgear i/c details of protection, meter indicating and interlock etc.

13.03.03 Technical literature, test certificate and operation and maintenance manuals required.

13.04.00 **Works Inspection and Testing of Equipment:**

13.04.01 Prior to dispatch of equipment the Institute reserves the right to inspect the same at the manufacturer's work and the contractor shall provide and secure every reasonable access and facility at the manufactures works for inspection, for witness of all acceptance and routing tests and per relevant Indian Standards. Contractor shall give a reasonable notice of about 15 days for the purpose of test, and witness of all major equipment.

External Lighting

- External Lighting to be provided with LED light fittings minimum IP 65 of required wattage, placed on GI Octogonal poles at suitable height & spacing along the Road and Boundary Wall.
- Gates are to be provided with appropriate Illumination as per Architectural Considerations.
- Lighting poles for street lights shall be of GI Octogonal poles as per applicable standard.
- The steel poles shall be coated with bituminous preservative paint on the inside as well as embedded outside surface. Exposed outside surface of steel poles shall be painted with one coat of red lead oxide primer. After completion of installation two coats of aluminium paint shall be applied.
- The bracket of street light shall be of the same make of street light pole

Weather Proof Outdoor Junction Box for street lighting poles

- The terminals shall be supplied for branching and terminating the lighting cables. The junction boxes shall be dust and vermin proof shall be complete with removable cover plate.
- Suitable rubber gaskets shall be provided on the doors of the junction boxes. The junction boxes shall have a locking facility, suitable to be opened by a common panel key for all the junction boxes.
- The provision shall be made to run 1.1 kV cable from ground to integral junction box for termination & looping.

ACCEPTABLE MAKES FOR INTERNAL ELECTRICAL INSTALLATION WORKS

1.	MS Conduit (ISI marked) and accessories such as bend, junction box etc	BEC/ AKG/ NIC/ SteelKraft Note: All MS conduit pipe accessories shall confirm & complying with IS / 4768 part 2 2003.
2.	PVC Conduit (ISI marked with heavy duty PVC conduit accessories	AKG/norpack/BEC/Polypack/Precision
3.	FRLS PVC insulated copper conductor single core cable for wiring (ISI marked)	Finolex/ Polycab/ Havells/ RR Kabel/KEI/Gloster
4.	XLPE insulated PVC sheathed Aluminium / Copper conductor Armoured cable of 1.1 KV grade	Havells/ Polycab/ Grand lay/ RR Kabel/KEI/Gloster/finolex
5.	MCB, Isolator, Industrial Plug Socket, RCCB, RCBO's	Schneider Electric ACTI-9(N)/ LK(L&T)) / ABB S200M) / Seimens (Betaguard)
6.	MCBDB & Loose Wire Box	LK(L&T) / Schneider Electric / ABB / Siemens
7.	ACBs with Display	Schneider Electric (Masterpact NW6.0A/ LK(L&T) (U-Power-OMEGA)/ ABB (Emax) PR 122 / Seimens (3WL-ETU45B
8.	Moulded Case Circuit Breaker (MCCB) Thermal release / Microprocessor based (Ics=Icu=100%)	Schneider Electric / LK(L&T) (D-Sine) / ABB (TMax) / Seimens (VLseries)
9.	Timer	Schneider Electric / LK(L&T)/ ABB/ Seimens
10.	Change Over Switch	LK(L&T) / Schneider / HPL
11.	Automatic Transfer Switch (ATS)	Asco / Socomec / ABB / LK(L&T)
12.	Selector Switch & Toggle switch	Salzer (Larsen & Toubro)/ Siemens / Kaycee/Rishabh/ABB

13.	PVC Trunking	MK Honeywell / Legrand / Schneider Electric
14.	Terminal Blocks and connectors	Elmax / Wago / Hensel / Connectwell
15.	Phenolic Laminated sheet / Bakelite sheet	Hylam / Formica (P-I Grade) / Mylam/Greenlam
16.	Cat-6A Cable, Wires & Fiber Optic Cable	Amp / AVAYA / Beldon / Molex /Schneider/D-Link
17.	Polycarbonate Junction Box/ Enclosure	Hensel / Schneider / Naptune-Bals
18.	Sandwich & Air Insulated rising Main	C&S / LK(L&T)/ Schneider / Legrand
19.	HT panel / Rising Main Unit	Seimens / ABB / LK(L&T) / Schneider
20.	Modular Switch, Socket/ Telephone socket outlet/ TV Socket outlet/ Data socket socket/ Fan Regulator/ USB Charger/ Key fab/ GI Boxes & cover plates etc. (Wiring Accessories).	Honeywell (Blenze)/ LK(L&T) (Englaze)/Legrand (myrus)Schneider(zencelo)/ABB(ivie)
21.	Call bell/ Buzzer	Anchor/ Leader/ Rider
22.	Ammeter & Voltmeter	AE/ Rishab / LK(L&T)/C&S/HPL
23.	Conventional / Electronic Digital Meter (A/V/PF/Hz/KW/KWH)	Conzery / LK / Secure elite/ AE
24.	LED type indicating lamp / Push Button	Schneider Electric / LK(L&T) / Siemens / C&S/Vaishno
25.	LED Street, Post top, Flood light fitting	Crompton/ Havells/Philips/Wipro
26.	LED fittings	Philips/ Wipro/Havells/Crompton
27.	Wall Bracket Fitting	Philips/ Wipro/Havells/Crompton
28.	G.I. Pipe	Tata / Jindal (Hissar)/Prakash/ Surya
29.	1200 mm BLDC Ceiling Fan	Crompton Greaves /RR Global / Orient
30.	2400 mm HVLS ceiling fan	RR Global/Eco Air Cooling Systems/ Marut Air Systems
31.	Angle Holder/ Batten Holder	ISI marked Kinjal/ Emperor/ Anchor.
32.	Internet Cable CAT -6/6A	Panduit - Pannet/Siemon/Belden/ Systimax
33.	Armoured / Unarmoured Telephone, TV cable, Co-axial cable, Tag Block	Delton/ Finolex/ Polycab

34.	Exhaust fan/ Fresh air fan	Crompton Greaves / Polar/Orient/ USHA
35.	Cover plate for junction boxes/ switch boxes for piano type switch.	Hylem / Formica (i.e. white 3 mm thick).
36.	Octagonal/ Decorative pole	Trilux/ Bajaj/ K-lite
37.	LT Panel / Meter panel board / Outdoor Feeder Pillar / APFC Panels	Tricolite Electrical Industries/ Control & Switchgears Pvt. Ltd./ Milestone/ Adlec Control System Pvt. Ltd./ Advance Panels & Switchgear Pvt. Ltd. LK(L&T)/ABB/ Siemens/
38.	Raceway, Cable Tray	Honeywell (MK)/Schneider/ BEC/ Legrand
39.	DLP trunking	Schenider/Legrand/MK(Honeywell)
40.	Lightning protection	Cape/OBO/DEHN/ABB
41.	Paints	Nerolac / Asian / Berger
42.	Any other item not mentioned above	With prior approval from the Engineer-in-charge

Note: - Any item not mentioned herein shall be ISI marked and shall be as approved by the Executive Engineer (electrical)

FIRE DETECTION & ALARM SYSTEM

INTELLIGENT AND ADDRESSABLE FIRE DETECTION & ALARM SYSTEM

1. SCOPE OF WORK

- a. This specification outlines the requirements for an intelligent, addressable fire detection and alarm system.
- b. The work described in this specification consists of all labour, materials, equipment and services necessary and required to complete , test and commission the fire detection and alarm system. Any material not specifically mentioned in this specification or not shown on drawings but required for proper performance and operation shall be provided and installed for a complete and operational system, by the contractor at no extra cost.
- c. The contractor shall furnish, and install complete and ready for intended use and operation, an intelligent, addressable fire detection and alarm system including Fire panel (s), initiating devices (manual pull stations, addressable smoke, heat detectors etc.) indicating devices (hooters, bells, visual warning signals, etc.) and supervisory devices, annunciators, wiring apparatus and accessories.
- d. The installation and locations of equipment and devices in the building shall be governed by the specifications and drawings with due regard to actual site conditions, manufacturers' recommendations, ambient factors affecting the equipment and other operations in the vicinity. If any departure from the specifications or drawings is necessary, approval shall be obtained from the Engineer-in-Charge before work is started thereon.
- e. Materials and equipment shall be new, first grade, standard, current models of the manufacturer and shall be suitable for this system. Where two or more pieces of equipment performing the same function are required, they shall be exact duplicates produced by the same manufacturer.

All materials, devices, and equipment shall be compatible with the circuits or systems in which they are utilized.

- g. The Contractor shall submit specific catalogue cuts for each of the item specified in BOQ for approval from Engineer in charge before procurement.

3. REQUIREMENTS

- a. This installation shall be made in accordance with the drawings, specification, local codes and local fire authorities having jurisdiction over this project.

b. Reference Standards

- i) The design, supply, installation, testing and commissioning of the entire fire detection and alarm system shall conform to BS:5839 or NFPA 71 and 72. The Detectors shall conform to relevant codes for Fire Alarm System.
- ii) The system installed shall comply with the following codes/publications:
 - a) IS 2175
 - b) IS 2189
 - c) IS 11360
 - d) IS 732
 - e) UL "UNDERWRITERS" laboratory/NFPA/FM/VDS/FOC for addressable detector, fire panel.
 - f) EN 54
 - g) BS 5445

C. TESTS AT SITE

- i) All commissioning tests at site will be in line with BS : 5839 or NFPA 71 and 72.
- ii) Following test shall be conducted :-
 - i. Loop Checking
 - ii. Checking of smoke detectors, Heat detectors etc. by simulation.
 - iii. Functional tests for fire alarm panel.
 - iv. The Mock trial of the complete Fire Detection and Alarm system.

e. TESTS AT MANUFACTURER'S WORK

- i). Tests certificates will be furnished for approval of all Fire alarm devices and system devices.
- ii) All routine tests as per relevant codes for the Fire Alarm Panel, shall be conducted and results furnished to the Engineer-in-Charge.

5. POWER SUPPLY

- a. The control panel shall derive 230 Volts power from main supply. A standby power supply shall be immediately available in the event of failure of normal supply and shall automatically be connected so as to maintain the equipment in condition such that fire alarm originating from the operation of Detector can be given. The standby battery as secondary supply shall be such that when charged by associated battery charging equipment it can operate independently for a period of 12 hours. It shall have enough power supply to cope with additional load resulting in alarm originated from two separate zones for the one hour. Batteries shall be of Lead Acid type and sealed Maintenance free.
- b. Suitable arrangements shall be incorporated to prevent secondary batteries from discharging through the charging equipment in the event of its breakdown or a failure in the supply.
- c. In addition to the batteries, a battery charger suitable for operation on the auxiliary power available in the plant as specified above shall be supplied. The capacity of the charge shall be such that the same can boost charge the battery (within 8 hrs) while supplying the rated load of the fire detection and annunciation system. Facilities shall be provided to limit the voltage supplied to fire detection and alarm system to their rated values during the time of boost charging. The charger shall normally supply the battery trickle charging current and the DC load of the fire detection and alarm system. In case the AC supply on the input side of the charger fails the necessary power for the complete fire detection and alarm system shall be supplied by the battery.
- d. Visible and audible annunciation for troubles or failure in the power supply system like "charger Failure", "Battery Low Voltage", etc. shall be provided.
- e. Battery earth/fault indication/annunciation shall be included in the panel.

6. FIRE ALARM SYSTEM DEVICES

6.1 General

- i. Each device shall be assigned a unique address via easily understood decade (01 to 99) switch. Address selection via binary switches or by jumpers is not acceptable. Devices which take their address from their position in the circuit are unacceptable

because if devices are later added, existing addresses, descriptors and commands need to be reprogrammed.

- ii. Devices shall receive power and communication from the same pair of conductors. For fault isolating modules a separate power wiring which shall be fault tolerant shall be provided.
- iii. Each device shall contain screw terminals with rising plates for positive termination suitable for 1.5 sq.mm. copper conductor wire.

6.2 Addressable Manual Stations

- i. Manual stations shall be of rugged die cast construction designed for semi-flush mounting. Plastic stations will not be acceptable. Stations shall be of the break-glass design and must be opened to be reset. Closing the box after opening it shall automatically perform the reset function. It shall be possible, for testing purposes, to initiate an alarm without breaking the glass. All stations shall be furnished with a spare glass break rod.
- ii. Provisions shall be made such that the address cannot be changed merely from opening the station.

6.3 Addressable Analog Detectors

- i. 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.
- ii. If the Fire Alarm Panel determines that the sensor is in alarm, the Fire Alarm Panel shall command the sensor LED to remain on to indicate alarm.
- iii. Each sensor shall be capable of being tested for alarm via command from the Fire Alarm Panel.
- iv. Each sensor shall respond to Fire panel scan for information with its type identification to preclude inadvertent substitution of another sensor type. The Fire Alarm panel shall operate with the installed type but shall initiate a mismatch (trouble) condition until the proper type is installed or the programmed sensor type changed.

Each sensor shall respond to Fire Alarm Panel scan for information with an analog representation of measured fire related phenomena (smoke density, particles of

combustion, temperature). Such response proves end-to-end sensor including the operation of the sensor electronics. Systems which only monitor the presence of a conventional detector in an addressable base shall not be acceptable.

- v. The Detector shall meet the requirements of either EN 54 or shall be listed with UL. It shall be possible to test the Detector's working both from the Panel as well as locally by means as designed by the Contractor and approved by the Engineer-in-Charge. The approved coverage per Detector for unhampered areas shall not be less than 50 sq. M. The detector shall be capable of being reset automatically after any alarm condition.

6.4 Addressable Analog Heat Detectors

- i. The Detector shall be Analog, Addressable Detector with its own manually set digital code and be able to give a single digitised output to the Fire Alarm Panel regarding its condition. The Detector shall employ the thermistor principle for heat sensing and the fixed temperature setting shall be at 60 degrees Centigrade. It shall be able to communicate with the Fire Alarm Panel by the Pulses emitted from the Panel.
- ii. The Base of the Detector shall be interchangeable with other Smoke Detectors and the construction shall be of flame retardant material. LEDs shall be provided to indicate locally alarm condition.
- iii. It shall be able to withstand temperature variations from 0o C to 50o C. Further, relative Humidity (non Condensing type) upto 95% shall not hamper its performance.
- iv. It shall have in built safety device to monitor the removal and pilferage of the Detector. The Detector also must have facility for remote indication. The quiescent current flow must not exceed 50 milli amps. and alarm condition current shall be maximum 60 milli amps.

6.5 Alarm Hooters

Alarm hooters shall be suitable for indoor, or outdoor, application with the appropriate 4 x 4 in. electrical box. All hooters shall be 24 V DC operated. The minimum sound level shall be 90 db at 10 feet. Hooters shall be surface semi-flush mounted.

6.6 Monitor Module

- i. The monitor module shall provide an addressable input for N.O. or N.C. contact devices such as manual stations, waterflow switches, sprinkler supervisory devices, etc.

- ii. It shall provide a supervised initiating circuit. An open-circuit fault shall be annunciated at the Fire Alarm panel (Subsequent alarm shall be reported.)
- iii. The device shall contain an LED which blinks upon being scanned by the Fire Alarm panel. Upon determination of an alarm condition of an alarm condition, the LED shall be latched on.

6.7 ADDRESSABLE CONTROL MODULE

- a) Addressable Control Module shall be provided to operate dry contacts for switching ON OFF Pressurisation fans, AHU' s etc. in case of fire etc.
- b) It shall have a built in type identification to automatically identify this device to the control panel.
- c) It shall have internal circuitry & relay powered directly by two-wire loop.

6.8 Fault Isolator Device

- i. The Fault Isolator Device shall detect and isolate a short-circuited segment of a fault-tolerant loop.
- ii. The device shall automatically determine a return to normal condition of the loop and restore the isolated segment.

The fault isolator device shall be placed every [20] devices to limit the number lost in the event of a short-circuit.

7 FIRE ALARM PANEL

Fire Alarm panel shall be provided with 80 character backlit Liquid Crystal Display (LCD) Annunciator, function key pad, and printer as specified below. Necessary software and hardware shall be furnished at the location shown on the drawings.

7.1 Automatic Functions

The alarm shall be displayed at the FP on an LCD display. The FP printer shall print out the same information displayed on the LCD display.

7.2 Manual Functions

At any time, the operator shall have the following manual capabilities at the FP by means of switches located behind a key locked cover:

- a) Initiate an alarm summary display on the FP LCD display. This display shall step through all currently active alarm in the system.

- b) Initiate a summary printout of all currently active alarms on the FP printer.
- c) Initiate an "all point summary" printout on the FP printer recording the status of each system point (initiating circuits, indicating circuits, etc.)

At any time the operator shall have the following manual capabilities at the FP under password control. Operator privileges and ID numbers of up to four digits shall be assignable only by the main operator or designated alternate. Actions taken by operators shall automatically be printed on the FP printer with operator initials, time and date.

- d) Command output points to different mode. Such commands shall be printed with selected descriptors

ON/OFF, ON/OFF/AUTO, OPEN/CLOSE, DAY/NIGHT, etc.

- e) Modify system parameters. Full alphanumeric key pad shall be provided for operators to modify the following parameters:-

change sensor alarm and prealarm thresholds

update date and time

change point descriptions

change action messages

- f) Select a system status report for printing on the FP printer. 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.

- g. Select printing of a trend log which, when enabled, shall print the last 24 analog values for every addressable analog sensor taken at predetermined intervals selected by operator. Systems which limit the number of addressable analog sensors which can be trended are not acceptable.
- h. Select a sequence of preprogrammed commands which shall be automatically executed, in sequence, via a single command. Provide a minimum of 255 commands which can be divide among a minimum of seven sequences.
- f. Perform a walktest function such that a single operator can periodically check out all initiating devices on a loop. In walktest mode all initiators on the selected loop shall automatically be isolated. As each device is placed into an alarm or trouble condition the FP shall print the condition and automatically reset the device. No audible signals shall be initiated from the loop to prevent disruption of building occupants. If a loop is inadvertently left in the walktest mode it shall automatically reset to normal after a five minute idle time is exceeded.

7.3 System Supervision

- a) In the normal supervisory condition, only the green "POWER" LED, and green "RUN" LED 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 same. Following restoration to 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. 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 reset. The FP printer shall record this action.

The FP shall contain an integral backlit LCD display of two lines of 40 characters each, and a 40 character width printer. Both display and printer shall be viewable through the FP door.

7.4. Programming

The LCD display and printer programming shall be accomplished on-site by means of a lap-top personal computer which shall plug into the FP. Modules requiring off-site programming are not acceptable. Programming functions shall include alarm/trouble

type assignment, point descriptor assignment, etc. Data file for the LCD display and printer shall be stored in EEPROM.

7.5 Networking

An additional output drive card must be provided to facilitate networking between two or more panels.

8. Approval of Fire Detection and Alarm System

The Contractor has to get the drawings for Fire Detection and Alarm System approved from the local fire authorities. On completion of the work, the Contractor has get the installation approved and obtain a certificate from the local fire authorities and handover the same to the Construction Manager. The contractor shall be responsible for obtaining the required approval from Tariff advisory committee and other statutory authorities.

9. Testing & Commissioning

9.1 PHOTOTHERMAL SMOKE AND HEAT DETECTOR :

9.1.1 The testing shall be carried out for each loop initially with one detector in a loop and subsequently two or more disassociated detectors in each loop with time gap between the detectors for alarm acknowledge and Reset.

9.1.2. An identified smoke detector will be subjected to smoke aspiration from burning paper or cigarette puffs, held at 0.3 m distance from the detector. The panel should indicate through piezo sounder and hooter that alarm signal has been transmitted throughout the system. This test shall be carried out in different loops as well as two loops simultaneously. This part of the detector test shall be repeated again after 24 hours gap.

9.1.3 The same test in the same sequence shall be carried out for heat detector but with the application of heat from a hair dryer-held at approximately 60 cm distance. Repeat testing of the same detector shall be carried out at 24 hours interval.

9.2 Combined Test :-

9.2.1 The panel shall be checked for basic tests, such as, visual checking of input voltage and amperage. All loops one by one, shall be D-wired to check for fault signal indication in the panel.

9.2.2 Subsequently, in every loop of panel, a detector shall be subjected to smoke or heat test and signals shall be checked on the panel

9.3.1 The hooter shall sound automatically and the piezo sounders shall also sound. It shall also be possible to check that the hooters of all panels sound automatically when the panels are auto moded.

9.3.2 The power source shall be cut off and checked for standby supply from the batteries. After six hours the power source shall be switched on to check for auto switch over to mains mode. The trickle charger shall take over the charging of the battery to its maximum cut off level with auto cut off. A set of discharged batteries shall be connected to the panel in place of the new batteries and the trickle/boost switch checked for charging of the batteries.

9.3.2 Tests shall be conducted for AC failure, charger failure, battery disconnected or battery failure. In all such cases the relevant indication should come and the sounder shall also sound alarm.

9.4 Manual Call Box :

The manual call box glass shall be removed by unscrewing the back. The micro switch shall instantaneously give a fire signal in the pa

9.5 Random Sample Testing :

About 5% of all fire alarm components shall be subjected to random testing by connecting to the panels. All smoke detectors shall be tested as given above and later cleaned with a vacuum cleaner. Hooters shall also be tested through direct 24V supply. It shall be tested for 10 minutes.

9.6 Testing of Earthing system:

The earth continuity conductor including metallic parts of the equipments shall be tested for earth to electrical continuity. All tests shall be carried out as per IS 3043 and resistance of complete installation shall not be more than one ohm.

9.7 COMMISSIONING AND ACCEPTANCE TESTS

The commissioning and acceptance tests shall be apart from the standard or routine tests prescribed and normally conducted by the manufacturer and will be irrespective of the fact whether the same are covered by such tests or not.

Each sounder circuit shall be energised separately and the sound level reading taken to check for conformity with the minimum standards.

- b. Mains failure performance
- c. Battery disconnection test.
- d. Open circuit of each sounder circuit to be tested.
- e. Short circuit of each sounder circuit to be tested.
- f. The results of the above tests either by fault warning or fire alarm shall be recorded in the log books which will be signed both by the Consultant and Engineer in charge.

Contractor shall preserve the copies of invoices, test certificates, gate passes etc to prove the genuineness of material/purchases. The responsibility of procurement, genuine material of specialized works shall rest with the contractor.

No inspection out side the country is permissible if required so the same will be deemed to be waived off and necessary test reports shall be submitted before the dispatch of equipment.

Approved makes for Fire alarm system:

S.N	Item	Makes
1.	Addressable multi sensing fire detector (Combination of optical type smoke detector and ROR type head detector	Notifier / Johnson control/ Honeywell / Siemens / Bosch
2.	Analog Addressable Type Multimedia Detector with Dual LED	EDWARD, NOTIFIER, APPOLO, HONEYWELL, SYSTEM SENSOR,
3.	Duct Detector Housing	EDWARD, NOTIFIER, APPOLO, HONEYWELL, SYSTEM SENSOR,
4.	Addressable type fault Isolator	Johnson Control / Honeywell / Siemens / Bosch / ETS (Edward)
5.	Response Indicators	Agni devices / Apollo / System sensor / Electro quip
6.	Intelligent Analog Addressable Type Control/Output Modules	EDWARD, NOTIFIER, APPOLO, HONEYWELL, SYSTEM SENSOR,
7.	Intelligent Analog Addressable Type	EDWARD, NOTIFIER, APPOLO,

	Monitor Modules	HONEYWELL, SYSTEM SENSOR,
8.	Analog Addressable type Active Repeater Fire Alarm panel with Backlit LCD Display	EDWARD, NOTIFIER, APPOLO, HONEYWELL, SYSTEM SENSOR,
9.	Fire alarm control panel	Notifier / Johnson Control/ Honeywell / Siemens / Bosch
10.	Exit Point Directional Sounder with minimum 4 district Sound patterns	GST, EDWARD, NOTIFIER, APPOLO, HONEYWELL (Morley), SYSTEM SENSOR, JOHNSON CONTROL, BOSCH
11.	Addressable Manual Call box	Notifier / Johnson/ Control / Honeywell / Siemens / Bosch
12.	Addressable control Modules for hooter	Notifier / Johnson Control/ Honeywell / Siemens / Bosch
13.	Addressable monitor module for flow switch	Notifier / Johnson Control/ Honeywell / Siemens / Bosch
14.	Exit Signs	PROLITE, LEGRAND, VOICE, SELFGL0
15.	Copper conductor pvc insulated FRLS wire	KEI/UNIVERSAL/NICOO/R.R.KABLE/FIN OLEX/LAPP KABLE/ LK(L&T)/HAVELLS/ PARAMOUNT/ PLAZA/SKYTONE.
16.	Armoured copper conductor cable	POLYCAB/FINOLEX/LK(L&T)/NICCO/KEI/ GRANDLAY/PLAZA/GLOSTER/UNIVERSA L/HAVELLS/PARAMOUNT.
17.	PA SPEAKERS	BOSCH, AHUJA, ATEIS, AKG
18.	AMPLIFIERS	BOSCH, AHUJA, ATEIS, AKG
19.	CD PLAYERS	SAMSUNG, PHILIPS,ATEIS,AKG
20.	RG6, RG11	D LINK, BELDEN, SKYTONE, BONTON, FINOLEX
21.	Conventional System	EDWARD, NOTIFIER, APPOLO, HONEYWELL(Morley), SYSTEM SENSOR, Daksh

22.	Any Other Item	As per approval of Engineer-in-charge.

LIFTS

Special Condition for Comprehensive & Maintenance

Provision of maintenance service by the contractor comprehensive maintenance for five years.

The contractor shall perform the maintenance services as agreed to in the contract and in these general terms and conditions. In performing the said services, the contractor shall take all reasonable steps to maintain the equipment in proper operating condition. The contractor shall use trained and appropriately supervised personnel to perform the maintenance services shall be conducted during the normal working hours, shall send at regular intervals and as frequently as the company thinks necessary, having regards to the age, the nature and condition of the elevator (but not less than----- times per annum), a technician to systematically inspect, adjust and lubricant the parts of the elevator to the extent necessary to maintain the elevator in satisfactory working order. If not separately agreed, any work conducted outside the normal working hours is not included in the price and shall be invoiced separately. The contractor will supply all lubricants (made as per standards of the contractor). Necessary for this purpose.

Upon notification by the costumer of a breakdown or failure in the elevator, the contractor shall send as soon as may reasonably be possible the during the contractors normal working hours a technician to carry out necessary repairs in order to restore the elevator to satisfactory working condition.

The contractor will carry out according to its standards customary annual safety test to examine all safety devices the contractor will not be required to make any other tests. The contractor will neither be required to install new attachments' nor to make replacements with parts of a defective design to the elevator whether or not recommended or directed by Insurance companies or by governmental or non governmental authorities.

In performing the services, the contractor will replace (identical or equivalent item) or rectify at its option any components of the elevator rendered defective due to normal wear and tear and arising out of ordinary and reasonable use of the elevator except for such items and conditions which are excluded hereunder as particular and general exclusions. The parts which are replaced shall become the contractor's property.

The contractor reserves the right to keep the control cubicle locked.

The equipment under contract will remain out of commissioning while the maintenance process is being carried out. No one will be allowed to use the equipment during this period.

TECHINICAL SPECIFICATION FOR ELEVATORS/LIFTS

1. Electric Supply

The available system of electric supply is 415 volts between phases and 230 volts between neutral & phase and neutral – 3 phase 4 wire AC 50 Hz system suitable for operation at $\pm 10\%$ of rated supply voltage. In addition for illumination and control power required for elevators and equipment shall be indicated in the tender. Power shall be provided at one point in each Machine Room at a point to be indicated by the Contractor. All subsequent electrical systems shall be the responsibility of the Contractor.

1.2 Technical Particulars

The technical particulars of the Elevators are detailed in the enclosed schedule. The schedule indicates the capacity, travel, speed, number of openings, machine room and hoist way sizes etc. Should any further information required by the Contractor the same can be obtained from the offices of the Consultants.

1.3 Driving Mechanism

1.3.1 Elevator Machine

The Elevator machine shall be suitable for 415 volts 3 phase 50 Hz AC supply with a voltage variation of $\pm 10\%$ and shall be placed directly above the hoist way upon the machine room floor slab and steel beam furnished in place by the Contractor.

The machine shall have a high efficiency and low power consumption and shall be designed to withstand the peak currents in lift duties. Anti vibration rubber pads of adequate thickness shall be used below the machine to reduce the noise and vibrations.

The elevator machine shall be worm gearless reduction type and shall consist of a motor, electromechanical brake worm gear, sheave shaft and sheave all completely mounted on a common bed plate. The worm shall be provided with ball bearings to take the end thrust and roller bearings shall be provided for the sheave shaft to ensure alignment and long bearing life. The hard alloy cast iron or steel sheave shall have rope grooves to ensure proper traction and minimum rope wear. Adequate means of lubrication shall be provided for all bearings and worm gear.

Means for manual operation of the lift car shall be made by providing winding wheel suitably marked to indicate the direction of the movement to enable the lift car to be

brought to the nearest landing. There shall be a warning display for switching off electrical supply before the manual operations.

1.3.2 Brake

The electromagnetic brake shall be spring applied and electrically released. It shall come into action after the lift has come to a complete halt to hold the car in position. The brake shall operate automatically with the safety devices and release the brake manually such release requiring the action of manual force to move the lift in short stops.

1.3.3 AC Motor

The AC self lubricating motor shall be suitable for elevator use with high starting torque and low starting current. Thermostats shall be embedded in the stator winding to indicate the temperature rise in the motor. The AC motor shall have class F insulation and suitable for 210 starts per hour with a maximum temperature rise of 50°C over the ambient.

1.4 Controls

The Elevators control shall be AC variable voltage variable frequency (A.C.V.V.V.F). The system shall control the starting, stopping direction of motion, running of the lift motor and application of the brake and/or safety devices in the event of power failure or any other emergency. It shall be so designed as to ensure a smooth and constant acceleration and retardation under all opening conditions.

The contractor shall be wall/floor mounted, vertical totally enclosed cubicle type with hinged doors on the front and the rear to provide easy access to all components in the controller. The cubicle shall be well ventilated such that the temperature inside never exceeds the safe limits of the components at ambient room conditions in the machine room.

The controller shall operate within the supply voltage variation of plus 10% to minus 20% of the nominal voltage.

- a) Over current
- b) Under voltage
- c) Over voltage
- d) Single phasing
- e) Phase reversal

The controller shall be designed to cut off the power supply, apply the brake and bring the car to a rest in the event of any of the above failures occurring.

The Contractor must state clearly the forms of protection provide for each equipment.

If any devices of the electro mechanical type are used the same shall be equipped with arc chutes to prolong the life of contacts. Contractors must stipulate the type of devices used and the material of the contacts.

Contractors must support such offers with complete details of experience, number of lifts installed and operational in India, collaboration for equipment design and manufacture etc.

1.5 Hoist Ropes

Round standard steel wire ropes as per Indian standards shall be used for Lift suspension. The number and size of the hoist way ropes shall be so selected to ensure proper factor of safety minimum 10 and adequate traction for the elevator. The governor ropes shall also be wire ropes.

The Hoist way landing door shall be provided with an interlock such that:

- a) It shall not be possible for the car to be started or kept in motion until all the landing doors and the car door are locked in the closed position.
- b) It shall not be possible to open the landing door from the landing unless the Lift car is within the particular landing zone.
- c) The car doors & Hoist way landing doors open automatically as the car is stopping at a landing. The closing of the car and landing door must occur before the car is set in motion.

1.6 Car Platform

The car platform shall be of framed construction and designed on the basis of rated load.

1.7 Car Enclosure

The elevator car enclosure shall be as per parameters enclosed in the schedule of quantities. The ceiling shall have an arrangement for a cabin fan mounted on the roof of the car. Indirect fluorescent lighting shall be provided to evenly illuminate the car. The car enclosure shall pre-laminated particle board 12 mm thick to wall and ceiling in desired shade and grooves covered with teakwood beading of desired shape with floor 5mm thick steel chequered plate.

Car Design:

Car walls finish stainless steel, front and doors in stainless steel, mirror on rear car panel, Dimpled anti skid vinyl flooring

Car operating Panel:

Stylish brushed SS finish car operating panel, visual call confirmation, dot matrix display, car position indicator

Landing doors:

fully automatic landing doors in powder coated finish

1.8 Car Door

The car entrance for the elevators shall be protected by Steel collapsible gate duly painted and providing car and landing doors with horizontal biparting as per IS14665

1.9 Hoist way Landing Doors

For the hoist way doors at each landing, two mild steel painted panels centre opening horizontal sliding doors shall be provided to give a clear opening as indicated in the technical parameters. These shall be duly painted to the shade approved by the institute and suit to the site condition.

1.10 Car and Hoist way Operations

The car and hoist way doors shall be mechanically connected such that both move simultaneously for opening and closing. The hoist way landing door shall be provided with and interlock such that.

It shall not be possible for the car to be started or kept in motion until all the landing doors and the card door are locked in the closed position.

It shall not be possible to open the landing door from the landing unless the lift car is within the particular landing zone.

The car doors and hoist way landing doors open automatically as the car is stopping at a landing. The closing of the car and landing door must occur before the car is set in motion.

2. 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 steel with moulded nylon collar and shall include shielded ball bearings. Tracks shall be of suitable steel section with smooth surface. The landing doors shall be complete with headers, sills, frames etc as reqd.

2.1 Cabin Fan

A noiseless cabin fan shall be include for all elevators.

2.2 Emergency Light

An emergency light unit using sealed maintenance free battery power pack and flourescent lamp to operate automatically in case of power failure shall be provided in each elevator car.

2.3 Alarm Bell

An emergency alarm bell including wiring shall be provided and connected to plainly marked push button in the car operating panel. The alarm shall be provided in the Ground floor lobby if required, The Owner may at his own cost extend the alarm bell to the security/control room.

The alarm unit shall be solid state siren type operated by 2 nos. 9 volts dry batteries to give a waxing and warning siren when the alarm button in the car is pressed momentarily.

2.4 Operation Buttons

The following operation buttons shall be provided

2.5 In Each Lift Car

Stainless steel return panels of suitable thickness shall be provided on each side of the door with the following flush mounted controls on one side:-

- a) Illuminated type push buttons corresponding to the floors served. Floor nos. on push buttons shall be numbered from 1 to onward.
- b) Door open button
- c) Emergency stop button
- d) Emergency call button connected to a bell for an emergency signal
- e) Two position key operated switch for 'with attendant' and 'without attendant' operation
- f) Ventilation fan ON/OFF switch
- g) Built in intercom of the pick and speak type

- h) UP/DOWN direction display

2.6 At Landing

Illuminated type 'UP' and 'DOWN' push buttons at each intermediate landings and single illuminated type push buttons at terminal floors. The push buttons shall illuminated when the same is pressed to indicate that the call has been registered. The button shall remain illuminated until the call is answered.

One set of calling buttons shall be provided for a bank of two elevators

2.7 Indications

2.7.1 In Each Car

The following indications shall be provided in the cars:

- a) Digital car position indicator provided above door to indicate the landing at which the car is stopped or passing.
- b) Illuminate "UP" and "DOWN" arrows on the position indicator above door to indicate direction of travel.

2.17.2 At all landings

Combined hall position indicator and hall lanterns is not part of the offer. This feature is generally a standard part of the equipment for Duplex Lifts i.e. two Lifts in the same control.

2.17.3 Safety Devices

The following safety devices shall be provided:

2.17.4 Self Leveling

The Lift shall be provided with a +/- 5mm self leveling accuracy feature of the two way automatic type. The self leveling device should automatically correct for under run, over run and rope stretch.

2.17.5 Terminal & Final Limits

Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings and final limit switches shall be furnished to automatically cut off the power and apply the brake should the car travel beyond the terminal landings.

2.17.6 Terminal Buffers

Suitable spring buffers shall be used from existing Lift.

2.17.7 Interlocking

Adequate interlocking is to be provided so that the car shall not move if the landing doors are even partially open.

2.17.8 Car Safety and Governor

The car safety shall be provided to stop the car whenever excessive descending speed is attained. The safety will be operated by a centrifugal governor located at

the top of the hoistway and connected to the governor through a continuous steel rope. Suitable means shall be supplied to cut off power from the motor and apply the break on application of the safety.

2.17.8 Fireman Switch

Each elevator shall have a fireman switch glass front for access by the fireman. The operation of this switch shall cancel all calls to this Lift and will stop at the next nearest landing if traveling upwards. The doors will not open at this landing and the Lift will return to the ground floor. In case the elevator is traveling downwards when the fireman's switch is operated it will go straight to the ground floor by passing all calls enroute. The emergency stop button inside the car shall be rendered inoperative.

3. Gearless machine:

The gearless machine shall consist of a motor, traction sheave and break-drum or brake disc completely aligned on a single shaft. Gearless machine shall be A.C. gearless with VVVF drive.

4. Hand winding wheel or handle:

At times of lift stoppage due to any reasons, it shall be possible to move the lift car to the nearest landing manually. The manual operation shall be by means of winding. Wheel or handle mounted on the end of the motor shaft. The up or down direction of the movement of the car should be clearly marked on the motor or at suitable location. A warning plate written in bold signal red colour advising the maintenance staff to switch off the mains supply before releasing the break and operating the wheel is to be prominently displayed.

5. Inter- communication system:

Recommends for provision of either an emergency or a telephone inside the car but as a general experience it is seen that over a period of time these devices become inoperative due to one reason or the other. Therefore, in order to have at least one device of communication functioning at all the times, as an alternative arrangement, provision of both i.e. telephone with minimum two connections-one at the operator's room and other at guard room and the emergency signal with re-chargeable batteries as source of supply shall be made in the lift cars.

The device used for emergency signals should incorporate a feature that gives immediate feed-back to the car passengers that the device has worked properly and the signal has been passed on to the intended agency. This shall be achieved by pressing of button from control room which shall give audio signal to the passengers in the car.

6. Emergency Power Supply for lift car:

This shall include suitable secondary battery with trickle/boost charge arrangement and inverter power pack with necessary contactors for supplying the light fixtures in the lift car. The same battery shall also feed the alarm bell and communication equipment.

7. Car landings:

All the lift car landing shall be well lit to an illumination level of 150 lux and shall be free from obstructions. The control for landing lights and the sign lights shall be tamper proof. Wherever stand by power supply is available, these lights shall be connected to standby circuits also.

8. Instructions:

Detailed instructions as specified for guidance of passengers shall be prominently displayed inside the car by contractor and outside the car at all landings by the department. The Braille signage will be posted by the department outside lift lobby at all landings for the lift meant for barrier free requirements as per Appendix VII.

9. Levelling:

All lift (s) shall be incorporated with suitable floor leveling devices. In case of lifts with automatic power operated doors and with A.C. VVVF controller a separate level device for automatic leveling with leveling accuracy of $\pm 5\text{mm}$ shall be incorporated.

10. Counter Weight Guards:

Guards of wire metal/ mesh shall be provided in the lift pit to a suitable height above the pit floor to eliminate the possibility of injuries to the maintenance personnel.

11. Guide shoes:

Two numbers of guide shoes at the top and two numbers at the bottom shall be provided on the lift car and counter-weight.

12. Type of shoes:

For passenger lifts and bed-cum-passenger lifts

i. For speed upto 1.5 mps sliding guide shoes shall be used. Sliding guide shoes

For car shall be always flexible and for counterweight solid guide shoes can be

Used upto 1.0 mps.

- ii. For speeds more than 1.5 mps roller guide shoes shall be used for car and Counter weight.

13. Rope fastenings:

The ends of lift ropes shall be properly secured to the car and counter weight hitch plates as the case may be with adjustable rope shackles having individual tapers babbitt sockets, or any other suitable arrangement. Each lift rope shackle shall be fitted with a suitable shackle spring, seat washer, shackle nut & shackle nut split pin.

14. Guards for lift ropes:

Where lift ropes run round a sheave or sheaves on the car and/ or counterweight of gearless machine suitable guards shall be provided to prevent injury to maintenance personnel.

15. Number & size of ropes:

The contractor must indicate the number and size of lift ropes and governor ropes proposed to be used, their origin, type, ultimate strength and factor of safety. The contractor should furnish certificate of ropes from the rope from the rope manufacturers issued by competent authority.

16. Safety Equipments:

Every lift installation shall necessarily be provided with the following safety features:

The safety gear shall be provided in accordance with IS (part-4-Sec.4):2001, each type of car safety shall be actuated by a speed governor.

17. Governor:

The car safety shall be operated by speed governor located overhead and driven by governor rope suitable connected to the car and mounted on its own pulleys. The rope shall be maintained in tension by means of weighted or spring loaded tension sheaves located in the pit. Governor shall be provided for lifts with a travel of more than 5.5 meters. The governor rope shall be not less than 6mm in dia and shall be made of steel or phosphorbronze. These shall be in accordance with IS 14665 (part 4/sec-4):2001. Governor for car safety gears shall be adjusted to actuate the safety gear at the following speeds: -

- i. For rated speeds upto 1m/s maximum governor tripping speed shall be either 140 percent of rated speed or 0.88 m/s, whichever is higher. For rated speed above 1m/s maximum governor tripping speed shall be 115 per cent of the rated speed plus 0.25 m/s.
 - ii. Minimum governor tripping speed shall be 115 per cent of the rated speed.
18. The governor shall be of "V" groove wheel design and only wheel is stopped to actuate the car safety upon a pre-determined over speed downward without damaging the rope.
 19. The governor, rope and sheave shall be so located so as to minimize danger of accidental injury to the equipment.
 20. The governor sheave and tension sheave shall be according to clause 2.4 and the sheave bearing shall be according to clause 2.7 of this chapter.
 21. The requirements for field tests on car safety and governor and for drop tests to sliding type safety shall be as specified in section IV of this specifications.

22. Buffers –

Buffers shall be oil resistant rubber pad type for speeds upto 0.25 mps and spring/ oil type for speeds upto 1.5 mps and only oil type for speeds higher than 1.5 mps.

Buffers shall be suitable for installation in the space available. Buffers anchorage at pit floors shall be installed avoiding puncturing of water proofing.

Oil buffers of the car and counter weight shall be of the spring return type of gravity type.

The partial compression of spring return oil buffers when the car is in level with terminal landing will not be acceptable.

All buffers shall be tested at manufacturer's works and a copy of the test report shall be submitted.

When the lift car rests on fully compressed buffers there shall be at least 60 cms clearance between the lowest point in its car frame and any obstruction in the pit exclusive of buffers and their supports. Similarly when the lift car cross head is 60cm from the nearest obstruction above it, no projection on the car shall strike any part of overhead structure.

The contractor must indicate the name of buffer manufacturers, buffer stroke & certified maximum loads.

23. Door Locks:

Electro-mechanical door lock shall be provided for all the landing doors and they shall be such that the doors cannot open unless the car is at rest at the particular landing. It shall not be possible to move the car unless all the landing doors and the car door are closed and locked. This requirement however does not apply when the lift car is provided with automatic leveling devices and in such cases, it shall be permitted to move the car with both the doors open in the leveling zone for the purpose of leveling.

24. Automatic- cum-attendant operation:

i. Single automatic Push Button with/ without attendant – The operating devices for this operation shall incorporate in the car control panel, car buttons corresponding to the various landings served and single landing button at each landing, all electrically connected to controller governing floor selection, direction of travel, acceleration, retardation etc.

This system shall be so arranged that when the car is not in use, on pressing a landing call button the car shall start automatically provided all the doors are closed. During the movement of the car and also when car tops at floor landing, other landing call buttons are in-operative for a predetermined time. The pressing of a car button shall automatically start the car and sent it to the desired landing. In all the cases, the starting of the car is contingent on the establishment of landing door and car inter-lock circuits. To indicate the availability, or 'in use' light shall be place in the landing call button panel. When light shall be 'OFF' the passenger shall be able to call the car. In case of manual operated door if the lift is standing at any landing with doors open (when not in use), the pressing of the landing call button shall ring a bell, fitted at the top of car to attract the attention of the people soliciting their help for closing the lift door if any one of the them happens to be near the lift incase of power operated doors, the landing and car doors shall be arranged to open automatically when the car is parked at landing after all the calls are served and the lift is parked at any landing. The doors can remain open or alternatively if desired, the car shall be arranged to close after a pre-determined time unless closing is prevented or interpreted by the car doors re-opening device or the door open button.

The lift shall be suitable for dual operation with or without attendant by the provision of key operated transfer switch indicating 'attendant' and 'automatic' positions. During 'attendant' operations the landing call shall be disconnected from the control system and shall be connected to an annunciator in the lift car. The attendant shall

then operate the car to answer the registered calls. This operation is recommended for single speed control lift for low rising building having a single lift installation.

25. Simplex Selective-Collective operation with/ without attendant:

Automatic operation by means of one button in the car for each landing level served and by up and down buttons at the landings, wherein all stops registered by the momentary actuation of the car made defined under non-selective Automatic Operation but where in the stops registered by the momentary actuation of the landing buttons are made in the order in which the landing are reached in each direction of travel (irrespective of the sequence in which the buttons have been actuated). With this type of operation, all 'up' landing calls are answered when the car is traveling in the up direction and all 'down' landing calls are answered when the car is traveling in the down direction, except in the case of the uppermost or lowermost calls which are answered as soon as they are reached in-respective if the direction of travel of the car.

26. Duplex Collective Selective Operation with/ without attendant:

The control system for this operation shall be similar to the one described under simplex selective-collective operation except that in this system there shall be tow lift car adjacent wells. It shall be arranged to co-ordinate both cars for efficient service and prevent them from answering the same calls by the provision of only one set of landing call button fixtures. It shall automatically assign each call to the car that will be in the best position to answer promptly. The system shall be so arranged that when the cars are idle, normally one car will be parked at the lower main landing with its doors closed or open and the other car shall be free car parked with the doors closed or open to the landing where it answered its last call, and shall be the one to attend to the nearest call.

Each car shall always respond to calls registered by its own car call buttons. When either car is parked out of service for any reasons the other car shall function as single car (simplex) selective collective. Besides the control system shall also arranged for independent service from inside the car.

A by-pass button (non-stop button) shall also be provided inside the car to enable the attendant to by-pass any landing if the car is full or if otherwise so required.

The two lifts shall be arranged with or without attendant operation and shall function as described using single car selective-collective operation. When the transfer switch is in the attendant position the operation of the cars shall be identical with that described for automatic operations except that:

- i. Closing of doors and starting of cars shall be initiated by the car buttons only.
- ii. Buzzers and directional lights in the car are operative, and
- iii. Landing by-pass shall be effective.

The pressing of an up or down landing call shall illuminate appropriate direction indicator in the car panel, which is to answer that call and if the doors are open shall also sound buzzers as a signal to the attendant. If both cars are parked at the lower landing the above signals shall be given to the car which has been at the floor for longest time.

27. Automatic selection of traffic programme:

The group supervisory control continuously examines traffic conditions in the building and automatically puts into operation the programme which can best cope with the demand at any particular time. This is fully automatic and requires no supervision or attendant. To suit the traffic demand in the building, suitable traffic programmes can be selected for inclusion in this control.

28. Controlling Equipment:

The movement of the car shall be electrically controlled by means of a controller located in the machine room.

29. Control circuits:

The control circuit shall be designed to the type of lift specified for safety operation. It shall not be possible to start the car unless all the car and landing doors are fully closed and landing doors locked. The circuit shall have an independent fuse protection for fault and over loads and be arranged so that earth fault or an open circuit shall not create unsafe condition. The circuit shall be so arranged that for the stoppage of the car at specified landing or for actuation of a contactor by emergency switches or operation of safety gears the system shall not depend upon the completion or maintenance of an electrical circuit to cut off power supply and apply the brakes. This requirement is not applicable to dynamic braking and speed control devices.

30. Terminal Boards:

All wiring for external control circuits shall be brought to a terminal board with means of identification of each wire. Metallic/plastic identification tags shall invariably be provided. All connections of wires to terminal boards shall be adequately clamped or screwed.

31. Auxiliary Switches:

i. Emergency stop switches:

On top of the lift car an emergency stop switch shall be provided for use by maintenance personnel. Stop switch shall be provided in the machine room. Operation of these switches/ buttons shall cancel all the registered calls and landing calls for that particular lift.

ii. Maintenance switch on top of the car

For purpose of inspection and maintenance, maintenance switch shall be provided on top of the car. The control circuitry shall be so arranged that in the event of the operation of this switch:

- a. The car speed shall be less than the rated speed not exceeding 0.85 meters/sec.
- b. The car movement shall be possible only on the application of the continuous pressure on a button. It shall be so mounted to prevent any inadvertent operation.

iii. Fireman Switch:

Fireman switch with glass to break for access shall be provided at ground or main floor for all the lifts. The operation of this switch shall isolate/ or cancel all calls to all the lifts and the lifts will stop at the next nearest landing if traveling upward. The doors will not open at this landing and the lifts will start traveling to ground floor. If these were already traveling down, they will go straight to ground floor direct without stopping enroute.

iv. Inspection facility:

An inspector's change over switch and set of test buttons shall be provided in the controller. Operation of the inspector's change over switch shall make both the car and landing buttons inoperative and permit the lift to be worked in either direction from machine room for test purposes by pressing corresponding test buttons in the controller. It shall not however interfere with the emergency stop switches inside the car or on the top of the car.

v. Safety line indicators:

If specified visual tell tale lights may be provided to monitor the conditions of faults in the safety line of the lift for easier fault finding. These indicators will remain lit when safety circuits are normal.

One indicator shall be provided for each safety on the controller. If any indicators fail to light up as the lift proceeds in its sequence of operation, there shall be visual indication of the safety line open circuit and also its location for easier fault finding.

32. Control Wiring:

i. Wiring in machine room:

Power wiring between the controller and main board controller to various landings shall be done in heavy gauge conduit or metal duct & shall conform to I.E. Rules 1956 and CPWD Specifications for electrical works. Following general principles shall be followed in wiring:

- a. i) Control cables carrying DC and power cable carrying AC shall not be run in the same conduit or metal duct and they shall be laid as per I.E. rules.
ii) Metal duct with removable inspection cover shall be preferred.

iii) in case of control cables also the harness shall be separate as far as feasible for separate functions and laid separately in suitably dimensioned metal duct or in a separate conduit such as the signaling, locking, lamp indication and safeties. Control cables for different voltages in the lift installation works should be laid as per IE. Rules.
- b. At least 5 percent with a minimum of 5 unconnected spare wires shall be available out of all the lines to be provided in the wiring harness from the midway junction box to the machine room.
- c. There shall be a master isolating switch Fuse associated with the controller heavy duty load break, quick make quick break type TP&N preferably interlocked with controller cabinet door. Isolator handle shall have provision for external locking in off position.
All relays shall be suitable for lift service and shall incorporate adequate Contact wipe for reliable operation. Relays shall operate satisfactorily between 80 percent to 110 percent of their voltage.

Main motor contactors shall be suitable for A.C. duty. Tenderer shall be required to furnish full details of make, type, applicable standard, voltage and current rating, duty class, type and routine tests done etc., on contactors and relays. Copies of type test certificates and other test certificates shall also be furnished by the successful tenderer.

All cables shall be with copper conductors and flame retardant or PVC insulated of appropriate size. The cables feeding motor and in heavy current flow paths shall be

so selected that the size matches the protecting fuses and will not result in more than 2 percent voltage drop from the main board to the terminals of motor. Control cables shall not be less than 0.5 sq. mm. or equivalent if stranded; where installation of heavy gauge conduits present difficulties, short lengths of flexible conduits will be permitted but effective electrical continuity and earth bonding shall be ensured. Ferrules shall be slipped at the ends of all cables as per standard control wiring practice. All terminal blocks shall be suitably marked.

33. Trailing Cables:

A single trailing cable for lighting control and signal circuit is permitted, if all the conductors of this trailing cable are insulated for maximum voltage running through any one conductor of

this cable. The lengths of the cables shall be adequate to prevent any strain due to movement of the car. All cables shall be properly tagged by metallic/plastic tags for identification.

Trailing cables shall run from a junction box on the top of the car to a junction box located in the shaft near mid point of travel and from these junction boxes conductors shall be run to the various locations

Trailing cables exceeding 30 meters in length shall run so that the strain on individual cable conductors will be reduced to a minimum and the cables are free from contact with the car counterweight, shaft walls or other equipment.

Trailing cables exceeding 30 meters in length shall have steel supporting fillers and shall be suspended directly by them without rubbing over other supports.

Cables less than 30 meters in length shall have no – metallic fillers and shall be suspended by looping cables around supports of porcelain spools type or equivalent.

5 per cent of the total capacity subject to a minimum of 5 wires shall be available unutilized in the trailing cable everywhere suitably distributed between various functions.

34. Earthing:

Metal frames and all metal work of the lift controller frame etc., shall be earthed with double earth leads taken to the earth bar. Looping shall be permitted if such routing is feasible. All other individual metallic frame work of components etc., shall be loop earthed.

35. Lift Rope Compensation:

The lift rope compensation for lift travel shall be provided for lift travels beyond 40m in all cases.

36. Automatic Rescue Devices (ARD):

The automatic rescue devices (ARD) meant for the purpose of bringing the lift car to the nearest landing doors. Are being used selectively and is generally restricted to commercial buildings having heavy traffic. However, frequent power failures being the common phenomenon, the provision of ARD shall be made in all the lifts in public buildings. The ARD shall have the following specifications:

- i. ARD should move the elevator to the nearest landing in case of power failure during normal operation of elevator.
- ii. ARD should monitor the normal power supply in the main controller and shall activate rescue operation within 10 seconds of normal power supply failure. It should bring the elevator to the nearest floor at a slower speed than the normal run. While proceeding to the nearest floor the elevator will detect the zone and stop. After the operation is completed by the ARD the elevator is automatically switched over to normal operation as soon as normal power supply resumes.
- iii. In case the normal supply resumes during ARD in operation the elevator will continue to run in ARD mode until it reaches the nearest landing and the doors are fully opened. If normal power supply resumes when the elevator is at the landing. It will automatically be switched to normal power operation.
- iv. All the lift safeties shall remain active during the ARD mode of operation.
- v. The battery capacity should be adequate so as to operate the ARD at least seven times a day provided the duration between usages are at least 30 minutes.

LIST OF APPROVED MAKES

SL.NO.	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
1.	ELEVATORS	OTIS / KONE / SCHINDLER/MITSUBISHI/JOHNSON LIFTS PVT.LTD.

LIFT ADDITIONAL SPECIFICATION

List work item details and specification for items to be used in addition to CPWD specifications

1. SITC of MR Gearless lift having contract speed & serving different floors in the lift shaft as per detailed specifications enclosed and as under:

Built in special features:

- a. Automatic Rescue Device- ARD Automatically takes the lift to the nearest level in the case of a power interruption.
- b. VVVF Controller: This world leading technology comes standard in all Lifts. The Variable Voltage Variable Frequency (VVVF) control, ensures 50% energy savings. It also creates a super comfortable ride quality - when jerk- free starts and stops. Smooth acceleration and deceleration and no landing variations. Time after time. In the long run, this prevents wear and tear of components, which comes means less downtime and huge savings on spares.
- c. Stainless Steel Buttons: Sophisticated design - button flush with back plate. Orange LED illumination. Engraved numbers. Highly tamper resistant.
- d. Fireman Switch: To enable fire- service personnel to take over complete control over one or more lifts.
- e. VVVF Door Controller: Silken Smooth door movement. Advanced features like adjustable independent times for opening and closing. Slow -nudging features ideal for high traffic situations.
- f. Infra Red Screen Sensor: Curtain of 154 infra red beams to prevent accidental closing of the door.
- g. Infra Red Screen Sensor: Curtain of 154 infra red beams to prevent accidental closing of the door.
- h. Floor Height Car Fixture: Designed specially for high- rise buildings. With Press & Speak facility and overload indicator.
- i. Overload Indicator: When the lift is overloaded indicator light turns on and the alarm beeps.
- j. Door Frame: Only lifts come with elegant door frames in corrosion - resistance, pre-coated steel that gives strength as well as an enlarged appearance.

A. UPS SYSTEM

RATED POWER 10 KVA / 10 KW – Three Phase

1.0 ABBREVIATIONS

For the purpose of this document, we have used the following standard abbreviations:

UPS Uninterruptible Power Supply

IGBT Insulated Gate Bipolar Transistor

DSP Digital Signal Processor

THDU Total Harmonic Distortion Voltage Phase/Phase)

THDI Total Harmonic Distortion in Current

VFI Voltage and Frequency Independent

Output Voltage and frequency of the UPS independent from the input voltage and frequency thanks to the double conversion AC/DC & DC/ AC

AC Alternative Current

N Neutral Generic symbol used for neutral connection

VRLA Valve Regulated Lead Acid

AGM Absorbent Glass Mat

EMC Electro Magnetic Compatibility

IEC International Electrotechnical Commission

EC European Conformity

EN European Norms

PURPOSE OF THE SPECIFICATION DOCUMENT

This specification document describes the system of 10 KVA Double Conversion Uninterruptible Power Supply system(s) (hereafter referred to as UPS).

The system must provide high quality power to protect sensitive equipment which maximum power is 10 KVA / 10 KW. The system can be installed as single unit as standalone UPS or more than one units in parallel mode.

NORMATIVE CONFORMITY

The system must comply with the following UPS standards:

Safety	:	EN / IEC 62040-1.
EMC Emission	:	EN / IEC 62040-2
EMC Immunity	:	EN /IEC 62040-2

PRODUCTION SITE CERTIFICATION

The development and the production site must be certified according to ISO14001 (Environmental management system) and ISO 9001 (Quality management system).

GLOBAL DESCRIPTION OF A STATIC UNINTERRUPTIBLE POWER SUPPLY

Each UPS must include the following sub-assemblies:

UPS unit having Rectifier – Charger - Inverter

Battery Bank (External)

Automatic static by-pass

Maintenance manual by-pass built in the UPS

General characteristics

Environment

Operating temperature range : from 0°C up to + 40°C

Storage temperature range : from -20°C up to + 70°C

Altitude, without derating : ≤1000m,

Maximum relative humidity : 95 % at room temperature, without condensation

Each UPS module must comply with the following key technical specifications:

Apparent rated power	10 KVA
Active rated power (Pn)	10 KW
Type of network (input/output)	Three-phase / Single-phase
UPS classification	VFI - SS – 111

Rated input voltage	380 - 400 - 415 V
Rated input frequency	50 / 60 Hz
Rated output voltage	220-230-240 V
Rated output frequency	50 / 60 Hz
Acoustic pressure measured with a rated load and at a distance of 1 mtr	□ 55 dBA
Protection Index for UPS system	IP 20

Automatic system transfer on bypass (eg in case of downstream short-circuit) instantly reactivate the static switch of all the units to take advantage of the overall system capability.

The activation / inhibition of this management function must be available to the user through the display / keypad interface.

Rectifier

The UPS rectifier must be equipped with a isolator switch. The rectifier shall be with input phase sequence correction built-in so that UPS shall continue to work in mains mode during phase sequence reversal condition and it shall not go to battery mode.

Rectifier technology	Fully IGBT
Rated voltage	380 / 400 / 415 V - 3 ph
Voltage tolerance (without the use of batteries)	400V +/-15 %
Frequency range	45 - 65 Hz
Input power factor at full load (without additional filters)	≥ 0.99
Input Harmonic distortion (THDi) at full load (without additional filters)	□ 4%

Battery management

The UPS will be capable of charging the battery in sustained floating mode and will automatically switch to intermittent charging mode if necessary. The temperature threshold for switching from one mode to the other will be configurable.

Battery bank monitoring system shall be available with UPS to monitor parameters related to VRLA battery. For LI Battery, cell monitoring system shall be required inbuilt with LI battery. LI battery must comply with UL9540A standard.

.Battery bank

The UPS must be able to be connected to a battery bank which must ensure a backup time of 30 minutes on each UPS on full load at 0.9 load power factor. Technology of the battery can be either sealed maintenance free (SMF) valve regulated lead acid (VRLA) technology with a design life of 4-5 years or Lithium Ion (LI) battery with NMC / LMO / LFP technology with design life of 11-12 years.

In case of SMF VRLA battery: Battery bank VAH shall be ≥ 11232 VAH with each UPS. Battery bank VAH calculation to be done by following way: $12V \times \text{no's of battery with each UPS} \times \text{AH of individual battery}$.

In case of LIB: Battery sizing must be shared along with technical proposal. Battery backup calculation shall be done at beginning of life (BOL) for LIB.

Batteries will be supplied and installed in a separate metal rack. The battery calculation sheet will be attached to the offer, specifying the rated output power (KW), the inverter efficiency and the voltage at the end of discharge.

IGBT inverter

The UPS inverter must use IGBT technology with a DSP control and a high switching frequency. The inverter must comply with the following specifications:

Inverter technology	Three level fully IGBT
Rated output voltage	220 / 230 / 240 V with neutral
Rated frequency	50 / 60 Hz
Frequency stability (in back-up mode)	50 / 60 Hz $\pm$ 0.2 %
UPS rated apparent power	10 KVA
UPS rated active power	10 KW
Total output voltage distortion with a linear load	THDv $\leq$ 1 %
Total output voltage distortion - non-linear load	THDv $\leq$ 5 %
Short circuit current withstand capacity for inverter "when bypass is not available"	Up to 2.2 times for upto 100 ms
Overload capacity for 10 minutes	125%
Overload capacity for 60 seconds	150%

The inverter must be equipped with its own current limiting algorithm, so components are not damaged in case of an output short- circuit.

The UPS must provide a signal making possible to trip the battery protection at the end of the discharge or in case of emergency stop activation.

Automatic Static Bypass

The bypass ensures the system switches over to the auxiliary source without any interruption in power.

The auxiliary source branch (line) of each UPS module must be equipped with a static switch sized for a permanent operation at full power. The control logic of the bypass must ensure a no break transfer in case of overload, inverter failure or downstream short circuit. If one of the fans stops, the bypass must continue to be cooled.

Manual maintenance bypass built in the UPS

The manual bypass switch will be fitted in the same UPS cabinet.

It must be possible to switch the load from the bypass static switch to the manual bypass without power interruption, and vice versa.

CONSTRUCTION SPECIFICATION

The UPS will be cooled with forced ventilation with air inlet and outlet vent will be on the cabinet.

Display operations will be done via front access only.

USER INTERFACE, CONTROLS AND ALARMS

The user interface on the UPS must consist of

A semi graphical black and white interface with the following characteristics:

Light bar showing the system state

Information state visualization, measurements & UPT alarms

Events log

Control

With its dedicated input terminal blocks, the system will be able to manage the following external devices/signals:

External Emergency stop in order to activate following functions :

UPS stop and separation by opening the inverter downstream contactor

Static by-pass stop

Battery protection tripping (if equipped with a trigger device)

Genset, with the option to inhibit battery being recharged when information is active ;

Battery protection (open/closed), taking into account the status on the display;

Battery temperature, to display on the screen and manage the battery charge;

External maintenance bypass (open/closed), to secure manual and automatic operations ;

Report the upstream back feed isolation device position;

Trigger the upstream back feed isolation device if a fault is detected

It must be possible to configure these protocols via an HTML interface.

The system will provide an alarm of any faults that could appear on the UPS (general alarm).

It will also have empty slots for additional communication cards to interface with the centralized management system. As options, following interfaces could be supplied with the UPS or installed later:

RS232 or RS485 serial communication cards;

In/Out programmable card, with at least 3 inputs and 4 outputs (VFC) by card

Card programming must allow affecting to each output a state or an alarm available inside the system..

MODBUS communication card on TCP/IP and server shutdown

FACTORY TESTING AND INSPECTION

The supplier of the equipment must be able to offer factory acceptance tests and in the presence of the customer at customer's expense.

All tests will be carried out with appropriate measuring instruments, their accuracy assurance by a certificate of calibration. Following the positive outcome of the test procedure, the manufacturer shall prepare a certificate listing the tests performed and the results obtained.

COMMISSIONING

After installing the equipment and its power supply, commissioning will be carried out by technicians trained and certified by the UPS manufacturer.

The following steps must be performed on the supplied equipment:

Visually inspect of the equipment and the absence of intruding objects,

Checking of electrical and mechanical connection,

Functional tests to check its operation,

Validate the measurements taken during factory testing

Load testing

Install and verify the transfer of data to the supervision station

Basic training for system users:

- * General description of how to use the system
- * Instructions on use and maintenance

At the end of the commissioning procedure, the technician will need to create a full report on the work undertaken.

MAINTENANCE CONTRACT

The UPS manufacturer must be able to ensure the maintenance of the installed equipment, by means of a maintenance contract. This should be done by technicians trained and certified by the manufacturer of the equipment.

The manufacturer must be able to provide a remote supervision and diagnostic 24/7/365.

Approved makes for UPS

1.	MCB, Isolator, Industrial Plug Socket, RCCB, RCBO's	Schneider Electric ACTI-9(N)/ Hager / LK(L&T) (Exora) / ABB S200M) / Seimens (Betaguard)
2.	Online / Offline UPS	SOCOMEK/MERLIN GERIN/ MITSUBHISHI /EMERSON /Eaton/ Fuji
3.	Any other Item	As per approval of Engineer-in-charge.

ANNEXURE – A

Technical Data Sheet for UPS			
Name of the bidder:			
Sr. No.	Description of Parameter	Required specification	To be filled by the bidder
1	Make and model of UPS	As per approved make	
2	Capacity in KVA and KW	10 KVA / 10 KW	
3	Working temperature range	0 to 40°C	
4	Storage temperature range	-5 to 60°C	
5	Humidity	Upto 95%	
6	Standards		
a	Safety	IEC/EN 62040-1	
b	EMC	IEC/EN 62040-2	
7	Noise level at 1 mtr distance	<55 dBA	
8	Conversion technology	Double conversion true online	
9	Configuration (Stand alone / Parallel)		
10	No's of same unit can be paralleled	at least 6 units	
11	Input Electrical Characteristics		
a	Technology of Rectifier	Fully IGBT based	
b	Input Power Factor	0.99 or better	
c	Input Current Harmonics (THDi)	<4% without any additional filter	
d	UPS able to work on 3 wire (without neutral) input except bypass mode	required	
12	Output Electrical Characteristics		
a	Technology of Inverter	Fully IGBT based	
b	Output Power Factor	0.9 or higher	

c	Output Voltage Harmonics (THDv): on linear and non linear load	<2% for linear load, <5% for non- linear load	
d	Short circuit withstand capability only for inverter without bypass (times of nominal current & duration)	at least 2.2 times of nominal current for upto 40 msec	
13	Overload capability (in minutes)		
a	at 125% load	for 10 minutes	
b	at 150% load	for 1 minute	
14	Crest factor	3:1	
15	Efficiency in online double conversion mode		
a	at 100% load	>94.5%	
b	at 75% load	>94.5%	
c	at 25% load	>93%	
16	Static Bypass	Required built-in	
17	Maintenance Bypass	Required built-in	
18	Battery Charger		
	Temperature Compensated Charging	Required	
19	Battery Details		
a	Type of battery	SMF VRLA 12V / Lithium Ion	
b	Design life of battery	4 to 5 years for VRLA, 11 to 12 years for LIB	
c	AH of individual battery block	to be specified	
e	Total number of battery per UPS	to be specified	
f	Battery bank VAH per UPS (VAH calculation 12V x no's of battery per UPS x individual battery AH)	minimum 11232 VAH per UPS in case of VRLA battery	
g	Back up time when UPS on full load	minimum 30 minutes on each UPS at 0.9 load power factor	
h	Battery bank monitoring	Battery bank monitoring required with UPS in case of VRLA battery. Individual cell monitoring required inbuilt with LIB.	

i	DC breaker between UPS and battery bank	required of Schneider / ABB make	
j	Certification for LI battery	LI battery must comply UL9540A certification	
20	Miscellaneous		
a	Construction of UPS	With rectifier, battery charger, inverter, static bypass & maintenance bypass	
b	Base frame for UPS & height of the same	Base frame for UPS required of 150 mm height	
c	MTBF of UPS in VFI mode	minimum 3,25,000 hrs	
d	Isolation transformer with UPS	N. A.	
e	Isolation transformer specification	N. A.	
f	Compatibility for Lithium Ion Battery	Required with UPS	
h	Confirmation on environment friendly substance for UPS	UPS certified with internationally accepted standard e.g. RoHS for confirmation on environment friendly substance	

RATED POWER 6 KVA / 4.8 KW – SINGLE PHASE INPUT / SINGLE PHASE OUTPUT

NORMATIVE CONFORMITY

The system must comply with the following UPS standards:

Safety : EN / IEC 62040-1.

EMC Emission : EN / IEC 62040-2

EMC Immunity : EN / IEC 62040-2

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Battery Bank (External)

Automatic static by-pass

General Characteristics

Environment

Operating temperature range : from 0°C up to + 40°C

Storage temperature range : from -20°C up to + 70°C

Altitude, without derating : ≤1000m,

Maximum relative humidity : 95 % at room temperature, without condensation

Each UPS module must comply with the following key technical specifications:

Apparent rated power	6 KVA
Active rated power (Pn)	4.8 KW
Type of network (input/output)	Single-phase / Single-phase
UPS classification	VFI - SS – 111
Rated input voltage	220 - 230 - 240 V
Rated input frequency	50 / 60 Hz
Rated output voltage	220-230-240 V

Rated output frequency	50 / 60 Hz
Acoustic pressure measured with a rated load and at a distance of 1 mtr	□ 55 dBA
Protection Index for UPS system	IP 20

Automatic system transfer on bypass (eg in case of downstream short-circuit) instantly reactivate the static switch of all the units to take advantage of the overall system capability.

Rectifier

Rectifier technology	Fully IGBT
Rated voltage	220 / 230 / 240 V - 1 ph
Voltage tolerance (without the use of batteries)	230V +/-15 %
Frequency range	50 / 60 Hz
Input power factor at full load (without additional filters)	≥ 0.99
Input Harmonic distortion (THDi) at full load (without additional filters)	□ 4%

Battery bank

The UPS must be able to be connected to a battery bank which must ensure a backup time of 30 minutes on each UPS on full load at 0.8 load power factor. Technology of the battery can be either sealed maintenance free (SMF) valve regulated lead acid (VRLA) technology with a design life of 4-5 years.

Battery bank VAH shall be ≥ 7056 VAH with each UPS. Battery bank VAH calculation to be done by following way: 12V x no's of battery with each UPS x AH of individual battery.

Batteries will be supplied and installed in a separate metal rack. The battery calculation sheet will be attached to the offer, specifying the rated output power (KW), the inverter efficiency and the voltage at the end of discharge.

Inverter

The UPS inverter must use IGBT technology with a DSP control and a high switching frequency. The inverter must comply with the following specifications:

Inverter technology	Fully IGBT
Rated output voltage	220 / 230 / 240 V with neutral
Rated frequency	50 / 60 Hz
Frequency stability (in back-up mode)	50 / 60 Hz $\pm$ 0.2 %
UPS rated apparent power	6 KVA
UPS rated active power	4.8 KW

Automatic Static Bypass

The bypass ensures the system switches over to the auxiliary source without any interruption in power.

The auxiliary source branch (line) of each UPS module must be equipped with a static switch sized for a permanent operation at full power. The control logic of the bypass must ensure a no break transfer in case of overload, inverter failure or downstream short circuit. If one of the fans stops, the bypass must continue to be cooled.

CONSTRUCTION SPECIFICATION

The UPS will be cooled with forced ventilation with air inlet and outlet vent will be on the cabinet.

Display operations will be done via front access only.

USER INTERFACE, controls and alarms

The user interface on the UPS must consist of

A semi graphical black and white interface with the following characteristics:

Light bar showing the system state

Information state visualization, measurements & UPT alarms

FACTORY TESTING AND INSPECTION

The supplier of the equipment must be able to offer factory acceptance tests and in the presence of the customer at customer's expense.

All tests will be carried out with appropriate measuring instruments, their accuracy assurance by a certificate of calibration. Following the positive outcome of the test procedure, the manufacturer shall prepare a certificate listing the tests performed and the results obtained.

COMMISSIONING

After installing the equipment and its power supply, commissioning will be carried out by technicians trained and certified by the UPS manufacturer.

The following steps must be performed on the supplied equipment:

Visually inspect of the equipment and the absence of intruding objects,

Checking of electrical and mechanical connection,

Functional tests to check its operation,

Validate the measurements taken during factory testing

Load testing

Install and verify the transfer of data to the supervision station

Basic training for system users:

General description of how to use the system

Instructions on use and maintenance

At the end of the commissioning procedure, the technician will need to create a full report on the work undertaken.

MAINTENANCE CONTRACT

The UPS manufacturer must be able to ensure the maintenance of the installed equipment, by means of a maintenance contract. This should be done by technicians trained and certified by the manufacturer of the equipment.

The manufacturer must be able to provide a remote supervision and diagnostic 24/7/365.

Annexure – B

Technical Data Sheet		
Name of the bidder:		

Sr. No.	Description of Parameter	Required specification	To be filled by the bidder
1	Make and model of UPS	As per approved make	
2	Capacity in KVA and KW	6 KVA / 4.8 KW	
3	Working temperature range	0 to 40°C	
4	Storage temperature range	-5 to 60°C	
5	Humidity	Upto 95%	
6	Standards		
a	Safety	IEC/EN 62040-1	
b	EMC	IEC/EN 62040-2	
7	Noise level at 1 mtr distance	<55 dBA	
8	Conversion technology	Double conversion true online	
9	Configuration (Stand alone / Parallel)		
10	No's of same unit can be paralleled	N. A.	
11	Input Electrical Characteristics		
a	Technology of Rectifier	Fully IGBT based	
b	Input Power Factor	0.99 or better	
c	Input Current Harmonics (THDi)	<4% without any additional filter	
d	UPS able to work on 3 wire (without neutral) input except bypass mode	required	
12	Output Electrical Characteristics		
a	Technology of Inverter	Fully IGBT based	
b	Output Power Factor	0.9 or higher	
c	Output Voltage Harmonics (THDv): on linear and non linear load	<2% for linear load, <5% for non- linear load	

13	Overload capability (in minutes)		
a	at 125% load	for 1 minutes	
b	at 150% load	for 2 seconds	
14	Crest factor	3:1	
15	Efficiency in online double conversion mode		
a	at 100% load	>92%	
b	at 75% load	>91.5%	
c	at 25% load	>89%	
16	Static Bypass	Required built-in	
17	Maintenance Bypass	N. A.	
a	Type of battery	SMF VRLA 12V / Lithium Ion	
b	Design life of battery	4 to 5 years for VRLA, 11 to 12 years for LIB	
c	AH of individual battery block	to be specified	
e	Total number of battery per UPS	to be specified	
f	Battery bank VAH per UPS (VAH calculation 12V x no's of battery per UPS x individual battery AH)	minimum 7056 VAH per UPS in case of VRLA battery	
g	Back up time when UPS on full load	minimum 30 minutes on each UPS at 0.8 load power factor	
i	DC breaker between UPS and battery bank	required of Schneider / ABB make	
20	Miscellaneous		
a	Construction of UPS	With rectifier, battery charger, inverter, static bypass & maintenance bypass	
b	Isolation transformer with UPS	N. A.	
c	Isolation transformer specification	N. A.	

B. CCTV

Tropical Conditions

All equipment/material supplied against respective Specification shall be suitable for satisfactory continuous operation, storage & maintenance under tropical conditions as specified below:

Ambient temperature : 45 degree Celsius

Annual Average Relative humidity : 50%

Isokeraunic level (days per year) : 50

Seismic Zone : Zone-IV

Climate type : Moderately hot and humid tropical, climate, conducive to rust and fungus growth

General:

The Security work shall be carried out in accordance with Indian Standard Code of Practice. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply authority and Fire Insurance regulations so far as these become applicable to the installation.

The scope includes the jobs to be performed for all equipment and materials furnished under this specification. The scope is however not limited to the items detailed below:

Design, manufacture, testing at manufacturers works packing and dispatch.

Transportation to site and insurance.

Receiving at site, unloading, handling, opening, inspecting, reporting and submitting claims in case of damages and short supply items.

Arranging to repair/re-ordering all damaged and short supply items.

SPECIFICATION IP C.C.T.V. System

Scope

This section covers the design, supply, installing, testing and commissioning of Closed Circuit Television system comprising Cameras, recorder, switches and monitors.

The IP camera family shall include a choice of

Fixed-format Mega pixel dome models.

Fixed-format Mega pixel Bullet models.

Fixed-format High resolution dome models. These IP cameras shall offer M-JPEG, H.264 and MPEG-4 video compression in order to align with or optimize network bandwidth and video storage provisioning.

These IP cameras shall include megapixel-resolution models, and shall offer several lens options.

The Megapixel-resolution IP cameras shall be supplied with Megapixel lenses. The housing enclosure for megapixel cameras shall be IP66 compliant. Suitable mounting accessories are supplied as per the mounting needs.

All cameras shall support a Power over Ethernet (PoE) interface.

The dome cameras shall offer a sensor based true wide dynamic range of 100 db.

The bullet cameras shall offer a sensor based true wide dynamic range of 100db.

The cameras shall be capable of generating (At Least) up to 2 simultaneous video streams, with the following attributes:

Individual camera feeds shall be recorded by the VMS at different compression, resolution and capture rate settings simultaneously.

An adaptive transmission algorithm shall throttle these video streams to a preset maximum data rate or scale that rate based on variable network bandwidth available at the time of transmission.

All IP cameras shall provide backlight compensation.

Technical Specification Requirement		
5MP Outdoor Bullet /Dome Camera Varifocal Lens		
S.N.	Parameter	Specification
1	Image Sensor	1/2.8" CMOS
2	Pixel Resolution	5MP resolution
3	Video Compression	Licensed HEVC H.265, H.264 (MP) M-JPEG
4	Lens	2.7 ~ 13.mm (+/-10%) MVF
5	Streaming Capability	Minimum Four Stream Support (All stream should Support H.265 Compression)
6	Supported resolutions	2592x1944,1920x1440, 1280x960, 640x480
7	Resolution and Frame Rate	30ips : 2592 x 1944(WDR)
8	Bit Rate	H.265 VBR / CBR,H.264 VBR/CBR
9	Activity/Motion Controlled Video Recording	During negligible to no motion, the frames/bit rate shall be dropped automatically and as soon as motion is detected, the frames/bit rate should return to normal. In any case the recording should be available 24x7. This should be supported in both CBR and VBR mode,
10	Minimum Illumination	
	Colour Mode	0.15Lux
	Black & White Mode	0 Lux IR LED On
11	Day/Night Camera	Auto
12	IR Distance	30 mtr
13	Video Streaming	Unicast and Multicast streams
14	Text Superimposing	Camera shall support superimposing the title and date & time on the video
15	Shutter speed	1/30 ~1/10000 sec or higher
16	WDR	12dB True WDR

18	Automatic Balance	White	Required
19	Two way/ Audio Output	Bi-directional Input /	Required
20	Trigger		Motion Detection, Alarm in, Tampering, Trip zone
21	Edge Storage		Should support 256GB inbuilt micro SD/ SDHC / SDXC In the event of network communication break with NVR, the camera should record on memory card and upon resumption of network communication with NVR, the data from memory card should be backfilled to NVR storage automatically without any human intervention.
22	Camera Tampering		Active Tampering Alarm
23	Recording Buffer	Session	Yes (Up to 60MB)
24	Network Connectivity		Ethernet, 10/100 Base T
25	Discovery Interface		OEM interface to detect the camera automatically and configure network settings
26	Network Protocols		Suitable and required network protocol stack to work Camera in TCP/IP based Ethernet network environment. (As required for system working)
27	Security		SSL Encryption, Multi-User Authority, IEEE802.1x, IP Filtering, HTTPS, The cameras offered must be cyber security certified with NDAA/UL Cyber security certificate/ STQC.
28	Web Server		Internal Web server required with embedded operating system.
29	Privacy masking		8 Zones
30	Alarm Inputs / outputs		1 input & 1 output
31	Input Voltage		Power should be drawn on PoE, 220V AC Voltage (Nominal) / 24V AC or DC/12V DC POE - IEEE 802.3af/at compliant
32	Operating Temperature		-40°C ~ +50°C
33	Operating Humidity		0% ~ 90% RH non-condensing
34	Outdoor Ready		To be supplied with IP67 & IK10 Housing (Test report for Vandal Proof (IK10) (issued from an NABL accredited lab or International reputed labs)
35	MAC Address		The MAC address of the proposed IP cameras must be registered in the same name of the OEM. The IP Camera OEM must confirm that the MAC address of the surveillance cameras; OUI (Organizationally Unique Identifier) must be in the name of the OEM. Letter with MAC ID and OUI details on OEM's letterhead should be

		provided.
36	Interoperability/ ONVIF Compliance	ONVIF Profile or SDK is to be shared with the purchaser for integration purposes.
37	Regulatory Approvals/Certifications	BIS
38	MTBF	1,25,000 Hours 1.MTBF Report with software generated data on Telcordia Method-I
40	License Software	The Camera OEM should be a genuine manufacturer and should be a MPEG LA licensor. They should be paying the license fee for using the genuine HVEC compression legally. The same will be checked on following official website : https://www.mpegla.com/programs/hevc/licensees/

Technical Specification Requirement		
32 Channel NVR		
S.N.	Parameter	Specification
1	Network Camera	32 Channels
2	Supported Resolution	Upto 8MP or better
3	Storage	Upto 60TB or better RAID 5/6 eSATA/ External iscsi storage support required
4	Onvif	Support required
5	Live Display	VGA/ DVI/ HDMI with Dual Display
6	Video Codec	H.264, H.265 or better
7	VMS	Pre-Installed with Embedded Linux/ Windows
8	Live Monitoring and Playback	Upto 32 Channels or better
9	Calendar / Event / Bookmark / Smart Search	Support required
10	Recording Bandwidth	350 Mbps or better
11	Playback	Fast/Slow Forward/Backward, Move one step up/down
12	Recording Mode	Normal, Schedule (Continuous / Event), Event (Pre

		/ Post), Event profile
13	Event	Alarm input, Video loss, Camera event (Sensor, MD, Video analytics)
14	Event Trigger	E-mail, PTZ preset, Alarm out, Buzzer, Monitor out
15	Audio	Bidirectional for all channels
16	Audio In/Out	1/1
17	Alarm In/Out	16/4
18	Camera Setup	Auto/ Manual
19	USB Support	USB 2.0 x 2, USB 3.0 x1
20	Camera Features	Automatic device IP scan, Profile edit, Resolution, Fisheye dewarping, Hallway/ Corridor view, Brightness / Contrast, Device setup page, Exporting / Importing devices settings, Device firmware update
21	Date & Time Sync	NTP server
22	PTZ	Control Device Via GUI, Controller, Preset
23	RAID	Support 1,5,6,10
24	HDD	8 X SATA
25	Protocol Support	Support Required
26	DDNS	Support required
27	IPv4, IPv6	Support required
28	Security	IP address filtering, User access log, 802.1x authentication, Encryption, Signed Firmware. The cameras offered must be cyber security certified with NDAA/UL Cyber security certificate/ STQC.
29	Language	English
30	Viewer Software	Required
31	Network	RJ-45 (1000 Base-T) x2 or more
32	Power Supply	230VAC 50 Hz
33	Operating Temperature / Humidity	+0°C ~ +40°C, Upto 80% RH
34	Certification	BIS,FCC,CE,UL
35	MTBF	1,25,000 @ 40 degree temprature

Technical Specification Requirement		
64 Channel NVR		

S.N.	Parameter	Specification
1	Network Camera	64 Channels
2	Supported Resolution	Upto 8MP or better
3	Storage	Upto 80TB or better RAID 5/6 eSATA/ External iscsi storage support required
4	Onvif	Support required
5	Live Display	VGA/ DVI/ HDMI with Dual Display
6	Video Codec	H.264, H.265 or better
7	VMS	Pre-Installed with Embedded Linux/ Windows
8	Live Monitoring and Playback	Upto 64 Channels or better
9	Calendar / Event / Bookmark / Smart Search	Support required
10	Recording Bandwidth	450 Mbps or better
11	Playback	Fast/Slow Forward/Backward, Move one step up/down
12	Recording Mode	Normal, Schedule (Continuous / Event), Event (Pre / Post), Event profile
13	Event	Alarm input, Video loss, Camera event (Sensor, MD, Video analytics)
14	Event Trigger	E-mail, PTZ preset, Alarm out, Buzzer, Monitor out
15	Audio	Bidirectional for all channels
16	Audio In/Out	1/1
17	Alarm In/Out	4/1
18	Camera Setup	Auto/ Manual
19	USB Support	USB 2.0 x 2, USB 3.0 x1
20	Camera Features	Automatic device IP scan, Profile edit, Resolution, Fisheye dewarping, Hallway/ Corridor view, Brightness / Contrast, Device setup page, Exporting / Importing devices settings, Device firmware update
21	Date & Time Sync	NTP server
22	PTZ	Control Device Via GUI, Controller, Preset
23	RAID	Support 1,5,6,10
24	HDD	8 X SATA
25	Protocol Support	Support Required
26	DDNS	Support required
27	IPv4, IPv6	Support required

28	Security	IP address filtering, User access log, 802.1x authentication, Encryption, Signed Firmware. The cameras offered must be cyber security certified with NDAA/UL Cyber security certificate/ STQC.
29	Language	English
30	Viewer Software	Required
31	Network	RJ-45 (1000 Base-T) x2 or more
32	Power Supply	230VAC 50 Hz
33	Operating Temperature / Humidity	+0°C ~ +40°C, Upto 80% RH
34	Certification	BIS,FCC,CE,UL
35	MTBF	1,25,000 @ 40 degree temprature

Technical Specification Requirement		
128 Channel NVR		
S.N.	Parameter	Specification
1	Network Camera	128 Channels
2	Supported Resolution	Upto 8MP or better
3	Storage	Upto 80TB or better RAID 5/6 eSATA/ External iscsi storage support required
4	Onvif	Support required
5	Live Display	VGA/ DVI/ HDMI with Dual Display
6	Video Codec	H.264, H.265 or better
7	VMS	Pre-Installed with Embedded Linux/ Windows
8	Live Monitoring and Playback	Upto 64 Channels or better
9	Calendar / Event / Bookmark / Smart Search	Support required
10	Recording Bandwidth	520 Mbps or better
11	Playback	Fast/Slow Forward/Backward, Move one step up/down
12	Recording Mode	Normal, Schedule (Continuous / Event), Event (Pre / Post), Event profile
13	Event	Alarm input, Video loss, Camera event (Sensor, MD, Video analytics)
14	Event Trigger	E-mail, PTZ preset, Alarm out, Buzzer, Monitor out

15	Audio	G.711 u-law (PCM), G723, G726 (ADPCM), AAC, Bidirectional for all channels
16	Camera Setup	Auto/ Manual
17	Camera Features	Automatic device IP scan, Profile edit, Resolution, Fisheye dewarping, Hallway/ Corridor view, Brightness / Contrast, Device setup page, Exporting / Importing devices settings, Device firmware update
18	Date & Time Sync	NTP server
19	PTZ	Control Device Via GUI, Controller, Preset
20	Redundancy/ Failover	N + 1 Support required
21	Protocol Support	CP/IP, UDP/IP, IPV4/IPV6, RTP (UDP), RTP (TCP), RTSP, NTP, HTTP, DHCP (Server, Client), PPPoE, SMTP, DNS, DDNS, uPnP, HTTPS, SNMP, ONVIF (Profile-S), API (Server, Client)
22	DDNS	Support required
23	IPv4, IPv6	Support required
24	Security	IP address filtering, User access log, 802.1x authentication, Encryption, Signed Firmware. The cameras offered must be cyber security certified with NDAA/UL Cyber security certificate/ STQC.
25	Language	English
26	Viewer Software	Required
27	Network	RJ-45 (1000 Base-T) x2 or more
28	Power Supply	230VAC 50 Hz
29	Operating Temperature / Humidity	+0°C ~ +40°C, Upto 80% RH
30	Certification	BIS
31	MTBF	1,25,000 @ 40 degree temprature

Special Points for Passive Components:

All copper & Fiber component should be from single OEM as per the makes given in the tender documents.

All passive components should be RoHS (Restriction of Certain Hazardous Substances) complied. Declaration-RoHS Should be clearly mentioned on datasheet of each Passive Component.

The manufacturer of Passive component should be a technology development partner with any of the leading Manufacturer of Active Component.

Bidder has to submit an authorization letter from the OEM only specific to this work. All bids without the authorization letter will be liable to be rejected.

All work related to fiber including digging, laying of HDPE Pipe/Hume Pipe/Conducting will be in the bidders scope. The Bidder Should take in consideration all the cost involved for the same, nothing shall be paid extra on account for this.

Bidder has to support the complete system for one year after the completing the installation and assign one dedicated resource for the same for one year on their own cost only.

Bidder should have adequate facilities, manpower and staff for installation testing and commissioning and can provide after sales services. OEM has to authorize their System Integrator in this regards stating that they will Support the solution through their SI.

OEM Eligibility Criteria for Passive Products

Sr. No.	Eligibility Criteria	Compliance with Document
1	OEM of Passive Networking Products must be registered in India for more than 15 years.	
2	OEM of Passive Networking Products shall have their own ISO 9001:2008 and 14001 certified copper and fiber components manufacturing facility in India.	
3	OEM of Passive Products should have atleast 1 RCDD Residing in India is preferred.	
4	OEM must not propose any mix of Co-branded equipment. All Products (Cat6 and Fiber) shall be of same brand name written on each quoted product.	
5	All the Passive Products (Cat6 and Fiber) Shall be from Single OEM & offered products should have Min. 25 years of performance warranty.	
6	OEM shall be TIA Full Committee Member and its name shall be available on TIA Website.	

CAT6 U/UTP 4 Pair LSZH CABLE

Details	Specification	Compliance
Type	23 AWG Solid Bare Copper, Unshielded Twisted 4 Pair, Category 6, TIA / EIA 568-2.D, ISO/IEC 11801 & NEC Articles UL 444.	
Application	Premise Horizontal Cable, Gigabit Ethernet, 100BaseTX, 100BaseVG ANYLAN, 155ATM, 622ATM, NTSC/PAL Component or Composite Video, AES/EBU, Digital Video, RS-422, 250MHz Category 6, IEEE 802.3bt Type 1, Type 2, Type 3, Type 4	
Conductors	Solid Bare Copper	
Insulation	Polyethylene / Polyolefin	
Jacket	LSZH jacket complying to: Fire rating IEC 60332-1 Toxicity IEC 60754-1 Smoke density IEC 61034-1	
Pair Separator	Cross-member (+) fluted Spline.	
ETL Test Report	ETL Transmission Test Report as per ANSI/TIA-568.2-D Min. 250 MHz to be provided with Minimum 4 Connector Channel NEXT Headroom of 3dB.	
Packing	Box of 305 meters	
Cable Outer Diameter	5.8 mm	
Propagation Delay Skew	≤ 45ns/100m or Better (ETL/UL Tested)	
Bend Radius	4 * Cable Diameter	
Impedance	100 Ohms + / - 15 ohms,	
Maximum Capacitance	ETL Report to be submitted for below parameters:- Max. Capacitance Unbalance: ≤ 20 pF/100 Mtr Max. Mutual Capacitance :- ≤ 5.0 nF/100m	
Max. DCR	≤ 7.3 Ohms Max /100 mtr (ETL/UL Tested)	
PoE Capability	IEEE 802.3bt Type 1, Type 2, Type 3, Type 4	

Details	Specification	Compliance
Performance characteristics as per ANSI/TIA-568.2-D	Max. Attenuation: 32.8dB/100m Min. NEXT : 38.3 dB Min. PS NEXT : 36.3 dB Min. ELFEXT : 19.8 dB Min. PSELFEXT : 16.8 dB Min. Return Loss: 17.3 dB Min. ACR : 5.5 dB Min. PSACR :3.5 dB	
ROHS Compliant	ROHS/ELV Compliant	
Operating Temperature Range	-20 to +75 Deg C	
Test Reports	Test Reports from any NABL Accredited Lab needs to be submitted for below test at time of bidding.. 1. Oxygen Index Test 2. Smoke Density Test 3. Halogen Acid Test with Acidity & Conductivity Test 4. Vertical Flame Test IEC 60332-1 5. Temperature Index Test	

Cat 6 Unshielded Modular Jack (without PCB)

Parameters	Specifications	Compliance
Type	Cat6 Modular Jacks shall meet and exceed channel specification of Category 6 transmission requirements for connecting hardware, as specified in Commercial building telecommunications Cabling standard and ISO/IEC 11801:2002 second edition. when used as a component in a properly installed UTP channel.	
Front Connection	Lead Frame : Copper Allow with 50u inch Gold over Nickel	
Rear Connection	IDC: Copper Alloy with Nickel Plating	
Connector Body	Plastic: UL940V-0	
Housing	Encapsulated Lead Frame technology (Without PCB)	
Accessories	-Jack should support uniform hassle free termination technology and be able to ensure performance in each termination without	

Parameters	Specifications	Compliance
	dependency on expertise of technician. - Integrated bend-limiting strain-relief unit for cable entry with locking facility at IDC contact point	
Termination Interface	Front Mated Connection: 750 Cycles or Better	
	Rear Mated Connection: 20 Cycles (Gas Tight IDC Connection) or Better	
Jack Details	Connector/hardware retention of at least 88.5 N Plug /connector retention of at least 50N Storage temperature range of -40 Deg C to +70 Deg C.	
IEEE Specification (PoE)	IEEE 802.3at type 1 and 2 (up to 30W). CoC to be provided.	
Termination Pattern	TIA / EIA 568 A and B	
Performance	1 Gbps support for 100 MT Channel Link	
Guaranteed Bandwidth	250 Mhz Guaranteed Bandwidth for 100 MT Channel Link	
Approvals (Proof to be provided along with Bid)	UL Listed	
	ETL verified to TIA / EIA Cat 6. Should be part of the registered 4 connector channel as per Intertek / ETL report	
UL Rating	UL 94V-0	
Other Specifications	UL 1863, IEC 60603-7, FCC part 68-F	
RoHS	Compliant	
Feature	The jacks shall not have an integrated spring shutter as the shutter malfunctions and causes operational issues in Panel.	
Safety listing	ACA and Bi-national standard listed.	
Operating Temperature	-10° to 60°C	
Dielectric Strength	1,000 V RMS @ 60 Hz for 1 minute (Signals to Ground)	
Termination Process	Termination of cable on IO through Termination Tool to minimize any manual termination like punch down. All the four pairs should get crimped and cut together with the help of the tool. Pairs should be separated via mechanism in the termination process to avoid any cross talk issue	

Parameters	Specifications	Compliance
	at Jack. Tool-less jack is not required because the tool-less jack is installer dependent, whereas the termination using a tool has consistent terminations ir-respective of the installer.	
Cat6 Jack	Should be covered under 25 year warranted solution from OEM. All the four pairs should get crimped and cut together with the help of the tool.	

Cat 6 Unshielded Patch Cords, LSZH, ETL Tested

Details	Specification	Compliance
Type	Unshielded Twisted Pair, Category 6, TIA / EIA 568-C.2 & ISO/IEC 11801, IEC 60603-7, FCC Part 68 Subpart F Specifications.	
Conductor	Cat6 Patch Cord should be 4 Twisted Pair, 24 AWG Stranded Bare Copper Conductors. Contact Blade should be Phosphor bronze plated with 50u" gold over 100u" nickel undercoat.	
Length	1 MT , 3 MT	
Plug Protection	Factory fitted Strain relief boots on either side	
Performance Characteristics	Max. Current Rating should be 1.5 Amp Min. Insulation Resistance should be 500MOhm Max. Contact Resistance should be 20mOhm Dielectric Strength should be 1000 VAC (RMS)	
Jacket	LSZH	
Outer Diameter	≤ 6.0 mm	
Operating Environment Range	The patch cord should have Insertion Life of 750 mating cycles Pull force of min. 89 Newton, Operating Temperature range of -20 Deg C to +60 Deg C	
Boot	Clear / Transparent with Snagless feature	
Third Party Verification	4 Connector ETL/UL Test Report 600 Mhz for ANSI/TIA-568-2.D needs to be submitted along with bid. This Patch Cord shall be part of ETL/UL test report of 4 connector channel submitted for quoted Cat6 cable.	

CAT6A U/UTP LSZH CABLE

Details	Specification	Compliance
Type	23 AWG Solid Bare Copper, Unshielded Twisted 4 Pair, Category 6A, confirming to TIA 568.2.D, Class EA - ISO/IEC 11801:2002	
Conductors	Solid Bare Copper 23 AWG	
Insulation	Polyolefin/Poylethylene	
Jacket	LSZH jacket complying to: Acid Gas Emission pH per IEC 60754-1 : ≥ 4.3 Acid Gas Conductivity per IEC 60754-2 : $\leq 10\mu\text{s/mm}$ Smoke density IEC 61034-2 : $\geq 60\%$ Light Transmittance Flame Test: IEC 60332-1 Third Party Test Report of above parameters needs to be enclosed with bid.	
Pair Separator	+ Shape Spline	
Suitable Applications:	Premise Horizontal Cable, 10 Gigabit Ethernet, 100BaseTX, 100BaseVG ANYLAN, 155ATM, 622ATM, NTSC/PAL Component or Composite Video, AES/EBU Digital Audio, AES51, RS-422, Noisy Environments, PoE	
Guaranteed Bandwidth	500 Mhz for 100 MT Channel	
Packing	Box of 305 meters	
Cable Nominal Outer Diameter	7.2 mm	
Max. Delay Skew	45 ns @ 100M	
Bend Radius (Installation)	50 mm	
Maximum Conductor DC Resistance:	DCR @ 20°C (Ohm/100 m) < 8.0	
Third Party Verification for Cable	Cable ETL Test Report for compliance to 61156-5 as referenced in ISO/IEC 11801-1 for Min. 500Mhz or Higher Cable ETL Test Report for Alien crosstalk for ANEXT, AFEXT, PS ANEXT. All above test reports to be submitted along with bid	
Nom. Mutual Capacitance	Capacitance (nF/km) < 56	

Details	Specification	Compliance
Nom. Velocity of Propagation	67 % or Better	
Temperature Range Operation	-20 Deg C to +60 Deg C	
IEEE Requirement	IEEE 802.3bt Type 1, Type 2, Type 3, Type 4	
RoHS	Yes	
Test Report	Enclose ETL 4 Connector Channel Test Report as per ANSI/TIA-568.2-D Category 6A Standard.	

Cat 6A Unshielded Modular Jack

Parameters	Specifications	Compliance
Type	Modular Jacks shall meet and exceed channel specification of ANSI/TIA/EIA-568-C.2 Category 6a and ISO/IEC 11801:2002/Amd 1:2002 Ed2 when used as a component in a properly installed UTP channel.	
Front Connection	RJ 45 : 50uin Gold plated contacts over Nickel	
Rear Connection	Copper alloy, Gold plated contacts over Nickel or IDC	
Connector Body	PBT glass reinforced UL94V-0 or Plastic	
Accessories	Jack should support uniform hassle free termination technology and be able to ensure performance in each termination without dependency on expertise of technician.	
Termination Interface	Front Mated Connection: 750 Cycles Min.	
	Rear Mated Connection: 20 Cycles Min.	
IEEE Specification (PoE)	IEEE 802.3bt type 3 and 4 (up to 100W)	
	Cisco UPOE (up to 60W) and Power over HDBase-T (up to 100W)	
Performance tests	Modular Jacks shall be tested for performance to ANSI/TIA/EIA-568-C.2	
Guaranteed Bandwidth	Min. 500 Mhz or higher Guaranteed Bandwidth for 100 MT Channel Link	
Approvals	UL Listed, UL2043 Air Handling Spaces	
UL Rating	UL 94V-0	
Other Specifications	UL 1863, IEC 60603-7, FCC part 68-F	

Parameters	Specifications	Compliance
RoHS	EU Directive 2002/95/EC Compliant	
Feature	The jacks shall not have an integrated spring shutter as the shutter malfunctions and causes operational issues in Panel.	
Operating Temperature	-10° to 60°C	
Dielectric Strength	1,000 V RMS @ 60 Hz for 1 minute (Signals to Ground)	
Termination Process	Termination of cable on IO through Universal Termination Tool to minimize any manual termination like punch down. All the four pairs should get crimped and cut together with the help of the tool. Pairs should not be separated in termination process to avoid any cross talk issue at Jack. Tool-less jack is not required because the tool-less jack is installer dependent, whereas the termination using a tool has consistent terminations ir-respective of the installer.	
Cat6A Jack	It should be covered under 25 year warranted solution from OEM.	
Third Party Test Report	Enclose 4 Connector ETL/UL/3P Test Report ANSI/TIA – 568 Cat6 6A, ISO/IEC 11801 (Class Ea), EN 50173 (Class Ea) and IEEE 802.3-2012.	

Cat 6A Unshielded Patch Cords, LSZH

Parameters	Specifications	Compliance
Type	Modular Cord shall meet and exceed channel specification of ANSI/TIA/EIA-568-B.2 Category 6a and ISO/IEC 11801 2nd edition (2002) & Amendment 2 (2010) up to 500 MHz when used as a component in a properly installed UTP channel. It should also comply to EN 50173-1 (2002) & EN 50173-1 Amendment 1 (2009).	
Conductor	Stranded copper, 7/26AWG	
Insulation	Foam Polyethylene/PE	
Plug Boot	Clear boot with PVC material, Snagless	
Plug Housing	Polycarbonate (PC)	
Plug contact blade	Phosphor bronze plated with 1.27um gold over 2.54um nickel undercoat	
Insertion Life	750 Cycles or Better	
Operating/Storage Temperature	-20 to +60 Deg C	

Parameters	Specifications	Compliance
Range		
Channel compliance certificate	Certificate by Intertek (ETL)/UL/3P for the 4-Connectors and 3 Connectors channel testing to the Cat 6A Cabling system as per the ANSI/TIA 568 C.2 standards, ISO/IEC 11801 and EN 50173-1. Document to be submitted.	
Guaranteed Bandwidth	500 Mhz or Better Guaranteed Bandwidth	
Sheath Material	LSZH	
Flame Rating	IEC 60332-3 or higher	
Outer Diameter (Nominal)	6.1 ± 0.3 mm	

24 Port, 1U Jack Panel, Unloaded (For Cat6 and Cat6A)

Parameters	Specifications	Compliance
Type	- 24 Port 1RU Unloaded Straight Patch Panel - 19" rack mountable. - Patch panels Ports should be individually replaceable & Consistent port-to-port performance.	
Ports	24 Ports in 1RU and 48 Ports in 2RU	
Cable management	Panel shall have in-built cable manager at the rear end	
Height	1U (1.75")	
Feature	The jacks shall not have an integrated spring shutter as the shutter malfunctions and causes operational issues in panels.	
Storage Temperature Range	-40Deg C to +70 Deg C	
Operating Temperature range	-10Deg C to +60 Deg C	
Color and Material	Black Color SPCC Steel Frame Material with ABS Front Plastic Panel	
RoHS	EU Directive 2011/65/EU (ROHS II)	

Face Plate, UK Style, 6C Type, White Color, Square with Shutters

Details	Specification	Compliance
Type	Simplex/Duplex/Quad	
Material	Fire -retardant Plastic UL-94 V0, ABS, UK Style.	
Acceptability	Should be able to accept Cat6A, Cat6 and Cat5e information outlets	
Mounting screws	2 pcs, M3.5 x 25mm	
Compliant	RoHS	
Dimensions	(H x W x D) 86 x 86 x 10 mm	

6/12 Core Single mode Outdoor Armored Fiber Cable

Details	Specification	Compliance
Cable	12 Core Singlemode 9/125, Central Loose Tube Cables, High mechanical and rodent protection provided for Outdoor – Corrugated Steel Tape Armor (CST), complying to 9/125 ITU G.652D	
Application	Cable should be suitable for Structured (premises) wiring systems: For outdoor use in structured (data) wiring systems such as industrial backbone, campus backbone, building backbone (riser). Suitable for direct burial. Easy to install in ducts, tunnels and trenches.	
Jacket	Black UV resistant HDPE outer jacket. Glass yarns and two steel wires embedded in jacket as strength members.	
Loose Tube Construction	Central tube, jelly filled (non-dripping and silicon-free) with up to 12 fibers. Individually colour coded optical fibres.	
Optical Properties	Core: 9.2 +/- 0.4 μ m Cladding: 125 +/- 0.7 μ m Loose Tube fibres: $\varnothing$ 250 $\pm$ 15 μ m 1310 Wavelength (nm) : 0.36 Attenuation max. (dB/km) 1550 Wavelength (nm) : 0.22 Attenuation max. (dB/km) Zero Dispersion Wavelength : 1302 – 1322 nm Core-Clad Concentricity Error : $\leq$ 0.5 μ m	

Details	Specification	Compliance
	Clad Non-Circularity : $\leq 0.7\%$ Cutoff Wavelength : $\leq 1260\text{ nm}$ PMD (ps/km) : ≤ 0.1 Point Loss @ 1310nm & 1550nm : 0.05 dB Refractive Index @1310nm : 1.467 Refractive Index @1550nm : 1.468	
Warranty & Putup	Std. delivery length: 2000 $\pm$ 105m Minimum Warranty: 25 years.	
Temperature Range	-40 to +70 °C	
Physical Properties	Bending radii tube (Installation & Operation) : 20 x OD mm Cable Max. Tensile Strength Installation (Short Term): 2000 N Cable Max. Crush Resistance Installation (Short Term): 3000 N/100mm Nominal Cable OD : 9.2 mm Max. RoHS for Outer Jacket Buffer Tube Material : PBT – Polybutylene Terephthalate	

12/24 Fiber Port 1U Rack Mount Fiber Enclosure (LIU) including Splice Trays, Pigtails and Couplers

Details	Specification	Compliance
Fiber Interface Unit	Fiber Patch Panel Typically used in Server rooms, Network rooms, Data Centres and Small offices Can be mounted directly on any 19" rack or cabinet. It should be able to accommodate a variety of Fiber connectors and terminated to fiber cables using Splicing or other methods.	
Type	Fiber LIU should be 1U (1.75"), 19 Inch Rack Mount.	
	12/24/48Fiber Port should be available in 1U Rack Mount LIU.	
	LC Type Connectors will be required.	
Features & Compatibility	Each 1U LIU should be able to accommodate atleast 48 fibers in LC type connectors.	
	12/24/48 Fiber Splice trays should loaded in LIU with Pigtails, Splice Tubes, Min. 2 x PG13.5	

Details	Specification	Compliance
	Gland, Cable Ties and Velcro Straps	
	Panel Material – Powdered Coated Steel	
	Couplers in adapter strip should be colored to specify OM4 and shall meet Pigtail and Patch Cord Color	
	Operating Temp Range: -10°C to +60°C	
	Storage Temp Range: -40°C to +70°C	
	EU Directive 2011/65/EU (ROHS II)	
Pigtails Parameters factory loaded in Panel	LC - Simplex, Singlemode OS2, Min. 2 Mtr, 0.9mm Tight Buffer	
Standard	Optical Fiber Pigtail should comply with TIA 568.3-D	
Optical Performance	Insertion Loss of $\leq 0.30\text{dB}$	
Optical Performance	Return Loss of $\geq 55\text{dB}$	
Connector Standard	IEC 61754, TIA 604	
RoHS	EU Directive 2011/65/EU (ROHS II)	

Fiber Patch Cords, LC-LC Duplex, Singlemode OS2, 3MT

Details	Specification	Compliance
Type	2mm Duplex Zipcord or Better	
	Singlemode OS2	
Outside Diameter	(Duplex): 2.0mm or Better	
Jacket Material	LSZH	
Length	3 MT	
Cable Crush Resistance	500 N/100mm	
Insertion Loss	$\leq 0.30\text{ dB}$	
Return Loss	$\geq 55\text{dB}$	
RoHS Certified	Yes	
Cable/Connector Standard	IEC 61754, TIA 604, TIA 568.3 D, IEC 60793-2-10, IEC 60793-2-50	
Flame Standard for	IEC 60332, IEC 60794-2-50, IEC 60754, IEC 61034	
ANSI/TIA	ANSI/TIA-568.3-D (shall be mentioned in data sheet)	

C. DATA IT (ACTIVE NETWORK COMPONENTS)

1.0 Special Condition for System Integrator:

The Contractor will supply and install the equipment necessary to meet the requirements and provide all labour and materials, whether or not described in full, necessary to produce complete and fully operational systems in accordance with the intent of this document.

The Contractor/ Agency must familiarize himself with the site drawings and the scope of the facilities that is required in the various areas. Should ensure that agency is aware of the operational requirements under which the systems and associated facilities are to be installed and used.

All employees used by the contractor/agency to install this system must be competent technicians who are experienced in the installation and interconnection of systems.

Bidder shall be authorized by the manufacturer of the major components of the system to sell their products and initiate warranty service on the same items for this project. Manufacturing authorization letter must be submitted for this Work addressing to Client stating that bidder is authorized to provide sales and services on behalf of OEM.

In view of the above, commissioning and programming will have to be carried out to integrate all the system architecture hardware and software

2.0 Submittals:

Compliance Statement- (Mandatory)

Datasheet- (Mandatory- Relevant Pages only)

Bill of Quantity- (Mandatory)

Drawings as required

Manufacture Authorization Letter (Mandatory)

OEM Partner Certification

No Deviation Certificate (for Technical Compliance) on OEM letter head (Mandatory).

Makes and Models: - It is mandatory to provide make and model of the items and their subcomponents as has been sought in the technical bid. Please note that substituting required information by just brand name is not enough. Bidder should not quote hardware or software items which are impending End of Life or End of Support during the contractual period.

Software, Drivers and Manuals: - The bidder shall supply along with each item, all the related documents, Software Licenses and necessary media of the software loaded in the equipment without any additional cost. The media and documents shall be in English. These will include, but not restricted to, User Manual, Operation Manual, Other Software and Drivers etc.

Warranty: The Contractor/ Agency shall Warranty that all provided material and equipment will be free from defects, workmanship and will remain so, for a period of 12 months from after equipment/materials have put into the service or from date of final acceptance of system by Engineer In charge / Consultant whichever is earlier.

The Contractor/ Agency shall provide summary of all equipment's serviced quarterly during this Warranty period to facility in charge. The report shall clearly mention services rendered, parts replaced and repairs performed.

3.0 Software & Programming:

Any software, license or programming, whether or not specifically mentioned, but if required for successful installation, testing, commissioning and functioning of the all equipment and systems installed by the contractor, the same shall be in the scope of the contractor. All such software required shall be fully-loaded, genuine, latest versions, shall be as per OEM's specifications/ recommendations, shall not be trial versions or limited- feature or limited-period versions (unless the specified Model no. / Code no. means so) and shall not involve any extra or recurring cost.

The rate quoted by the contractor shall be inclusive of all such required software and programming and the contractor shall be responsible for making the entire system operational as per tender specification and no extra shall be paid to the contractor on this account.

4.0 Compatibility of System

It shall be contractor's obligation to ensure that all the software, hardware, equipment, and IT systems, including input-output connectors/ port/ terminals, are seamlessly compatible with one another. Any specific provisions, if required to be made on this account this, shall be done by the contract without compromising the performance of the IT system and without any extra cost. The rate quoted by the contractor shall be inclusive of all such required software and programming and no extra shall be paid to the contractor on this account.

The contractor shall ensure that the equipment being proposed are the prevalent models/ series of the OEM.

Technical Specification of LAN System

Core Switch

48 Port POE Switch

48Port Gigabit PoE Access Switch		
Sl. No	Specifications	Compliance (Yes/No)
1	Product details - Please specify	
1.1	Please mention Make, Model No. and Part Code.	
2	Architecture & Port Density	
2.1	Access Switch should provide 48 x 10/100/1G PoE+ RJ45 Ports and with minimum 740 watts of PoE power budget and 4x 1G/10G/25G SFP+ Slots, for Stacking/Uplinks, from Day 1.	
	Hardware, including modules, or Software, including licenses, to support all the speeds listed above, should be available from Day 1	

2.2	Should support Virtual Switching System (VSS) or Virtual Chassis (VC) or Virtual Switching Extension (VSX) or equivalent Switch Clustering/Stacking feature, where the Switch Clustering feature should combine multiple switches into a single network element. Switch should support aggregated stacking bandwidth of 800Gbps or more and 8 switches per stack or more.	
3	Performance	
3.1	Should provide Switch Fabric Bandwidth Capacity of 296 Gbps, or more.	
3.2	Should provide Packet Forwarding Capacity of 220 Mpps, or more.	
4	MAC Address and Route Table	
4.1	Should support up to 32K MAC addresses, or more.	
4.2	Should support 16K IPv4 routes and 4K IPv6 routes, or more.	
5	Physical Attributes	
5.1	Switch should be 1U and rack mountable in standard 19" rack.	
5.2	Should support 4GB RAM, 8GB Flash and 4MB Packet buffer or better	
6	Layer 2 features	
6.1	Should support Jumbo Frames (up to 9K bytes).	
6.2	Should support 4K Active VLANs, with the following features;	
	Port based VLANs	
	Dual-Mode VLANs	
	MAC-based VLANs	
	Dynamic VLAN Assignment	
	Dynamic MAC-based VLAN Activation	
	Dynamic Voice VLAN Assignment	
	VLAN mapping or VLAN Translation	
6.3	Should support Spanning Tree Protocols, with the following features;	
	802.1D Spanning Tree	
	802.1W Rapid Spanning Tree Protocol (RSTP)	
	802.1s Multiple Spanning Tree	
	802.1s Multiple Spanning Tree enhancement (MSTP+)	
	Fast Port Span, Fast Uplink Span or Equivalent	
	Compatibility with PVST/PVST+, PVRST+ and PVST+ or Equivalent	
	BPDU Guard	
	Root Guard for STP & MSTP	
	Port Loop Detection	

	Spanning Tree path cost method changes	
	MSTP path-cost configuration	
6.4	Should support Link Aggregation Groups (LAG), with the following features;	
	Static LAG	
	802.3ad Link Aggregation Control Protocol (Dynamic LAG)	
	Dynamic insertion and removal of ports	
	Support for LAG between different default port speeds	
6.5	Should support 802.1q Tunneling, with the following features;	
	802.1ad (Q-in-Q) tagging	
	Q-in-Q BPDU tunneling	
	Selective Q-in-Q	
6.6	Should support Private VLANs, with the following features.	
	PVLANs with dual mode support	
	PVLAN with LAG	
6.7	Should support VLAN Registration Protocol, with the following features;	
	Multiple VLAN Registration Protocol (MVRP)	
	MVRP with Per-VLAN STP and Per-VLAN RSTP	
6.8	Should support the following features;	
	Unicast Reverse Path Forwarding (uRPF)	
	Remote Fault Notification (RFN)	
	Link Fault Signaling (LFS)	
	Uni-Directional Link Detection (UDLD) on Tagged and Untagged Ports	
	To limit Unknown Unicast Packet Flooding (UUFB)	
	Virtual Extensible LAN (VXLAN)	
7	Layer 3 features	
7.1	Should support the following IPv4 and IPv6 Layer 3 Routing features;	
	Routing Between Directly Connected Subnets	
	Host routes & Virtual Interfaces	
	IPv4 & IPv6 Static Routes	
	RIP v1/v2 & RIPng	
	ECMP	
	OSPF v2, OSPF v3	

	PIM-SM, PIM-SSM, PIM-DM, PIM passive	
	Policy Based Routing (PBR)	
	VRRP v2 & VRRP v3	
	Non-Stop Routing (NSR)	
	GRE IP Tunnels	
	IPv6 over IPv4 tunnels and VRF	
	DHCP Server	
	MSDP	
8	Quality of Service (QoS) & Traffic Management	
8.1	Should support the following Quality of Service (QoS) features;	
	ACL Mapping and Marking of ToS/DSCP (CoS)	
	ACL Mapping and Marking of 802.1p	
	ACL Mapping to Priority Queue	
	Classifying and Limiting Flows Based on TCP Flags	
	DiffServ Support	
	Honoring DSCP and 802.1p (CoS)	
	Dynamic Buffer Allocation for QoS Priorities	
	Separate QoS Queuing for Unicast and Multicast	
	Priority Queue Management using Weighted Round Robin (WRR), Strict Priority (SP), and a combination of WRR and SP	
	Priority for PFC	
8.2	Should support the following Traffic Management features;	
	ACL-based Rate Limiting	
	Traffic Policies	
	Broadcast, Multicast, and Unknown Unicast Rate Limiting	
	Inbound Rate & Outbound Rate Limiting	
	CPU Rate Limiting	
9	Software Defined Networking (SDN)	
9.1	Should support the following SDN features and functionality;	
	OpenFlow v1.0 & v1.3	
	Hybrid Switch Mode	
	Hybrid Port Mode	
	Support for Multiple Controllers	
10	Security	

10.1	Should support the following Security features;
	Layer 3 & Layer 4 ACLs
	Layer 2 ACLs (MAC)
	DHCP Snooping
	DHCP Client & Server
	Dynamic ARP Inspection
	Neighbor Discovery (ND) Inspection
	Protection against Denial of Service (DoS) Attacks
	MAC Port Security
	RADIUS/TACACS/TACACS+
	Secure Copy (SCP)
	Secure Shell (SSHv2)
	Trusted Platform Module
	Protected Ports
	IP Source Guard (v4 & v6)
	IPv6 RA Guard
	RADSEC
10.2	The Switch should support the following Authentication features;
	Authentication, Authorization, and Accounting (AAA)
	802.1X Authentication and Accounting
	MAC Authentication and Accounting
	Web Authentication
	802.1x with Dynamic ACL Assignment
	802.1x with Dynamic VLAN Assignment
	802.1x and MAC Authentication on the same port
	802.1x Authentication with IP Source Guard Protection
	MAC Authentication with IP Source Guard Protection
	MAC Authentication with Dynamic VLAN Assignment
	MAC Authentication with Dynamic ACLs
	MAC Authentication with 802.1x
	802.1x together with Denial of Service (DoS) Attack Protection
	Periodic Reauthentication for MAC Authentication
	Periodic Reauthentication for 802.1x

11	Monitoring & Manageability	
11.1	The Switch should support the following Monitoring & Management features;	
	RSPAN	
	NTP	
	LLDP & LLDP-MED	
	Cisco Discovery Protocol (CDP) for IPv4 and IPv6 Traffic or equivalent	
	Automation with Ansible & RESTCONF	
	DHCP Auto Configuration	
	SNMP v1, v2, and v3	
	Mirroring based on Port, IP ACL, MAC ACL and VLAN	
	Configuration Archive, Replace & Roll back	
	IP DHCP binding scalability of minimum 2K Devices	
11.2	Should support Integrated Standard based Command Line Interface (CLI), Telnet, TFTP, HTTP access to switch management/monitoring.	
11.3	Should support manageability using Network Management Software with Web based Graphical User Interface (GUI) and Cloud based Management Solutions.	
11.4	Should support NetFlow or sFlow or equivalent.	
12	Mandatory Compliance & Warranty and support:	
12.1	All switches, WiFi, WLC, Transceivers, AAA should be from the same OEM for better interoperability, management and support	
12.2	The Switch OS should be EAL/NDPP and ROHS6 Certified. Certificate needs to be enclosed along with the bid	
12.3	The Switch must be MTCTE Certified and TEC certificate shall be submitted	
12.4	The Switch should be quoted with Five (5) Years of TAC Support and 5 years Hardware Warranty with advance hardware replacement.	
12.5	Bidder needs to submit bid specific MAF from the OEM.	
12.6	OEM should not share land border with India. OEM needs to share declaration on the letter head for the same	
12.7	OEM should be ISO 9001:2015 certified. Certificate to be enclosed	
12.8	OEM should have 7-8 RMA depots in India for faster replacements . Details to be shared on the OEM letter head.	
12.9	The switch should have MTBF of >800K Hours at 25° C	

24 Port POE Switch

24Port Gigabit PoE Access Switch		
Sl.No	Specifications	Compliance (Yes/No)
1	Product details - Please specify	
1.1	Please mention Make, Model No. and Part Code.	
2	Architecture & Port Density	
2.1	Access Switch should provide 24 x 10/100/1G PoE+ RJ45 Ports and with minimum 370 watts of PoE power budget and 4x 1G/10G/25G SFP+ Slots, for Stacking/Uplinks, from Day 1.	
	Hardware, including modules, or Software, including licenses, to support all the speeds listed above, should be available from Day 1	
2.2	Should support Virtual Switching System (VSS) or Virtual Chassis (VC) or Virtual Switching Extension (VSX) or equivalent Switch Clustering/Stacking feature, where the Switch Clustering feature should combine multiple switches into a single network element. Switch should support aggregated stacking bandwidth of 800Gbps or more and 8 switches per stack or more.	
3	Performance	
3.1	Should provide Switch Fabric Bandwidth Capacity of 248 Gbps, or more.	
3.2	Should provide Packet Forwarding Capacity of 184 Mpps, or more.	
4	MAC Address and Route Table	
4.1	Should support up to 32K MAC addresses, or more.	
4.2	Should support 16K IPv4 routes and 4K IPv6 routes, or more.	
5	Physical Attributes	
5.1	Switch should be 1U and rack mountable in standard 19" rack.	
5.2	Should support 4GB RAM, 8GB Flash and 4MB Packet buffer or better	
6	Layer 2 features	
6.1	Should support Jumbo Frames (up to 9K bytes).	
6.2	Should support 4K Active VLANs, with the following features;	
	Port based VLANs	
	Dual-Mode VLANs	
	MAC-based VLANs	
	Dynamic VLAN Assignment	
	Dynamic MAC-based VLAN Activation	
	Dynamic Voice VLAN Assignment	

	VLAN mapping or VLAN Translation	
6.3	Should support Spanning Tree Protocols, with the following features;	
	802.1D Spanning Tree	
	802.1W Rapid Spanning Tree Protocol (RSTP)	
	802.1s Multiple Spanning Tree	
	802.1s Multiple Spanning Tree enhancement (MSTP+)	
	Fast Port Span, Fast Uplink Span or Equivalent	
	Compatibility with PVST/PVST+, PVRST+ and PVST+ or Equivalent	
	BPDU Guard	
	Root Guard for STP & MSTP	
	Port Loop Detection	
	Spanning Tree path cost method changes	
	MSTP path-cost configuration	
6.4	Should support Link Aggregation Groups (LAG), with the following features;	
	Static LAG	
	802.3ad Link Aggregation Control Protocol (Dynamic LAG)	
	Dynamic insertion and removal of ports	
	Support for LAG between different default port speeds	
6.5	Should support 802.1q Tunneling, with the following features;	
	802.1ad (Q-in-Q) tagging	
	Q-in-Q BPDU tunneling	
	Selective Q-in-Q	
6.6	Should support Private VLANs, with the following features.	
	PVLANs with dual mode support	
	PVLAN with LAG	
6.7	Should support VLAN Registration Protocol, with the following features;	
	Multiple VLAN Registration Protocol (MVRP)	
	MVRP with Per-VLAN STP and Per-VLAN RSTP	
6.8	Should support the following features;	
	Unicast Reverse Path Forwarding (uRPF)	
	Remote Fault Notification (RFN)	
	Link Fault Signaling (LFS)	

	Uni-Directional Link Detection (UDLD) on Tagged and Untagged Ports	
	To limit Unknown Unicast Packet Flooding (UUFB)	
	Virtual Extensible LAN (VXLAN)	
7	Layer 3 features	
7.1	Should support the following IPv4 and IPv6 Layer 3 Routing features;	
	Routing Between Directly Connected Subnets	
	Host routes & Virtual Interfaces	
	IPv4 & IPv6 Static Routes	
	RIP v1/v2 & RIPng	
	ECMP	
	OSPF v2, OSPF v3	
	PIM-SM, PIM-SSM, PIM-DM, PIM passive	
	Policy Based Routing (PBR)	
	VRRP v2 & VRRP v3	
	Non-Stop Routing (NSR)	
	GRE IP Tunnels	
	IPv6 over IPv4 tunnels and VRF	
	DHCP Server	
	MSDP	
8	Quality of Service (QoS) & Traffic Management	
8.1	Should support the following Quality of Service (QoS) features;	
	ACL Mapping and Marking of ToS/DSCP (CoS)	
	ACL Mapping and Marking of 802.1p	
	ACL Mapping to Priority Queue	
	Classifying and Limiting Flows Based on TCP Flags	
	DiffServ Support	
	Honoring DSCP and 802.1p (CoS)	
	Dynamic Buffer Allocation for QoS Priorities	
	Separate QoS Queuing for Unicast and Multicast	
	Priority Queue Management using Weighted Round Robin (WRR), Strict Priority (SP), and a combination of WRR and SP	
	Priority for PFC	

8.2	Should support the following Traffic Management features;	
	ACL-based Rate Limiting	
	Traffic Policies	
	Broadcast, Multicast, and Unknown Unicast Rate Limiting	
	Inbound Rate & Outbound Rate Limiting	
	CPU Rate Limiting	
9	Software Defined Networking (SDN)	
9.1	Should support the following SDN features and functionality;	
	OpenFlow v1.0 & v1.3	
	Hybrid Switch Mode	
	Hybrid Port Mode	
	Support for Multiple Controllers	
10	Security	
10.1	Should support the following Security features;	
	Layer 3 & Layer 4 ACLs	
	Layer 2 ACLs (MAC)	
	DHCP Snooping	
	DHCP Client & Server	
	Dynamic ARP Inspection	
	Neighbor Discovery (ND) Inspection	
	Protection against Denial of Service (DoS) Attacks	
	MAC Port Security	
	RADIUS/TACACS/TACACS+	
	Secure Copy (SCP)	
	Secure Shell (SSHv2)	
	Trusted Platform Module	
	Protected Ports	
	IP Source Guard (v4 & v6)	
	IPv6 RA Guard	
	RADSEC	
10.2	The Switch should support the following Authentication features;	
	Authentication, Authorization, and Accounting (AAA)	
	802.1X Authentication and Accounting	

	MAC Authentication and Accounting	
	Web Authentication	
	802.1x with Dynamic ACL Assignment	
	802.1x with Dynamic VLAN Assignment	
	802.1x and MAC Authentication on the same port	
	802.1x Authentication with IP Source Guard Protection	
	MAC Authentication with IP Source Guard Protection	
	MAC Authentication with Dynamic VLAN Assignment	
	MAC Authentication with Dynamic ACLs	
	MAC Authentication with 802.1x	
	802.1x together with Denial of Service (DoS) Attack Protection	
	Periodic Reauthentication for MAC Authentication	
	Periodic Reauthentication for 802.1x	
11	Monitoring & Manageability	
11.1	The Switch should support the following Monitoring & Management features;	
	RSPAN	
	NTP	
	LLDP & LLDP-MED	
	Cisco Discovery Protocol (CDP) for IPv4 and IPv6 Traffic or equivalent	
	Automation with Ansible & RESTCONF	
	DHCP Auto Configuration	
	SNMP v1, v2, and v3	
	Mirroring based on Port, IP ACL, MAC ACL and VLAN	
	Configuration Archive, Replace & Roll back	
	IP DHCP binding scalability of minimum 2K Devices	
11.2	Should support Integrated Standard based Command Line Interface (CLI), Telnet, TFTP, HTTP access to switch management/monitoring.	
11.3	Should support manageability using Network Management Software with Web based Graphical User Interface (GUI) and Cloud based Management Solutions.	
11.4	Should support NetFlow or sFlow or equivalent.	
12	Mandatory Compliance & Warranty and support:	

12.1	Should support Virtual Switching System (VSS) or Virtual Chassis (VC) or Virtual Switching Extension (VSX) or equivalent Switch Clustering/Stacking feature, where the Switch Clustering feature should combine multiple switches into a single network element. Switch should support aggregated stacking bandwidth of 800Gbps or more and 8 switches per stack or more.	
12.2	The Switch OS should be EAL/NDPP and ROHS6 Certified. Certificate needs to be enclosed along with the bid	
12.3	The Switch must be MTCTE Certified and TEC certificate shall be submitted	
12.4	The Switch should be quoted with Five (5) Years of TAC Support and 5 years Hardware Warranty with advance hardware replacement.	
12.5	Bidder needs to submit bid specific MAF from the OEM.	
12.6	OEM should not share land border with India. OEM needs to share declaration on the letter head for the same	
12.7	OEM should be ISO 9001:2015 certified. Certificate to be enclosed	
12.8	OEM should have 7-8 RMA depots in India for faster replacements . Details to be shared on the OEM letter head.	
12.9	The switch should have MTBF of >800K Hours at 25° C	

24Port Multigigabit PoE Access Switch

24Port Multigigabit PoE Access Switch		
Sl.No	Specifications	Compliance (Yes/No)
1	Product details - Please specify	
1.1	Please mention Make, Model No. and Part Code.	
2	Architecture & Port Density	
2.1	Access Switch should provide 24 x 10/100/1G/2.5Gbps PoE+ RJ45 Ports and with minimum 740 watts of PoE power budget and 4x 1G/10G/25G SFP+ Slots, for Stacking/Uplinks, from Day 1.	
	Hardware, including modules, or Software, including licenses, to support all the speeds listed above, should be available from Day 1	
2.2	Should support Virtual Switching System (VSS) or Virtual Chassis (VC) or Virtual Switching Extension (VSX) or equivalent Switch Clustering/Stacking feature, where the Switch Clustering feature should combine multiple switches into a single network element. Switch should support aggregated stacking bandwidth of 800Gbps or more and 8 switches per stack or more.	
3	Performance	
3.1	Should provide Switch Fabric Bandwidth Capacity of 320 Gbps, or more.	
3.2	Should provide Packet Forwarding Capacity of 237 Mpps, or more.	

4	MAC Address and Route Table	
4.1	Should support up to 32K MAC addresses, or more.	
4.2	Should support 16K IPv4 routes and 4K IPv6 routes, or more.	
5	Physical Attributes	
5.1	Switch should be 1U and rack mountable in standard 19" rack.	
5.2	Should support 4GB RAM, 8GB Flash and 4MB Packet buffer or better	
6	Layer 2 features	
6.1	Should support Jumbo Frames (up to 9K bytes).	
6.2	Should support 4K Active VLANs, with the following features;	
	Port based VLANs	
	Dual-Mode VLANs	
	MAC-based VLANs	
	Dynamic VLAN Assignment	
	Dynamic MAC-based VLAN Activation	
	Dynamic Voice VLAN Assignment	
	VLAN mapping or VLAN Translation	
6.3	Should support Spanning Tree Protocols, with the following features;	
	802.1D Spanning Tree	
	802.1W Rapid Spanning Tree Protocol (RSTP)	
	802.1s Multiple Spanning Tree	
	802.1s Multiple Spanning Tree enhancement (MSTP+)	
	Fast Port Span, Fast Uplink Span or Equivalent	
	Compatibility with PVST/PVST+, PVRST+ and PVST+ or Equivalent	
	BPDU Guard	
	Root Guard for STP & MSTP	
	Port Loop Detection	
	Spanning Tree path cost method changes	
	MSTP path-cost configuration	
6.4	Should support Link Aggregation Groups (LAG), with the following features;	
	Static LAG	
	802.3ad Link Aggregation Control Protocol (Dynamic LAG)	
	Dynamic insertion and removal of ports	

	Support for LAG between different default port speeds	
6.5	Should support 802.1q Tunneling, with the following features;	
	802.1ad (Q-in-Q) tagging	
	Q-in-Q BPDU tunneling	
	Selective Q-in-Q	
6.6	Should support Private VLANs, with the following features.	
	PVLANs with dual mode support	
	PVLAN with LAG	
6.7	Should support VLAN Registration Protocol, with the following features;	
	Multiple VLAN Registration Protocol (MVRP)	
	MVRP with Per-VLAN STP and Per-VLAN RSTP	
6.8	Should support the following features;	
	Unicast Reverse Path Forwarding (uRPF)	
	Remote Fault Notification (RFN)	
	Link Fault Signaling (LFS)	
	Uni-Directional Link Detection (UDLD) on Tagged and Untagged Ports	
	To limit Unknown Unicast Packet Flooding (UUFb)	
	Virtual Extensible LAN (VXLAN)	
7	Layer 3 features	
7.1	Should support the following IPv4 and IPv6 Layer 3 Routing features;	
	Routing Between Directly Connected Subnets	
	Host routes & Virtual Interfaces	
	IPv4 & IPv6 Static Routes	
	RIP v1/v2 & RIPng	
	ECMP	
	OSPF v2, OSPF v3	
	PIM-SM, PIM-SSM, PIM-DM, PIM passive	
	Policy Based Routing (PBR)	
	VRRP v2 & VRRP v3	
	Non-Stop Routing (NSR)	
	GRE IP Tunnels	

	IPv6 over IPv4 tunnels and VRF	
	DHCP Server	
	MSDP	
8	Quality of Service (QoS) & Traffic Management	
8.1	Should support the following Quality of Service (QoS) features;	
	ACL Mapping and Marking of ToS/DSCP (CoS)	
	ACL Mapping and Marking of 802.1p	
	ACL Mapping to Priority Queue	
	Classifying and Limiting Flows Based on TCP Flags	
	DiffServ Support	
	Honoring DSCP and 802.1p (CoS)	
	Dynamic Buffer Allocation for QoS Priorities	
	Separate QoS Queuing for Unicast and Multicast	
	Priority Queue Management using Weighted Round Robin (WRR), Strict Priority (SP), and a combination of WRR and SP	
	Priority for PFC	
8.2	Should support the following Traffic Management features;	
	ACL-based Rate Limiting	
	Traffic Policies	
	Broadcast, Multicast, and Unknown Unicast Rate Limiting	
	Inbound Rate & Outbound Rate Limiting	
	CPU Rate Limiting	
9	Software Defined Networking (SDN)	
9.1	Should support the following SDN features and functionality;	
	OpenFlow v1.0 & v1.3	
	Hybrid Switch Mode	
	Hybrid Port Mode	
	Support for Multiple Controllers	
10	Security	
10.1	Should support the following Security features;	
	Layer 3 & Layer 4 ACLs	
	Layer 2 ACLs (MAC)	
	DHCP Snooping	
	DHCP Client & Server	

	Dynamic ARP Inspection	
	Neighbor Discovery (ND) Inspection	
	Protection against Denial of Service (DoS) Attacks	
	MAC Port Security	
	RADIUS/TACACS/TACACS+	
	Secure Copy (SCP)	
	Secure Shell (SSHv2)	
	Trusted Platform Module	
	Protected Ports	
	IP Source Guard (v4 & v6)	
	IPv6 RA Guard	
	RADSEC	
10.2	The Switch should support the following Authentication features;	
	Authentication, Authorization, and Accounting (AAA)	
	802.1X Authentication and Accounting	
	MAC Authentication and Accounting	
	Web Authentication	
	802.1x with Dynamic ACL Assignment	
	802.1x with Dynamic VLAN Assignment	
	802.1x and MAC Authentication on the same port	
	802.1x Authentication with IP Source Guard Protection	
	MAC Authentication with IP Source Guard Protection	
	MAC Authentication with Dynamic VLAN Assignment	
	MAC Authentication with Dynamic ACLs	
	MAC Authentication with 802.1x	
	802.1x together with Denial of Service (DoS) Attack Protection	
	Periodic Reauthentication for MAC Authentication	
	Periodic Reauthentication for 802.1x	
11	Monitoring & Manageability	
11.1	The Switch should support the following Monitoring & Management features;	
	RSPAN	
	NTP	
	LLDP & LLDP-MED	

	Cisco Discovery Protocol (CDP) for IPv4 and IPv6 Traffic or equivalent	
	Automation with Ansible & RESTCONF	
	DHCP Auto Configuration	
	SNMP v1, v2, and v3	
	Mirroring based on Port, IP ACL, MAC ACL and VLAN	
	Configuration Archive, Replace & Roll back	
	IP DHCP binding scalability of minimum 2K Devices	
11.2	Should support Integrated Standard based Command Line Interface (CLI), Telnet, TFTP, HTTP access to switch management/monitoring.	
11.3	Should support manageability using Network Management Software with Web based Graphical User Interface (GUI) and Cloud based Management Solutions.	
11.4	Should support NetFlow or sFlow or equivalent.	
12	Mandatory Compliance & Warranty and support:	
12.1	All switches, WiFi, WLC, Transceivers, AAA should be from the same OEM for better interoperability, management and support	
12.2	The Switch OS should be EAL/NDPP and ROHS6 Certified. Certificate needs to be enclosed along with the bid	
12.3	The Switch must be MTCTE Certified and TEC certificate shall be submitted	
12.4	The Switch should be quoted with Five (5) Years of TAC Support and 5 years Hardware Warranty with advance hardware replacement.	
12.5	Bidder needs to submit bid specific MAF from the OEM.	
12.6	OEM should not share land border with India. OEM needs to share declaration on the letter head for the same	
12.7	OEM should be ISO 9001:2015 certified. Certificate to be enclosed	
12.8	OEM should have 7-8 RMA depots in India for faster replacements . Details to be shared on the OEM letter head.	
12.9	The switch should have MTBF of >500K Hours at 25° C	

Fiber SFP Module

10G SFP+ SR Optics (300 Meters)		
SN	Specifications	Compliance (Yes/No)
1	SFP should support Multi-Mode Fiber 850nm.	
2	SFP should support OM3 Multi-Mode Fiber Cable	
3	SFP should be 802.3ae compliant and shall support a distance	

	up to 300 Meters	
4	SFP should have LC Connector	
5	SFP should be protocol independent & Hot-Swappable	
6	SFP should be MSA, ROHS 5 & 6 Compliant	
7	SFP should support Digital Optical Monitoring	
8	SFP should support operating temperature from (00 C to 700C)	

10G SFP+ LR Optics (10 KM)		
SN	Specifications	Compliance (Yes/No)
1	SFP should support Single-Mode Fiber 1310nm.	
2	SFP should support Single-Mode Fiber Cable	
3	SFP should be 802.3ae compliant and shall support a distance up to 10 Kilometers	
4	SFP should have LC Connector	
5	SFP should be protocol independent & Hot-Swappable	
6	SFP should be MSA, ROHS 5 & 6 Compliant	
7	SFP should support Digital Optical Monitoring	
8	SFP should support operating temperature from (00 C to 700C)	

Wireless Controller		
S. No	Specification	Compliance (Yes/No)
1	Wireless Controller should be tested for EAL 2/NDPP or above under Common Criteria Certification . Certificate must be submitted.	
2	Wireless Controller should be MTCTE (Mandatory Testing & Certification Of Telecommunication Equipment) Certified and Certificate issued by TEC (Telecommunication Engineering Center), Department of Telecommunications must be submitted.	
3	Wireless Controller should be quoted with 05 years of TAC Support & 5 years Hardware Warranty with advance hardware replacement	
4	Wireless Controller should support operating temperature from 00 to 400 degree celsius.	
5	Wireless Controller should have minimum of 4 x 1Gigabit Ethernet & 4 x 10Gigabit Ports or more. 4x10G Multimode SFP+ transceivers to be supplied with the controller	

6	Wireless Controller should support 1+1 Internal Redundant Power Supply.	
7	Controller should be able to manage the required number of APs on a single appliance from day one and should be scalable up to 2000 AP on single appliance and 6000 AP in a clustered configuration. Cloud Based solution will not be accepted. The controller or the solution should be able to monitor and manage the required number of switches.	
8	Support for N:1 redundancy for controller. In case primary controller goes down all features should be supported by redundant controller. Software/ Cloud Based Controller Solution will not be accepted.	
9	Each Controller or its cluster should have capacity to handle 40,000 or more Concurrent devices.	
10	Redundancy Features: WLC must support Active: Active with N+1 redundancy.	
11	Controller should support minimum 2000 WLAN's.	
12	The proposed WLAN solution must support a distributed forwarding/local breakout architecture in which only client authentication is tunneled to the centralized controller; all client data traffic is forwarded directly on towards its destination via the clients default gateway. Further: a. Specify any loss of functionality, caveats or loss of capacity/performance is exhibited by the solution in this distributed forwarding mode. b. On a per WLAN (SSID) basis there must be an option to tunnel traffic to the controller either unencrypted or encrypted format	
13	Controller should provide air-time fairness between the different speed clients – slower clients should not be starved by the faster clients and faster clients should not adversely affected by slower clients.	
14	Controller should have the Ability to map SSID to VLAN and dynamic VLAN support for same SSID.	
15	Controller should support automatic channel selection for interference avoidance.	
16	Controller should support external Captive Portal Integration - Web-services based API for external web-portals to integrate with the controller	
17	Controller should have the capability to limit/prevent clients from using static IP addresses thereby enhancing network efficiency and preventing network conflicts.	
18	The controller or WLAN solution should support client troubleshooting feature that allows an administrator to focus on a specific client device and its connectivity status. The tool should track the step-by-step progress of the client's connection, through 802.11 stages, RADIUS, EAP authentication, captive portal redirects, encryption key setup, DHCP, roaming, and more (depending on WLAN type).	
19	For troubleshooting purpose the administrator of the controller must have the ability to remotely capture 802.11 and/or 802.3	

	frames from an access point without disrupting client access.	
20	In order to have good visibility on the utilization of an AP, the controller or proposed solution should be able to provide the following statistics for each AP: a. List of all the SSIDs deployed on each of the radio of the AP. b. Number of client devices associated on each radio c. Average client RSSI. d. Data sent/received e. Air Time utilization (%RX, %TX, %Busy) f. Statistics on retransmitted packets g. Graphical collation of various trend and troubleshooting data such as estimated channel capacity, current channel utilization, number of associated clients, RF pollution, other APs detected	
21	The controller or proposed solution should support Role-based Access Controls that can provide policy controls on a single SSID such as: a. Time of day access b. VLAN assignment c. Per device rate limiting d. Deny/Allow specified device OS types	
22	The controller should support in built spectrum analysis feature.	
23	The controller should support the ability to create different zones in which AP can be grouped logically or physically based on location for example different buildings of a campus can be configured as different zones so that each zone will have different configuration and policies.	
24	The controller should support Hotspot 2.0 (pass point).	
25	Access points can discover controllers on the same L2 domain without requiring any configuration on the access point.	
26	Access points can discover controllers across Layer-3 network through DHCP or DNS option	
27	WIRELESS SECURITY & Authentication: Open, 802.1x/EAP, PSK, WISPr, WPA, WPA2-AES. Fast EAP-SIM re-authentication. EAP-SIM, EAP-AKA, EAP-AKA over WLAN for 802.1X Wi-Fi. It should also support WPA3 and Enhanced Open	
28	To aid to physically locating rogue devices in conjunction with scanning at the APs the controller should be able to list/classify detected Rogue Devices. Further: a) The information presented must include information about the detecting AP(s) and the rogues signal strength relative to them. It should display rogues on a map b) The controller should be able to send a filtered notification to the administrator when a rogue device has been detected c) Neighbouring APs should be capable of de-authenticating clients from a malicious rogue device i.e. one which is spoofing the BSSID or SSID of a genuine managed AP. d) The controller or proposed solution should support rogue classification policy. The policy should support rules for AdHoc Networks, Clear to Send (CTS) Abuse, De-Authentication Flood, Disassociation Flood, Request to Send (RTS) Abuse, Excessive Power, MAC (BSSID) Spoofing, Same Network, NULL SSID and SSID Spoofing.	

	e) The WLAN or proposed solution should support Known, Ignore, Malicious and Rogue as part of WIPS classification types.	
29	WLC Should support L2 Client Isolation so User cannot access each other's devices. Isolation should have option to apply on AP or SSID's.	
30	Support for Walled Garden "Walled Garden" functionality to allow restricted access to select destinations by unauthorized wireless users.	
31	The proposed architecture should be based on controller-based Architecture with thick AP deployment. While Encryption / decryption of 802.11 packets should be able to perform at the AP.	
32	The controller should provide a captive portal to authenticate Guest users that are not part of the organization via a Guest pass key. Further the solution must provide:	
	a. Provide a web-based application that allows non-technical staff to create Guest passes that are valid for a time limited duration	
	b. Allow the IT Administrator to view and delete individual Guest passes	
	c. Allow for batch generation of Guest passes	
	d. Provide customizable Guest portal and guest pass instructions.	
33	The controller or overall solution must also support Self registration of Guests.	
34	The controller must be capable of identifying device host OS type and the host name. Further the solution must be able to utilise the host OS information to provide per WLAN policy based access such as allow/deny access, rate limit and assign to VLAN	
35	When Wireless Mesh is enabled, the controller should be able to show the mesh topology on floor plans in a graphical format.	
36	The Wireless Mesh should support self-healing whereby if Root AP goes down then the Mesh AP should be able to automatically find and connect to another Root AP	
37	WLC should be able to present a customizable dashboard with information on the status of the WLAN network.	
38	The WLAN solution should support import of floor plans for indoor AP.	
39	WLC should be able to raise critical alarms by sending an email. The email client on the controller should support SMTP outbound authentication and TLS encryption.	
40	The controller or its integrated solution must support APIs for easier management and integration with existing network management devices. Provide the list of APIs supported.	
41	WLC or integrated solution should provide customized reporting	

	of historical WLAN information.	
42	Controller should support Filtering of Alarms and event Log based on APs, SSID or Zones	
43	Controller should support Syslog support towards external syslog server	
44	Controller should support per SSID or dynamic Per user bandwidth Rate Limiting	
45	Controller should support Self-healing (on detection of RF interference or loss of RF coverage) and vendor should provide their Interference mitigation techniques.	
46	System must support Band Steering where 5 Ghz clients are forced to connect over 5Ghz Radio to provide better load balancing among 2.4Ghz and 5Ghz Radios.	
47	WLC shall support Quality of Service features like 802.11e based QoS enhancements, WMM or equivalent and U-APSD to provide best performance on Video applications.	
48	The controller should provide Application recognition to allow the administrator to gain insight on the applications in use and the bandwidth they consume per system and per user.	
49	The Controller or WLAN solution should support Wired network (Network Switch) & Wireless Access Point (Indoor & Outdoor) management from single management interface.	
50	The Controller or WLAN solution should support switch registration and authentication	
51	The Controller or WLAN solution should support Switch inventory (model, FW version, last backup, etc)	
52	The Controller or WLAN solution should support Health and performance monitoring (status, traffic stats, errors, clients etc) with alarms	
53	The Controller or WLAN solution should support switch Firmware Upgrade	
54	The Controller or WLAN solution should support Switch configuration file backup and restore	
55	The Controller or WLAN solution should support Client troubleshooting - search by Client MAC to find the AP/switch port for that client	
56	Bidder needs to submit bid specific MAF from the OEM.	
57	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
58	Wireless Controller shall conform to TEC EMI EMC Standard EN/IEC 60950-1, EN 55022, EN 61000-3-2, EN61000-3-3. TEC certificate shall be submitted	
59	Wireless Controller should be capable to integrate with Cloud Based Network Analytics Engine to provide Wireless Performance Insights, KPIs and what are the applications (Top N apps) that are consuming the most network bandwidth,	

	monitors application traffic arriving from users (Top N talkers)	
60	All switches, WiFi, WLC, Transceivers, AAA should be from the same OEM for better interoperability, management and support	

Indoor WiFi Access Point

WiFi6 Indoor WiFi Access Point		
S.No	Specification	Compliance (Yes/No)
	General Features	
1	Access Point should be tested for EAL 2/NDPP or above under Common Criteria Certification or Certificate issued by Indian Common Criteria Certification Scheme (IC3S) Certificate must be submitted.	
2	Access Point should be MTCET (Mandatory Testing & Certification Of Telecommunication Equipment) Certified and Certificate issued by TEC (Telecommunication Engineering Center), Department of Telecommunications must be submitted.	
3	Access Point should have been approved by Wireless Planning Commission (TRAI, Govt. of India), ETA Certificate must be submitted.	
4	Access Point must be Wi-Fi Alliance Certified to ensure the interoperability with other make client devices.	
5	Access Point should be quoted with 05 years of TAC Support & 5 years for Hardware Warranty .	
6	Access Point should support operating temperature from 00 to 50 degree celsius.	
	Radio Specifications	
7	Access Point should be dual-band, dual-radio indoor access point which should support six spatial streams 4x4:4 SU/MU-MIMO on 5GHz and 2x2:2 SU/MU-MIMO on 2.4GHz.	
8	Access Point should support IEEE 802.11 a/b/g/n/ac/ax standards.	
9	Access Point should support total data rates of 2974 Mbps (5GHz: 2400Mbps & 2.4GHz: 574 Mbps)	
10	Access Point should support Channelization at 20 Mhz, 40Mhz, 80 Mhz, 160/ 80+80Mhz	
11	Access Point should provide 26dBm transmit power on both radios as per TRAI-WPC Regulatory Norms. Access Point should have -96dBm or lower receive sensitivity.	
12	Access Point should have adaptive antenna technology for performance optimization and interference mitigation features. Access Point should provide better coverage and performance utilizing multi-directional antenna patterns and polarization with maximal ratio combining.	

13	Access Point should direct the radio signals per-device on a packet-by-packet in real time to support high device density environments. Antenna should operate without the need for device feedback to support devices using legacy standards.	
	Interface & Power Requirements	
14	Access Point PoE port should have 1 x 2.5Gbps PoE+ and 1 x 1Gbps Ethernet Port and 1 x USB Port	
	Networking Requirements	
15	Access Point should have capacity to handle minimum 500 concurrent devices.	
16	Access Point should support minimum 30 SSID or more.	
17	Access Point should have built-in/ external support for BLE and Zigbee for IoT integration	
18	Access Point should have built-in diagnostics tools such as Spectrum Analyzer to analyse the RF Channel for Interference & Client speed test etc.	
19	Access Point should support Airtime Fairness, Client Load Balancing, Airtime Based WLAN Prioritization.	
20	Access Point should be flexible hardware to be deployed as Standalone, Controller less (Cluster), Controller Based (Hardware or Software), Cloud Based Controller without changing the Hardware.	
21	Access Point should support Dual Stack (IPv4 & IPv6), IEEE 802.1Q, Band Balancing, QoS, Layer 2/3 & 4 Access Control List.	
22	Access Point should be able to act as WIPS Sensor, Location Analytics Engine & Network Analytics Engine.	
23	Access Point should support Flexconnect or Site-Survivability, in case the controller goes down the Access Point must be able to handle the client traffic without any disruption.	
	Security & Monitoring	
24	Access Point should support AES Encrypted GRE Based Tunnel for Data Forwarding.	
25	Access Point should support auth/encryption methods for WLAN configuration: WPA-2 AES, PSK, WPA3, WPA2/WPA3 Mix, OWE. It should support Role Based Access Control, Rate-Limiting, Device Fingerprinting and 802.11r Fast Roaming.	
26	Access Point should support WMM Power Save, Tx Beamforming, LDPC, STBC, 802.11r/k/v, Hotspot 2.0, Captive Portal and WISPr.	
	Management Features	
27	Access Point should have administration access through HTTPS GUI, SSH & CLI. It should provide WLAN Configuration for standalone operation and provisioning tools for controller/ cloud operations. If controller dis-allows GUI/CLI access it should follow the same	

	policy/ rule.	
28	Access Point should have recovery SSID for easy access to Console (CLI) when the AP is unreachable through network.	
	Certification	
29	Access Point shall conform to UL-2043 Plenum, EN 62311 Human Safety/ RF Exposure, WEEE & ROHS Standard.	
30	Access Point shall conform to TEC EMI EMC Standard EN/IEC 61000-4-2, EN61000-4-3, EN61000-4-5.	
31	All Switches, Optical Transceivers, Wireless Controller and Wireless Access Point should be from the same OEM for better interoperability, ease of administration and ease of technical support.	

WiFi 6 Outdoor WiFi Access Point

WiFi6 Outdoor WiFi Access Point		
S.No.	Specifications	Compliance (Yes/No)
1	The APs should support IEEE 802/11a/b/g/n/ac/ax standards with Dual Band Concurrent 2x2:2 streams (2.4GHz) + 2x2:2 streams (5GHz)	
2	The proposed access point should be 802.11ax (Wi-Fi 6) and Operate in dual band radio.	
3	The AP Should supports on both bands for the capacity of 2.4GHz 802.11b/g/n/ac/ax 574 Mbps and 5 GHz 802.11b/g/n/ac/ax 1200 Mbps	
4	The AP shall have 1 ports, auto MDX, auto-sensing 10/100/1000 Mbps, RJ-45 port	
5	The access point should be capable to be managed as standalone or through Hardware/virtual controller/Cloud based controller or it should work as a controller based on the site requirement.	
6	The Outdoor AP should support 40 MHz channelization on 2.4GHz and 20/40/80 MHz channelization on 5 GHz. It should also support MU-MIMO.	
7	The access point should be able to operate in full MIMO mode with 802.3af/at POE.	
8	Antenna should dynamically choose antenna patterns in real-time environment to establish the best possible connection with every device. Should support at least 64 antenna patterns combinations.	
9	AP should have adaptive antenna technology for performance optimization and interference mitigation features. Antenna should provide better coverage and performance utilizing multi-directional antenna patterns and polarization diversity with maximal ratio combining .	

10	Since the WLAN network will be using an unlicensed band the solution should have mechanisms that reduce the impact of interference generated by other radio equipment operating in the same band. Please Describe techniques supported.	
11	The access point should be able to detect clients that have dual band capability and automatically steer those client to use the 5GHz band instead of the 2.4GHz band.	
12	The antennas to be dual polarised and should be integrated inside the access point enclosure to minimize damage and create a low profile unit that does not stand out visually. The antennas could be omnidirectional or directional as per the requirement or site survey done by the vendor.	
13	The access point should support 802.1q VLAN tagging	
14	The access point should support WPA2/3 enterprise authentication. AP should support Authentication via 802.1X and Active Directory.	
15	Implement Wi-Fi alliance standards WMM, 802.11d, 802.11h and 802.11e	
16	The Access Point should provide for concurrent support for high definition IP Video, Voice and Data application without needing any configuration change. This feature should be demonstrable.	
17	Channel selection based on measuring throughput capacity in real time and switching to another channel should the capacity fall below the statistical average of all channels without using background scanning as a method.	
18	Should support Transmit power tuning in 1dB increments in order to reduce interference and RF hazards	
19	Device antenna gain (integrated) must be at least 3dBi.	
20	AP should support AES encrypted GRE-based tunnel for data forwarding.	
21	AP Should support auth/encryption methods for WLAN configuration: Open, WEP, WPA2-AES, PSK, WPA3-SAE, WPA3-OWE, IEEE 802.1X/EAP, AAA, AES-GCMP-256.It should also support Role-Based Access Control, rate-limiting, device fingerprinting, 802.11w MFP and 802.11r Fast roaming.	
22	Should support 500 or more clients per AP and SSID up to 15 per radio	
23	Should support IPv6 from day one	
24	For troubleshooting purposes, the administrator should have the ability to remotely capture 802.11 and / or 802.3 frames from an access point without disrupting client access.	
25	Operating Temperature:-20°C to 65°C	
26	Operating Humidity: up to 95% non-condensing.	
27	The Outdoor AP should be IP67 rated & Wind Survivability Up to 266km/h (165 mph)	
28	Should be WiFi certified, and WPC approved; ETA certificate and TEC certificate to be enclosed	

29	Certifications Wi-Fi CERTIFIED a, b, g, n, ac Wi-Fi CERTIFIED ax WPA, WPA2 and WPA3 WMM, Wi-Fi Vantage Passpoint	
30	Regulatory EN60950 Safety/Equivalent Indian Standard EN60601 Medical/Equivalent Indian Standard EN 62311 Human Safety/RF Exposure /Equivalent Indian Standard ROHS UL 2043 Plenum	
31	Warranty & support: 5 years advance replacement warranty and 5 years OEM 24/7 TAC support	

Approved makes for CCTV & IT

A.	CCTV System			
1)	CCTV cameras (True IP)	PELCO	AXIS	IDIS
2)	Workstation/Server hardware	Dell	Lenovo	HP
3)	NVR	PELCO	AXIS	IDIS
4)	Monitor Screen	Samsung	LG	Sony
5)	Hard Disk	Seagate	WD	Toshiba
6)	Network cable & Component/ Racks/ Fiber Items	Simon	Panduit-Pannet	Belden
7)	Network Switch	Cisco / Aruba-HP/ Ruckus		
8)	VMS / Analytic Software	Mile Stone	Avigilon	IDIS
b.	Passive Components			
1)	Cat-6A & Cat-6 Cable and components	Siemon	Panduit-Pannet	Belden
2)	Face Plates	Siemon	Panduit-Pannet	Belden
3)	Jack panels	Siemon	Panduit-Pannet	Belden
4)	Network Racks	Rittal	Panduit-Pannet	APC (ABW)
5)	Fibre Cable & Components	Simon	Panduit-Pannet	Belden
6)	MDF & SDF	Krone		

7)	Analogue Telephone Cable	Delton	Bonton	Polycab
C	Active Components			
1)	L2/L3 Switches / POE Switchs	Cisco	HP	Ruckus
2)	Access Points (Wifi)	Cisco	HP	Ruckus
3)	AAA Solution	Cisco	HP	Ruckus
4)	Server	Dell	HP	Lenovo
6)	SFP Modules	Cisco	HP	Ruckus

General Notes:

- a) Supply, testing, packing, transportation and transit insurance from the source to the site is in bidders scope.
- b) Receipt, storage, insurance, preservation and conservation of equipment at the site is in bidders scope.
- c) All works including road cutting/horizontal boring which may be required for Road Crossing or any other crossings.
- d) Fabrication, pre-assembly (if any), erection, testing and putting into satisfactory operation of all the equipment/material including successful commissioning.
- e) The Bidder shall be responsible for providing all material, equipment and all other associated services specified or otherwise which are required to ensure operability, maintainability and the reliability of the complete work covered under this specification.
- f) All services & activities required to be provided contractually, by the bidder, during warranty period.
- g) The technical specification shall be read together with CPWD specifications for completeness scope of work and services.

QUALITY ASSURANCE, INSPECTION AND TESTING:

- a) The bidder shall have a Quality Assurance Programme (QAP) for the FMAKES
- b) execution encompassing quality assurance at manufacturers' works, storage, erection, testing and commissioning activities.
- c) Bidder shall submit the individual quality plan for various equipment after placement of award and obtain approval of IIT KANPUR.
- d) Drawings and Individual Manufacturing Quality plan (MQP)s and Field quality Plan (FQP)s pertaining to each equipment like LT panels, bus risers & cables etc shall be submitted by bidder after award for review and approval by IIT Kanpur.
- e) Suitable inspection call has to be raised for witness the routine test as per approved MQP by the bidder. EIC shall reserve the right to wave off the physical inspection and accept the equipment based on the reports submitted by the manufacturer/Bidder.
- f) Successful bidder should submit samples/technical data sheets of all light fixtures, wires, DBs and other bought out items for approval of Executive engineer (elec).
- g) Institute reserves the right to accept/reject any items based on the tendered specifications and site requirements without assigning any reason to contractor.
- h) Bidder shall strictly adhere to the provisions of approved MQP & FQPs. The bidder shall offer proven and type tested equipment for the project.
- i) All routine and acceptance tests shall be carried out as per approved MQP. The bidders shall arrange to give sufficient advance intimation of the manufacturing and testing schedules to facilitate timely inspection of the equipments by the IIT Kanpur
- j) The Manufacturing Quality Plans for each equipment submitted by supplier shall cover detailed checks at various stages of raw material, bought out items, in process, final testing, etc. and packing, prior to dispatch. The submitted Quality Plan shall be in line with manufacturer's plant, national/international standards, Approved Data Sheet and contract specification. This shall also contain statutory testing requirements, if any.
- k) This shall also contain statutory testing requirements, if any. Field Quality Plan (FQP) is intended to cover all activities at site from material receipt and storage, handling, pre-assembly, assembly up to completion of erection activities of equipment.
- l) Required commissioning checklists shall be submitted for approval for all equipment and systems of the project and putting them into successful commercial operation.

PART -D

HVAC COMPONENT

**Name of work: Construction of hostel block Hall 15 at IIT
Kanpur – HVAC Work**

Part	Name	Detailed Estimate amount (In Rs. Lacs)
1	HVAC- IVRF, Chilled water pumps, AHUs, TFAs and accessories (Ducting, Piping, Valves, Grills/Diffusers, Fitting etc.)	563.54

A. GENERAL TERMS AND CONDITIONS

1. SCOPE OF WORK

Scope of work covers planning, designing, supply, installation, testing & commissioning of HVAC services required to be provided in the said scheme. The scope of work to be carried out under the contract is illustrated in DBR, Drawings, Specifications and Schedule. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Executive Engineer (Air-conditioning). The contractor shall furnish all labour, materials and equipment as listed under Schedule and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete HVAC system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract.

The system includes:

- a. Supply, Installation, Testing and Commissioning of tertiary chilled water pumpsets for Block-3 & 4.
- b. Supply, Installation, Testing and Commissioning of AHRI Certified plate type heat exchanger for Block- 3 & 4.
- c. Supply, Installation, Testing and Commissioning of double skin air handling units.
- d. Supply, Installation, Testing and Commissioning of extract fan sections & inline fans associated with toilet ventilation and other areas.
- e. Supply, Installation, Testing and Commissioning of axial flow fans associated with pressurization and smoke evacuation.
- f. Supply, Installation and Testing of chilled water piping complete with modulating valves/ strainer & fittings etc.
- g. Supply, Installation, Testing and Commissioning of air distribution system comprising of factory fabricated GSS Rectangular duct work, round sheet metal ductwork complete with acoustic lining and thermal insulation, extruded aluminum powder coated grilles & diffusers, volume control dampers etc. as required.
- h. Supply & Installation of condensate drain piping complete with insulation.
- i. Supply, Installation, Testing & Commissioning of associated electrical work comprising of motor control centre, control panels, power cabling, earthing etc.

- j. Supply & Installation of automatic controls and instrumentation required for efficient functioning of the HVAC system.
- k. Supply , Installation, Testing & Commissioning of HVAC control system.
- l. Supply, Installation, Testing & Commissioning of VRF system for technical area air- conditioning.
- m. Balancing, Testing and Commissioning of the entire installation under scope.

2. Exclusions :

The following works associated with the HVAC installation do not fall in the scope of HVAC package and shall be carried out by other respective agencies in accordance with HVAC contract and shop drawings of and under direct supervision of HVAC contractor.

i. Associated Works : Civil :

- i. Foundations for various equipment including heat exchanger, Pumps and electrical panel being installed in tertiary plant room in Block- 3 & 4.
- ii. Overdeck thermal insulation for exposed roof using 50mm thick extruded polystyrene, density not less than 32Kg/CuM amalgamated with water proofing treatment.
- iii. Providing PCC/RCC Blocks as foundations for ventilation fans etc. as required.
- iv. Finishing & making good of the above openings/cutouts. Openings provided in slab on terrace to be provided with rain water protection arrangement.
- v. Any kind of false ceiling work required for enclosing the ductwork and piping.
- vi. Necessary epoxy paint to be applied on various components of structural platform to be installed on terrace for HVAC equipment.

ii. Associated Works : Electrical

- i) 415+10% V, 3 Phase AC power supply along with earthing to be terminated at the following locations :
 - a. In chilled water pump panel located within tertiary plant rooms.
 - b. In each ventilation fan panel at the locations indicated in the relevant design drawings.
- ii) 220 + 10% Volts, Single Phase power point to be provided near each inline fan for exhaust, fan coil unit, if any as shown in relevant design drawing.
- iii) Pressurization and smoke evacuation fans to be hooked-up with the fire alarm system.

iii. Associated Works : Plumbing

1. Providing drainage arrangement in tertiary plant rooms.

3.0 Equipment

Testing and Commissioning shall include furnishing all labour, materials, instruments etc. and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations.

Maintenance services for the complete HVAC installation under scope shall be provided during the defects liability period.

4. The above scheme of all the E & M work shall have to meet all the requirements of local bodies/ CEA/NBC norms as applicable and meet the technical specifications of various relevant CPWD specifications for E & M works.

5. Technical Submittals

The successful tenderer after award of work shall furnish technical submittals for various items incorporating complete technical details prior to procurement of equipment/materials, for the approval of the Engineer-in-charge . The submittals for items mentioned in the tender document but not restricted to the following:

a.	Air Handling Units.
b.	Fan coil units
c.	Axial Flow fans
d.	Pre insulated pipes
e.	Factory fabricated ducting, GS Sheet, dampers, grilles & diffusers and actuators, sensors etc.
f.	Insulation material.
g.	Variable frequency drive, variable air volume boxes
h.	Field devices and DDC controllers
i.	BMS software and hardware components
j.	Electrical Panels & components.
k.	Chilled water pumps
l.	IVRF type AC system
J	Plate Heat Exchanger

Test certificates for various items shall also be submitted by the contractor.

6.0 Performance Guarantee

The Contractor shall guarantee uninterrupted service and stipulated quality of performance of the installed HVAC system. The guarantee shall be furnished in the Proforma indicated in the Appendix-I. It is to be clearly understood that the specifications indicated represent minimum performance requirements for the tenderers guidance.

7.0 Fees and Permits

The Contractor shall obtain all permits /licenses and pay for any and all fees required for the installation, inspection and commissioning of the work.

8.0 Liability to Govt. Regulations:

- a. The Contractor shall be responsible and shall abide by all the Government rules and regulations pertaining to erection, testing and commissioning of complete HVAC system at site.
- b. Any compensation towards damage/loss of property/material/ equipment or to any person working at site shall be borne by the Contractor as per standard terms of Contract.
- c. No escalation/ change of prices would be admissible under any circumstances.

9 No Limit to Liability :

In addition to the liability imposed by law upon the Contractor for injury (including death) to persons or damage to property by reason of the negligence of the Contractor or his agents, which liability is not impaired or otherwise affected hereby, the Contractor hereby assumes liability for and agrees to save the Engineer-in-charge harmless and indemnifies him from every expense, liability or payment by reason of any injury (including death) to persons or damage, to property suffered through any act of omission of the Contractor, or any of his sub-Contractors, or any person directly or indirectly employed by any of them or from the conditions of the premises or any part of the premises which is in the control of the Contractor or any of his sub-contractors, or any one directly or indirectly employed by either of them, or arising in any way from the work called for by this contract.

10.0 Engineering Responsibility of the system

- a. The responsibility of system design, manufacturing, erection, working and safety will solely be responsibility of the Contractor for the parameters as mentioned in the tender documents prepared by the Engineer-in-charge.
- b. The system after commissioning shall be handed over to the Engineer-in-charges and thereafter they will monitor the performance for standard designed (without operation of any other equipment) parameters for 30 days continuously. In case during this period the performance is not found satisfactory and rectification/ replacement, design improvement or any other change as felt necessary, will be made by the Contractor at no extra cost. Though these improvements can only be done after getting the approval from the Engineer-in-charges.

11.0 Schedule and Manner of Operations

Time being the essence of this Contract, the Contractor will be expected to furnish all labour and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract. In addition to providing a detailed time and progress schedule, the Contractor shall submit an outlined and graphic schedule of proposed procedures to the Engineer-in-charge within two days of issue of work order.

12.0 Bye Laws & Regulations

The installation shall be in conformity with the bye-laws, regulations and standards of the concerned local authorities so far as these become applicable to the installation. However, if these specifications call for a higher standard of materials and /or workmanship than those required by the regulations and standards then these specifications shall take precedence over the said regulations and standards then these specifications shall take precedence over the said regulations and standards. If the specifications call for requirements which violate the bye-laws and regulations, the bye-laws and regulations shall govern the requirements of these installations.

13.0 Erection and Supervision :

- a. The Contractor shall depute engineers from time to time of commencement of assembly and installation work to inspect all relevant civil construction/ fabrication and other necessary facilities to make improved action if felt necessary. However, a site engineer preferably a graduate in mechanical or electrical discipline shall be deputed at site permanently till completion of the work and shall be identified to the Client at the time of appointment at site.
- b. All the ducting installation work shall be carried out in conformity with approved reflected ceiling plans well in advance to ensure uninterrupted working of other agencies.

14.0 Electrical Power

The tenderer shall submit with their quotation the break up of electrical power requirement for all the HVAC equipment.

15.0 Design Drawings

The drawings prepared by the Consultant/Engineer-in-charge as listed under HVAC LAYOUT DRGS are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation. The Contractor shall thoroughly examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation and report to the Engineer-in-charge any discrepancy and obtain clarifications. Any changes found necessary for coordination and installation of this work with other services and trades shall be made with prior approval of the Engineer-in-charge without any additional cost to the Engineer-in-charge.

16.0 Technical Data

The tenderer shall submit a comprehensive schedule of technical data and complete manufacturer's specifications for all items of equipment and material including the

manufacturer's name. The technical data shall be furnished in the proforma indicated in Appendix B.

17.0 Shop Drawings

- a. Within 45 days after the award of the Contract, the contractor shall furnish for the approval of the /engineer in charge, three sets of detailed shop drawings of all equipment and materials including plant room, ducting, piping, ventilation system electrical work associated with the HVAC system required to complete the project as per Specifications and as required by the engineer in charge. These drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics, and capacity of all items of equipment, as also the details of all related items of work by other Contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications.

If the Engineer-in-charge makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the engineer in charge, the Contractor shall submit a further six sets of shop drawings for the exclusive use of and retention by the Engineer-in-charge. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.

- b. The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Engineer-in-charge ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved CPM charts.
- c. Samples, drawings, specifications, catalogues, pamphlets and other documents submitted for approval shall be in quadruplicate, each item in each set shall be properly labeled, indicating the specific service for which material or equipment is to be used, giving reference to the governing section and clause number of Specifications clearly identifying in ink the items and the operating characteristics data of a general nature shall not be accepted.
- d. Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are approved said approval does not mean that drawings have been checked in detail nor does it way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract.
- e. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout , all such redesign and all new drawings and detailing required thereof, shall be prepared by the Contractor at his own cost and approved by the Engineer Incharge.

- f. Where the work of the Contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustments. If so directed by the engineer in charge, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Engineer-in-charge.

18.0 Co-operation /Co-ordination with other agencies

During the currency of the Contract, a number of Contractors will be at site to execute works under their respective contracts viz. structure, finishing works, electrical, lifts and other services. All these agencies will be at site at the same time. The Contractor shall offer full co-operation to, all these agencies with regard to use of materials etc. and co-ordinate the work in such a manner that the time schedules of all agencies are not adversely affected. The work shall be executed as per program approved by the engineer in charge. If part of site is not available, for any reason, or if there is some unavoidable delay in supply of materials stipulated by the Engineer-in-charge, the program of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.

No claim shall be entertained from the Contractor on the plea that the work has been executed in the above circumstances or under difficult conditions. It shall be the responsibility of the Contractor to enforce necessary discipline among his workers and staff to ensure smooth working at the site in spirit of co-operation and amity with all other agencies.

19.0 Construction Program & Schedule Of Operations:

A tentative construction program indicating the scheduling of various activities forms an annexure to this document. The Contractor should examine this program with respect to construction logic, scheduling and duration of various activities etc. in relation to the resources available at his disposal, and suitably modify the program without extending the total duration of the job as also the completion targets for major milestones of the job and submit a modified construction program along with a firm commitment to adhere to the dates of completion of various activities. This construction program shall after scrutiny and approval of the engineer in charge form part of the agreement and shall be treated as a baseline schedule to monitor, determine delays in individual activities, work milestones or the overall duration of the work.

In the event of the Contractor, not submitting any modified construction program, the tentative construction program shall remain binding on the Contractor.

The Contractor shall mobilize equipment, tools, plant, scaffolding, shuttering, material, labour etc. in sufficient quantities so as to complete the work to meet the above agreed construction program. In the event of delays in the construction activities, the Contractor shall mobilize additional resources to complete the job in the specified time period and at no extra cost to the Engineer-in-charge.

The Engineer-in-charge may suggest an alternative scheduling of operations, should they find it necessary to accomplish the targets and the Contractor shall accordingly mobilize additional resources at no extra cost to the Engineer-in-charge.

20.0 Electrical Installation and Cabling

The electrical works related to the HVAC system shall be carried out in full knowledge and with complete co-ordination of the Contractor. It is to be clearly understood that the final responsibility for sufficiency, adequacy, and conformity to the performance of the HVAC system shall be with the Contractor.

21.0 Testing and Commissioning

On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the and without any extra cost to the Engineer-in-charge. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by the Engineer-in-charge. All tests shall be carried out in the presence of the Engineer-in-charge or his representative.

22.0 Completion Certificate

On successful completion of the installation, a certificate in the approved format shall be furnished by the Contractor. The Contractor shall be responsible for getting the entire installation duly approved by the Electrical Inspector or concerned authority, if any, and shall bear the all expenses in connection with the same.

23.0 Completion Documents

- a. 5 copies of operation manuals/catalogues of all standard equipment to be furnished by the contractor immediately after commissioning of HVAC system.
- b. 5 copies of write up on preventive maintenance, trouble shooting and operating instructions of the system alongwith as-built drawings to be supplied by the Contractor at time of commissioning.
- c. 5 sets of catalogues of all accessories such as dampers, valves, strainers, gauges, electrical components etc.

24.0 Completion Drawings

On completion of the work in all respects, the Contractor shall supply five port folios (300 x 450mm) each containing a complete set of drawings at approved scale clearly indicating complete AHU layouts, ducting and piping layouts, location wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the BMS control room a schematic with BMS controls, one set of these consolidated control diagrams.

25.0 Training of Engineer-in-charge's representative

Upon completion of work and conclusion of all tests, the Contractor shall furnish necessary skilled labour and helpers for operating the entire installation for a period of thirty working days of eight hours each, to enable the Engineer-in-charge's representative to get acquainted with the operation of the system. During this period, the Contractor shall train the Engineer-in-charge's representatives in the operation, adjustments and maintenance of all equipment installed.

26.0 Correction of Work before Final Payment

The Engineer-in-charge shall conduct a final inspection just before the virtual completion of the work and prepare a final list of materials, equipment and item of work which fail to conform to the contract specifications. The Contractor shall promptly replace or re-execute such items in accordance with the contract and shall bear all expenses of making good all work and the cost of all work of the other Contractor, destroyed or damaged by such replacement or removal.

If the Contractor fails to remove and replace above rejected materials, equipment/ or workmanship within a reasonable time, fixed by written notice, the Engineer-in-charge may employ and pay other persons to amend and make good such defects at the expense of the Contractor. All expenses incurred by the Engineer-in-charge in rectifying the defects including all damages, loss and expense consequent on the defects shall be recoverable from any amount due or which may become due to the Contractor.

27.0 Virtual Completion

The work shall be considered virtually complete only upon fulfillment of the procedure laid down in the preceding clause and when the Consultants and the Engineer-in-charge has certified in writing that the work has been virtually completed. The defect liability period shall commence from the date of such certificate.

28.0 Maintenance of Liability Period

Defects liability period shall commence from the date of virtual completion upon fulfillment of the procedure laid down. The complete HVAC system shall be under warrantee of 36 months from the date of completion of the system. Contractor shall include incidental expenses towards necessary maintenance during defects liability period.

29.0 Force majeure

The right of the contractor to proceed with the work shall not be terminated because of any delay in the completion of the work due to unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not limited to acts of God, or of public enemy, restraints of a sovereign state, floods, unusually severe weather.

30.0 Use and Care of Site

Contractor will be permitted to use without charge, the site and the areas shown in the contracts drawing for execution of work and for related activities. The contractor shall not commence any operation on such and except with the approval of the Engineer-in-charge.

All rubbish shall be burnt or removed from the site as it accumulates. All surface and soil drains shall be kept in a clean sound and workman-like state. All the areas of contractor's

operation shall be cleared before returning them to the Engineer-in-charge. The contractor shall make good any damages or alternations made to areas, properly or land handed over to him before these are returned.

31.0 Safety Provisions

The contractor shall take full responsibility for the adequate stability and safety of all site operations and methods of construction, subject to provisions of excepted risks and special risks.

The contractor shall at his own expense arrange for the safety in his operations as required. Safety provisions shall be as per the latest safety manuals published by Indian Standard Institution, Statuary Rules, Regulations and Provisions of contract conditions.

32.0 Clearance of Site

The Contractor shall have to remove all malba and other unwanted materials from site of work, before handing over HVAC installation to the Engineer-in-charge. The work shall not be treated as complete in all respects unless these requirements are fulfilled by him. In the event of the Contractor failing to do so, the Engineer-in-charge shall have the right to get the site cleared at his expenses.

33.0 After Sales Services:

The HVAC Contractor shall ensure adequate and prompt after sales service in the form of maintenance personnel and spares as and when required with a view to minimizing the breakdown period. Particular attention shall be given to ensure that all spares are easily available during the normal life of the installation.

34. Works Inspection and Testing of Equipment:

Prior to dispatch of the AHU's, factory fabricated ducting, pre insulated pipes, valves and other equipment's the Institute reserves the right to inspect the same at the manufacturer's works and the contractor shall provide and secure every reasonable access and facility at the manufacturers works for inspection, for witness of all acceptance and routine tests as per relevant Indian Standards. Contractor shall give a reasonable notice of about 15 days for the purpose of test, and witness of all major equipment's. For this inspection the visiting expenses shall be borne by the Institute and not to be uploaded in to the contract except the testing charges. The contractor shall only facilitate the inspection, testing at manufacturer works. The Pre insulated chilled water pipe shall be tested at the manufacturing location as per the specification.

35.0 The work shall be executed on the basis of the following CPWD specifications:

i) Electrical & HVAC Works:

- General specifications for Electrical Works Part-1 (Internal) 2023 with up to date corrections.
- General specifications for electrical works (external) 2023 with upto date corrections.
- General specifications for electrical works Part-VII (DG set) 2013 with upto date corrections.

- General specifications for electrical works Part-IV Sub-station- 2013 with upto date corrections.
- General Specifications for Heating, Ventilation & Air-Conditioning (HVAC) – 2024 with up to date corrections.

36. RELATED DOCUMENTS

These Specifications shall be read in conjunction with the General conditions of contract, schedule of work, drawings and other documents connected with the work.

37. TERMINOLOGY

The definition of terms used in these specifications shall be in accordance with IS: 3615- "Glossary of terms used in refrigeration and air-conditioning". Some of the commonly used terms are defined in last chapter of the specification.

B. Eligibility condition for Associate agency for execution of HVAC works.

1. The associate agency for HVAC works shall be having valid electrical license.
- 2 .They should have successfully completed works, as mentioned under during last 7 year ending previous day of last date of submission of tender.

- i) Three similar works each of value not less than 40% (i.e. Rs. 225.42 Lacs without GST) of the estimated cost put to tender for HVAC component

OR

Two similar works each of value not less than 60% (i.e. Rs. 338.13 Lacs without GST) of the estimated cost put to tender for HVAC component

OR

One similar work each of value not less than 80% (i.e. Rs. 450.83 Lacs without GST) of the estimated cost put to tender for HVAC component

Out of the above at least one work must be in the Central Govt. /Central autonomous bodies/central PSU/State PSU/State Govt.

Similar nature of work means: Execution of central air-conditioning low side works i.e. supply, installation, testing & commissioning of chilled water pump, AHU/FCU, IVRF type AC system, ducting, piping, insulation and its controls etc.

- ii) Having GST, ESI & EPF registration No. of government authorities.
- iii) Details of average annual financial turnover of air-conditioning works should be at least 50% of the estimated cost during the last 3 consecutive financial years.

The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum; calculated from the date of completion to the previous day of last date of submission of tenders.

6. The main contractor / agency has to submit detail of such associate agency to Engineer-In charge (HVAC) within 45 days of issue of award of letter. (The associate agency shall be approved by Executive Engineer (AC) .In case the main contractor intends to change any of the above agency / agencies during the operation of the contract; he shall obtain prior approval of Executive Engineer (AC).
7. The new agency shall also have to satisfy the laid down eligibility criteria. In case Executive Engineer (AC) is not satisfied with the performance of any agency, he can direct the main contractor to change the agency executing such items of work and this shall be binding on the contractor.
8. The eligible tenderer for major component (i.e. civil) will quote rates for various items of minor components (i.e. HVAC) of work also. It will be obligatory on the part of the tenderer to sign the tender document for all the components.(After acceptance of the tender by competent authority, the SE, IWD shall issue letter of award on behalf of the Board of Governors.
9. Entire work under the scope of composite tender including major and all minor components shall be executed under one agreement.
10. The tenderer has to enter into agreement with the contractor(s) associated by him for execution of minor component(s). Copy of such agreement shall be submitted to EE in-charge of minor component as well as to EE in-charge of major component. In case of change of associate contractor, the main contractor has to enter into agreement with the new contractor associated by him. The Memorandum of Understanding between Main Contractor & the HVAC contractor& the certificate of willingness by the HVAC contractor shall be as per Proforma A & B respectively.
11. In case, the bidder is not having desired experience for execution of similar HVAC works, he shall associate air-conditioning contractor with adequate experience for the execution of similar nature of air-conditioning works. The bidder shall indicate minimum three agencies, to which he would like to associate for the execution of HVAC works. The proposed HVAC agencies shall be evaluated on the basis of eligibility criterion for the estimated value of HVAC component. The credentials of HVAC agency have to be submitted along with the technical bid.
12. The tenderer shall, within fifteen days of issue of award of letter, submit details of the agency which he proposes to associate with him for execution of HVAC items of work along with consent letter of HVAC Contractor. The details shall be submitted in the per the required eligibility criteria of HVAC Contractor attached with the tender documents to the Engineer-in-charge of HVAC item of work. The eligibility of the agency proposed to be associated for HVAC items of work shall be governed by the provisions contained in paras 5.
13. The main contractor shall be responsible for execution the HVAC work as per the detailed specification and as per requirement at the site. The contractor shall get approved the final execution drawing and specification before start of the work.

PERFORMA-A

MEMORANDUM OF UNDERSTANDING [M.O.U] BETWEEN

1] M/S [Name of firm with full address]

Enlistment Status

Valid Upto :

[Henceforth called the Sub contractor]

And

2] M/S [Name of firm with full address]

Enlistment Status

Valid Upto :

[Henceforth called the main contractor]

Name of work :- Construction of hostel block Hall 15 at IIT Kanpur – HVAC Work

[HVAC component only] as per schedule, specification, terms and conditions of the tender.

We state that M.O.U between us will be treated as an agreement and has legality as per Indian Contract Act (amended upto date) and the department (IIT Kanpur) can enforce all the terms and conditions of the agreement for execution of the work. Both of us shall be responsible for execution of the work as per the agreement to the extent this MOU permits.

We have agreed as under :

1- The associated contractor shall be liable for disciplinary action if he failed to discharge the action(s) and other legal action as per agreement beside forfeiture of the security deposit.

2- All the material, machinery, equipment's, tools and tackles required for the execution of HVAC works as per agreement shall be the responsibility of the associated contractor.

3- The site staff required for HVAC work shall be arranged be the associated contractor as per terms and conditions of the agreement.

SIGNATURE OF SUB CONTRACTOR

SIGNATURE OF MAIN CONTRACTOR

DATE

DATE

PLACE

PLACE

COUNTER SIGNED

EXECUTIVE ENGINEER (AC)

PERFORMA-B

WILLINGNESS CERTIFICATE

Name of work :- Construction of hostel block Hall 15 at IIT Kanpur – HVAC Work

I will execute the work as per specification and terms and conditions of the agreement and as per direction of the Engineer-in-Charge. Also I will employ full time technically qualified supervisor for the work. I will attend inspection of officers of the department as when required.

"I/We undertake and confirm that eligible similar work(s) has/ have not been got executed through another contractor on back to back basis. Further that, if such a violation comes to notice of the Department, then I/We shall be debarred for tendering in IIT Kanpur contract in future forever."

"I have also read the complete tender conditions and I am aware that complete tender condition of this tender document is applicable to me also"

Date :

Signature of Contractor

SPECIAL CONDITIONS OF CONTRACT

The specifications given hereunder relate to the supply, installation, testing and commissioning of HVAC System and shall be read in conjunction with the appropriate Indian and International Standard Specifications.

1.0 Engineers

The Institute Engineers & consultant have prepared the estimate for HVAC work at Hall 15.

2.0 Site

The air-conditioning work using water cooled centrifugal chillers shall be carried out for HOSTEL BLOCK HALL-15 IIT KANPUR to facilitate year round air conditioning.

3. Basis of Design Data

4. AIRCONDITIONING SYSTEM

The various parameters influencing the air conditioning system design have been furnished below.

i. Orientation

The building orientation is as envisaged in the architectural plans.

b. Outside design conditions

The outside design conditions for KANPUR have been given here under:

Season	Dry Bulb Temperature	Wet Bulb Temperature
Summer	109 °F (42.7 °C) db	77 °F (25 °C) wb
Monsoon	97 °F (36.1 °C) db	83 °F (28.3 °C) wb

c. Inside design conditions

Summer & Monsoon :

Temperature :	73 ± 2F (22.7 ± 1 C) db
Relative Humidity :	Not to exceed 65% during monsoon

d. Fresh air requirement: Generally in line with **ASHRAE 62.1 -2022** recommendations.

e. Design Data

Spaces on VRF System: (BLOCK-1)

Floor/ Space	Floor Area	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
Ground Floor							
Visitor's Area	1430	9.2	14	1	Nil	Nil	12-14
Total Ground	1430						
1st Floor							
Warden Room	300	9.2	3	1	Nil	Nil	12-14
Office	210	9.2	4	1	0.5	Nil	12-14
Meeting Room	760	9.2	30	1	1.0	Nil	12-14
Warden Room	300	9.2	3	1	Nil	Nil	12-14
Office	210	9.2	4	1	0.5	Nil	12-14
Total 1st Floor	1780						
2nd Floor							
Room-1	230	9.2	2	1	Nil	Nil	12-14
Room-2	230	9.2	2	1	Nil	Nil	12-14
Room-3	230	9.2	2	1	Nil	Nil	12-14
Room-4	230	9.2	2	1	Nil	Nil	12-14
Room-5	230	9.2	2	1	Nil	Nil	12-14
Room-6	230	9.2	2	1	Nil	Nil	12-14
Total 2nd	1380						
3rd Floor							
Room-1	230	9.2	2	1	Nil	Nil	12-14
Room-2	230	9.2	2	1	Nil	Nil	12-14
Room-3	230	9.2	2	1	Nil	Nil	12-14
Room-4	230	9.2	2	1	Nil	Nil	12-14
Room-5	230	9.2	2	1	Nil	Nil	12-14
Room-6	230	9.2	2	1	Nil	Nil	12-14
Total 3rd	1380						
Grand Total	5970						

Spaces on VRF System: (BLOCK-2)

Floor/ Space	Floor Area	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
Ground Floor							
Canteen	980	18.9	28	1.5	1.0	5	12-14
Kitchen	470	18.9	4	1.0	0.2	Nil	12-14
Total Ground	1450						

Floor/ Space	Floor Area	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
1st Floor							
MULTIPURPOSE HALL	4670	18.9	50	1.5	5.0	Nil	12-14
Total 1st Floor	4670						
2nd Floor							
Recreational Space-1	650	18.9	7	1.0	Nil	Nil	12-14
Reading Room	500	18.9	5	1.0	Nil	Nil	12-14
Library	640	18.9	6	1.0	Nil	Nil	12-14
Recreational Space-2	640	18.9	6	1.0	Nil	Nil	12-14
Recreational Space-3	490	18.9	5	1.0	Nil	Nil	12-14
Recreational Space-3	650	18.9	6	1.0	Nil	Nil	12-14
Corridor	970	18.9	10	1.0	Nil	Nil	12-14
Total 2nd	4540						
Grand Total	10660						

Spaces on CHW System: (BLOCK-3 Lower Side)

Floor/ Space	Floor Area (Sft)	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
1st Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Total 1st Floor	1320						
2nd Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14

Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 2nd Floor	2640						
3rd Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 3rd Floor	2200						
4th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14

Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 4th	2200						
5th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 5th	2200						
6th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14

Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 6th	2200						
7th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 7th	2200						
8th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14

Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 8th	2200						
9th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 9th	2200						
10th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14

Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 10th	2200						
11th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 11th	2640						
12th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14

Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 12th	2640						
Total Block-3 Lower	26840						

Spaces on CHW System: (BLOCK-3 Upper Side)

Floor/ Space	Floor Area	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
1st Floor LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Total 1st Floor	1320						
2nd Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14

Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 2nd	2640						
3rd Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 3rd	2200						
4th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 4th	2200						
5th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14

Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 5th	2200						
6th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 6th	2200						
7th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14

Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 7th	2200						
8th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 8th	2200						
9th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14

Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 9th	2200						
10th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 10th	2200						
11th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14

Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 11th	2640						
12th Floor							
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 12th	2640						
Total BLOCK-3 UPPER	26840						
GRAND TOTAL BLOCK-	53680						

Floor/ Space	Floor Area (Sft)	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
1st Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Total 1st Floor	1320						
2nd Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 2nd Floor	2640						
3rd Floor							
RHS Room							
Room-1	110	9.2	2	1	Nil	Nil	12-14
Room-2	110	9.2	2	1	Nil	Nil	12-14

PROPOSED HOSTEL BLOCK HALL-15 IIT

HVAC

Room-3	110	9.2	2	1	Nil	Nil	12-14
Room-4	110	9.2	2	1	Nil	Nil	12-14
Room-5	110	9.2	2	1	Nil	Nil	12-14
Room-6	110	9.2	2	1	Nil	Nil	12-14
Room-7	110	9.2	2	1	Nil	Nil	12-14
Room-8	110	9.2	2	1	Nil	Nil	12-14
Room-9	110	9.2	2	1	Nil	Nil	12-14
Room-10	110	9.2	2	1	Nil	Nil	12-14
Room-11	110	9.2	2	1	Nil	Nil	12-14
Room-12	110	9.2	2	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	2	1	Nil	Nil	12-14
Room-2	110	9.2	2	1	Nil	Nil	12-14
Room-3	110	9.2	2	1	Nil	Nil	12-14
Room-4	110	9.2	2	1	Nil	Nil	12-14
Room-5	110	9.2	2	1	Nil	Nil	12-14
Room-6	110	9.2	2	1	Nil	Nil	12-14
Room-7	110	9.2	2	1	Nil	Nil	12-14
Room-8	110	9.2	2	1	Nil	Nil	12-14
Total 3rd Floor	2200						
4th Floor							
RHS Room							
Room-1	110	9.2	2	1	Nil	Nil	12-14
Room-2	110	9.2	2	1	Nil	Nil	12-14
Room-3	110	9.2	2	1	Nil	Nil	12-14
Room-4	110	9.2	2	1	Nil	Nil	12-14
Room-5	110	9.2	2	1	Nil	Nil	12-14
Room-6	110	9.2	2	1	Nil	Nil	12-14
Room-7	110	9.2	2	1	Nil	Nil	12-14
Room-8	110	9.2	2	1	Nil	Nil	12-14
Room-9	110	9.2	2	1	Nil	Nil	12-14
Room-10	110	9.2	2	1	Nil	Nil	12-14
Room-11	110	9.2	2	1	Nil	Nil	12-14
Room-12	110	9.2	2	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	2	1	Nil	Nil	12-14
Room-2	110	9.2	2	1	Nil	Nil	12-14
Room-3	110	9.2	2	1	Nil	Nil	12-14
Room-4	110	9.2	2	1	Nil	Nil	12-14
Room-5	110	9.2	2	1	Nil	Nil	12-14
Room-6	110	9.2	2	1	Nil	Nil	12-14
Room-7	110	9.2	2	1	Nil	Nil	12-14
Room-8	110	9.2	2	1	Nil	Nil	12-14
Total 4th Floor	2200						
5th Floor							
RHS Room							
Room-1	110	9.2	2	1	Nil	Nil	12-14
Room-2	110	9.2	2	1	Nil	Nil	12-14
Room-3	110	9.2	2	1	Nil	Nil	12-14
Room-4	110	9.2	2	1	Nil	Nil	12-14
Room-5	110	9.2	2	1	Nil	Nil	12-14
Room-6	110	9.2	2	1	Nil	Nil	12-14
Room-7	110	9.2	2	1	Nil	Nil	12-14

Room-8	110	9.2	2	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 5th Floor	2200						
6th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 6th Floor	2200						
7th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14

LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 7th Floor	2200						
8th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 8th Floor	2200						
9th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14

Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 9th Floor	2200						
10th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room- 10	110	9.2	1	1	Nil	Nil	12-14
Room- 11	110	9.2	1	1	Nil	Nil	12-14
Room- 12	110	9.2	1	1	Nil	Nil	12-14
Total 10th Floor	2200						
11th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14

PROPOSED HOSTEL BLOCK HALL-15 IIT

HVAC

Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 11th Floor	2640						
12th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 12th Floor	2640						
Total Block-4 Lower Side	26840						

Floor/ Space	Floor Area (Sft)	Height (ft)	Occupancy (Persons)	Lighting Load (Watts/Sft)	Equipment Load (KW)	Appliances (Sft) *	Hours of Operation
1st Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Total 1st Floor	1320						
2nd Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 2nd Floor	2640						
3rd Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14

Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 3rd Floor	2200						
4th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 4th Floor	2200						
5th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14

Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 5th Floor	2200						
6th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 6th Floor	2200						
7th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14

Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 7th Floor	2200						
8th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 8th Floor	2200						
9th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14

Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 9th Floor	2200						
10th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Total 10th Floor	2200						
11th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14

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HVAC

Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 11th	2640						
12th Floor							
RHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
LHS Room							
Room-1	110	9.2	1	1	Nil	Nil	12-14
Room-2	110	9.2	1	1	Nil	Nil	12-14
Room-3	110	9.2	1	1	Nil	Nil	12-14
Room-4	110	9.2	1	1	Nil	Nil	12-14
Room-5	110	9.2	1	1	Nil	Nil	12-14
Room-6	110	9.2	1	1	Nil	Nil	12-14
Room-7	110	9.2	1	1	Nil	Nil	12-14
Room-8	110	9.2	1	1	Nil	Nil	12-14
Room-9	110	9.2	1	1	Nil	Nil	12-14
Room-10	110	9.2	1	1	Nil	Nil	12-14
Room-11	110	9.2	1	1	Nil	Nil	12-14
Room-12	110	9.2	1	1	Nil	Nil	12-14
Total 12 th Floor	2640						
Total BLOCK-4 UPPER SIDE	26840						
Grand Total BLOCK-4	53680						

Notes:

1. The design data furnished above is subject to further confirmation by the Client.

7.1 Heat Loads:

Based on the Interior layouts and above design data, the Heat Loads for the various spaces to be air conditioned have been worked out and the heat load results have been furnished below:

Spaces on VRF System: (BLOCK-1)

Floor/ Space	Floor Area	Calculated		Dehumidified Air Qty. (Cfm)	Fresh Air Qty.	Equipment Selection
		Summer	Monsoon			
Ground Floor						
Visitor's Area	1430	4.9	4.3	2220	200	4x 1.6 TR Four Way Cassette Units VRF
Total Ground Floor	1430	4.9	4.3			
1st Floor						
Warden Room	300	1.3	1.0	650	30	1x 2 TR Hi - wall Unit VRF Type
Office	210	1.3	1.1	630	30	1x 1.6 TR Four Way Cassette Unit VRF
Meeting Room	760	4.5	4.3	1800	200	2x 2.4 TR Four Way Cassette Units VRF
Warden Room	300	1.3	1.1	650	30	1x 2 TR Hi - wall Unit VRF Type
Office	210	1.3	1.2	660	30	1x 1.6 TR Four Way Cassette Unit VRF
Total 1st Floor	1780	9.7	8.7			
2nd Floor						
Room-1	230	1.4	1.4	570	100	1x 2 TR Hi - wall Unit VRF Type
Room-2	230	1.4	1.3	520	100	1x 2 TR Hi - wall Unit VRF Type
Room-3	230	1.4	1.4	570	100	1x 2 TR Hi - wall Unit VRF Type
Room-4	230	1.4	1.4	580	100	1x 2 TR Hi - wall Unit VRF Type
Room-5	230	1.3	1.3	510	100	1x 2 TR Hi - wall Unit VRF Type
Room-6	230	1.4	1.4	570	100	1x 2 TR Hi - wall Unit VRF Type
Total 2nd Floor	1380	8.3	8.2			
3rd Floor						
Room-1	230	1.6	1.5	680	100	1x 2 TR Hi - wall Unit VRF Type
Room-2	230	1.5	1.5	630	100	1x 2 TR Hi - wall Unit VRF Type
Room-3	230	1.6	1.5	680	100	1x 2 TR Hi - wall Unit VRF Type

Room-4	230	1.6	1.5	690	100	1x 2 TR Hi - wall Unit VRF Type
Room-5	230	1.5	1.4	620	100	1x 2 TR Hi - wall Unit VRF Type
Room-6	230	1.6	1.5	680	100	1x 2 TR Hi - wall Unit VRF Type

Total 3rd	1380	9.4	8.9			
Grand Total	5970	32.3	30.1			

Spaces on VRF System: (BLOCK-2)

Floor/ Space	Floor Area (Sft)	Calculated Load		Dehumidified Air Qty. (Cfm)	Fresh Air Qty.	Equipment Selection
		Summer	Monsoon (TR)			
Ground Floor						
Canteen	980	8.8	8.1	3330	390	1x 3500 Cfm CS DX AHU
Kitchen	470	2.6	2.0	1320	50	1x 1500 Cfm CS DX AHU
TFA for Kitchen	--	12.4	12.6	4600	4600	1x 4600 Cfm CS F/B TFA Unit & 1x 5000 Cfm Exhaust
Total Ground	1450	23.8	22.7			
1st Floor						
Multipurpose Hall	4670	28.7	23.6	13190	530	3x 4500 Cfm CS DX AHUs
Total 1st Floor	4670	28.7	23.6			
2nd Floor						
Recreational Space-1	650	5.2	4.1	2470	70	1x 2500 Cfm CS DX AHU
Reading Room	500	4.3	3.5	2020	60	1x 2500 Cfm CS DX AHU
Library	640	5.1	4.1	2420	70	1x 2500 Cfm CS DX AHU
Recreational Space-2	640	3.3	2.6	1470	70	1x 1500 Cfm CS DX AHU
Recreational Space-3	490	2.4	1.9	1080	50	1x 1500 Cfm CS DX AHU
Recreational Space-4	650	2.8	2.2	1220	70	1x 1500 Cfm CS DX AHU
Corridor	970	2.6	2.1	1140	60	1x 1500 Cfm CS DX AHU
Total 2nd	4540	25.7	20.5			
Grand Total	10660	78.2	66.8			

Spaces on CHW System: (BLOCK-3 Lower Side)

Floor/ Space	Floor Area (Sft)	Calculated Load		Dehumidified Air Qty. (Cfm)	Fresh Air Qty.	Equipment Selection
		Summer	Monsoon (TR)			
1st Floor						
LHS Room						
Room-1	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi- wall Unit
Room-2	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	390	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	390	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Total 1st	1320	8.6	7.2			
2nd Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall

Room- 10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room- 11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room- 12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total	2640	16.7	14.4			
2nd Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall

Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 3rd	2200	14.1	12.1			
4th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						

Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 4th	2200	14.2	12.1			
5th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall

Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 5th	2200	14.2	12.1			
6th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 6th	2200	14.2	12.1			
7th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW

						Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 7th	2200	14.2	12.1			
8th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall

Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 8th	2200	14.2	12.1			
9th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						

Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 9th	2200	14.2	12.1			
10th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall

Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW
						Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 10th	2200	14.2	12.1			
11th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall

Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total	2640	16.7	14.4			
11th Floor						
12th Floor						
LHS Room						
Room-1	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.7	440	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.8	0.6	420	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall
RHS Room						
Room-1	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall

Room-6	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.7	440	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.8	0.6	420	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall
Total 12th	2640	18	14.8			
Total BLOCK-3	26840	173.5	147.6			

Floor/ Space	Floor Area	Calculated Load		Dehumidified Air Qty. (Cfm)	Fresh Air Qty.	Equipment Selection
		Summer	Monsoon			
1 st Floor						
LHS Room						
Room-1	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.1	0.9	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.1	0.9	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 1 st	1320	13.4	10.8			
2 nd Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.2	1.0	660	20	1 x 1.5 TR CHW based Hi-wall Unit

						Hi-wall Unit
Room-11	110	1.1	0.9	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.1	0.9	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total	2640	21.9	18.1			
2nd and 3rd Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						

Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 3rd	2200	17.7	15.1			
4th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall

Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW Hi-wall Unit
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 4th	2200	17.7	15.1			
5th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.2	1.0	660	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.1	0.9	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit

Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 5th	2200	18.5	15.2			
6th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 6th	2200	17.7	15.1			
7th Floor						
LHS Room						

Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 7th	2200	17.7	15.1			
8th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit

Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 8th	2200	17.7	15.1			
9th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit

Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 9th	2200	17.7	15.1			
10th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall

Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.2	1.0	670	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total	2200	17.7	15.1			
10th Floor						
11th Floor						
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.0	0.9	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	580	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.0	0.9	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.0	0.9	570	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall

Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.1	0.9	620	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.1	0.9	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.1	0.9	610	20	1 x 1.5 TR CHW based Hi-wall Unit
Total	2640	21.1	18			
11th						
12th Floor						
LHS Room						
Room-1	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.2	1.0	680	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.2	1.0	660	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.2	1.0	660	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.1	0.9	630	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.2	0.9	650	20	1 x 1.5 TR CHW based Hi-wall Unit
RHS Room						
Room-1	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall

Room-6	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-7	110	1.2	1.0	680	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-8	110	1.2	1.0	660	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-9	110	1.2	0.9	640	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-10	110	1.2	1.0	660	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-11	110	1.1	0.9	630	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-12	110	1.2	0.9	650	20	1 x 1.5 TR CHW based Hi-wall Unit
Total 1st Floor	2640	23	19			
Total BLOCK-3	26840	221.8	186.8			
GRAND TOTAL	53680	395	334			

Spaces on CHW System: (BLOCK-4 Lower Side)

Floor/ Space	Flo or Are	Calculated		Dehumidif ied Air Qty.	Fresh Air Qty.	Equipment Selection
		Summ er	Monso on			
1 st Floor						
RHS Room						
Room-1	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi- wall Unit
Room-2	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	390	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
LHS Room						
Room-1	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	390	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall

Total 1st	1320	8.6	7.2			
2nd Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 2nd	2640	16.7	14.4			

3rd Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 3rd	2200	14.1	12.1			
4th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall

Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Total 4th	2200	14.2	12.1			
5th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW

						Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 5th Floor	2200	14.2	12.1			
6th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit

Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 6th	2200	14.2	12.1			
7th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW

						Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 7th Floor	2200	14.2	12.1			
8th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 8th Floor	2200	14.2	12.1			
9th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW

						Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 9th Floor	2200	14.2	12.1			
10th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit

Room-6	110	0.8	0.7	430	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 10th	2200	14.2	12.1			
11th Floor						
RHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW

						Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.6	0.6	320	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.6	0.6	300	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	330	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Total 11th	2640	16.7	14.4			
12th Floor						
RHS Room						
Room-1	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.7	440	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	420	20	1 x 1 TR CHW based Hi-wall Unit

Room-11	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.8	0.7	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.7	440	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	420	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Total 12th	2640	18	14.8			
Total BLOCK-4 Lower Side	26840	173.5	147.6			

Spaces on CHW System: (BLOCK-4 Upper Side)

Floor/ Space	Floor Area (Sft)	Calculated Load		Dehumidified Air Qty. (Cfm)	Fresh Air Qty. (Cfm)	Equipment Selection
		Summer (TR)	Monsoon (TR)			
1st Floor						
RHS Room						
Room-1	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi- wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	0.8	0.6	400	20	1 x 1 TR CHW

						wall Unit
Room-2	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-3	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-4	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 1st Floor	1320	8.6	7.2			
2nd Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	0.9	1.0	490	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit

Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 2nd	2640	21	19.3			
3rd Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	0.9	1.0	490	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW

						Hi-wall Unit
Total 3rd Floor	2200	17.5	15.9			
4th Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	0.9	1.0	490	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 4th Floor	2200	17.5	15.9			
5th Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW

						Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 5th Floor	2200	17.7	16			
6th Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit

Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 6th	2200	17.7	16			
7th Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit

Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 7th	2200	17.7	16			
8th Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW

						Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 8th Floor	2200	17.7	16			
9th Floor						
RHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit

Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit

Total 9th	2200	17.7	16			

10th Floor

RHS Room

Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit

LHS Room

Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	0.9	600	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	0.7	0.6	360	20	1 x 1 TR CHW based Hi-wall Unit
Room-6	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 10th	2200	17.7	16			

11th Floor

RHS Room

Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit

Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.0	1.0	550	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	530	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	520	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.7	0.6	370	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	340	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	350	20	1 x 1 TR CHW based Hi-wall Unit
Total 11th	2640	21.2	19.4			
12th Floor						
RHS Room						
Room-1	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit

Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW Hi-wall Unit
Room-5	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.7	440	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	390	20	1 x 1 TR CHW based Hi-wall Unit
LHS Room						
Room-1	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-2	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-3	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-4	110	1.0	1.0	570	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-5	110	1.1	1.1	590	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-6	110	1.0	1.0	560	20	1 x 1.5 TR CHW based Hi-wall Unit
Room-7	110	0.8	0.7	440	20	1 x 1 TR CHW based Hi-wall Unit
Room-8	110	0.8	0.6	410	20	1 x 1 TR CHW based Hi-wall Unit
Room-9	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-10	110	0.8	0.6	400	20	1 x 1 TR CHW based Hi-wall Unit
Room-11	110	0.7	0.6	380	20	1 x 1 TR CHW based Hi-wall Unit
Room-12	110	0.7	0.6	390	20	1 x 1 TR CHW based Hi-wall Unit
Total 12th	2640	21.8	20			
Total BLOCK-4 UPPER SIDE	2684 0	213.8	193.7			
Grand Total BLOCK-4	5368 0	387	341			

Assumptions and Notes:

The above heat loads have been worked out based on the following assumptions:

All structural glazing shall be provided with double glass – U Value = 0.32 BTUs/hr/Sft. Deg

F
& SHGC = 0.57.

Windows in Rooms shall be provided with thick curtains.

Over-deck thermal insulation shall be provided for exposed roof using at least 50mm thick extruded polystyrene insulation material (by other agencies).

All corridors, Block-3 & 4 corridors shall be non-air-conditioned & naturally ventilated.

Extract air quantities associated with Kitchen and various hoods has been considered based on inputs received from Facility Planners.

Local ON/OFF switch shall be provided for kitchen exhaust & Makeup air.

8.0 Maximum Demand & High Side Equipment Selection

Maximum demand associated with the HVAC system & High Side Equipment being proposed for the above building is given here under:

Chilled Water System:

S. No.	Description	BLOCK-3			
		Summer	Monsoon	Summer	Monsoon
a.	Floor area to be Air-Conditioned	53680 Sft	53680 Sft	53680 Sft 8	0 Sft 536
b.	Calculated Heat Load	395 TR	334 TR	387 TR	341 TR
c.	Diversity Factor	0.85	0.85	0.85	0.85
d.	Maximum Demand	336 TR	284 TR	329 TR	290
e.	Installed PHE associated with Tertiary System Water meter	1x 350 TR Water to Water Plate type Heat Exchanger			

VRF System: BLOCK-1

S.	Description	Heat Loads/ High Side Equipment Selection	
		Summer	Monsoon
a.	Floor area to be air- conditioned	5970 Sft	5970 Sft
b.	Maximum	32.2 TR	30.1 TR
c.	Proposed modules of VRF outdoor unit installation	Ground Floor 1x 8 HP VRF ODU for All IDUs 1st Floor 1x 16 HP VRF ODU for All IDUs 2nd Floor 1x 14 HP VRF ODU for All IDUs 3rd Floor	

BLOCK-2

S.	Description	Heat Loads/ High Side Equipment Selection	
		Summer	Monsoon
a.	Floor area to be air- conditioned	10660 Sft	10660 Sft
b.	Maximum	78.2 TR	66.8 TR
c.	Proposed modules of VRF outdoor unit installation	Ground Floor 1x 18 HP VRF ODU for Canteen & Kitchen AHUs 1x 20 HP VRF ODU for Kitchen TFA Units 1st Floor 1x 44 HP VRF ODU for Multipurpose Hall AHU 2nd Floor 1x 40 HP VRF ODU for All AHUs Total =122 HP	

(Spaces on Air-cooled Dx Split Packages)

Floor/ Space	Floor Area (Sft)	Height (Ft)	Lighting E Load (Watts/ Sq Ft)	Equipment Load (KW)	Calculated Summer	Monsoon	Dehumidified Air Qty. (Cfm)	Equipment Selection
Intermediate Floor								
Staff Rest Room	230	9.5	1	Nil	0.9	0.7	450	1x 1.5 TR Hi Wall

8.1 System Design

Primary-Secondary-Tertiary (P-S-T or District Cooling):

District Cooling is a system in which chilled water is distributed in pipes from a central cooling plant to buildings for space cooling and process cooling.

It contains three major elements: the cooling source, distribution system and customer installations.

Cooling Sources: Chillers.

Distribution System: Chilled water pumps and buried piping network.

Building Installation: Tie-in connection Energy Transfer Station (ETS) i.e. Heat Exchanger connected with secondary pumps for distribution of chilled water to fan coil units & AHU's.

P-S-T variable pumping is eminently suitable for spread out applications like Campuses. A major advantage of Tertiary pumping is the individual zones are hydraulically and thermally decoupled. This allows the designer flexibility to control each zone independently, relative to differential pressure and temperature. Zones may be collection of coils or air handlers or entire buildings. This advantage is ultimately expressed in district cooling and heating systems individual users are decoupled through the means of heat exchangers.

Since an additional pump is required at the zone or building, the pumped loop is called a tertiary (third) zone. As before, each tertiary zone is independent of the rest of the

system.

The secondary pumps must provide adequate head to fulfill the flow requirement at the farthest bridge. It no longer needs to provide the head for the farthest point in the farthest zone or any other zone decoupled by a common pipe. This design will lower the horsepower of the secondary pumps. The horsepower to pump the piping, coils and valves in the zone will be provided by the tertiary pumps.

Figure – PRIMARY- SECONDARY- TERTIARY PUMPING SYSTEM LAYOUT

9.0 MECHANICAL VENTILATION SYSTEM (Services Areas)

Various parameters influencing the mechanical ventilation system is being given hereunder:

Design Data & Equipment Selection

Floor/ Space	Floor Area (Sft)	Height (Ft)	ACPH for Exhaust/ Fresh Air	Extract Air Quantity (Cfm)	Fresh Air Quantity (Cfm)	Equipment Selection	
						For Exhaust	For Fresh Air
UGT & Electrical Panel Room Block							
Basement							
Pump Room	1000	13.8	15	3450 (@15 ACPH)	3450 @15 ACPH)	1x 3500 Cfm Extract Fan Section Unit	1x 3500 Cfm Fan Filter Unit
Block-3							
Tertiary Plant Room	400	13.1	15	1310 (@15 ACPH)	1310 @15 ACPH)	1x 1500 Cfm Extract Fan Section Unit	Fresh Air shall be replenished through Louver
Block-4							
Tertiary Plant Room	400	13.1	15	1310 (@15 ACPH)	1310 @15 ACPH)	1x 1500 Cfm Extract Fan Section Unit	Fresh Air shall be replenished through Louver

Lift-well Pressurization:

Pressure to be maintained in lift well (As per Part IV of NBC) :50 Pa (5mm)

Sr. No.	Type of Fan	Application Area	No. of Landings	No. of Doors	Door Size	Supply Air Qty. (Cfm)	Nos. of Fans
BLOCK-1							
Lift Well							
1	Axial Flow Fans	Lift Well -1	4	4	1000x2100	5700	1
BLOCK-2							
Lift Well							
1	Axial Flow Fans	Lift Well -1	3	3	1000x2100	5700	1
BLOCK-3							
Lift Well							
1	Axial Flow Fans	Lift Well -1,2	13	13	1100x2100	11600	(1 for each Well)
2	Axial Flow	BED Lift Well	13	13	1300x2100	12700	1

BLOCK-4							
Lift Well							
1	Axial Flow Fans	Lift Well -1,2	13	13	1100x2100	11600	(1 for each Well)
2	Axial Flow Fans	BED Lift Well	13	13	1300x2100	12700	1

Assumptions

It has been assumed that one of lift doors shall remain in open position while rest of the doors shall remain in closed position.

System Design:

Lift wells shall be pressurized in conformity with the standards stipulated in the relevant N B codes part VIII section -1 and clause D-1.6 of part IV. Fans associated with the pressurization system (for emergency operation only) shall be installed over the lift machine room as shown in the relevant drawings, and shall get activated through the fire alarm control system in the unlikely event of fire.

10.0 Noise Level

Noise level in conditioned spaces due to all refrigeration and air conditioning equipment shall not exceed 48 dB 150cm from supply air grille at 125 Hz (with out operation of any other equipment) when measured at any point within other occupied spaces or 60 cm from any return air grille.

11.0 Design Parameters

Performance rating of various equipment shall be based on the following design parameters :

Design Parameters for selection of air handling units and its components :

Maximum face velocity across filters	500 FPM (152 MPM)
Maximum face velocity across coils	500 FPM (152 MPM)
Maximum fan outlet velocity	2000 FPM (610 MPM)
Maximum fan motor speed	1440 RPM

Design parameters for duct designing shall be:

Maximum flow velocity	1500 (457 MPM)
Maximum friction	0.09 inch WG per100 ft. run (7.5mm WG per100 M
Maximum velocity at supply air outlet	500 FPM (152 MPM)
Maximum flow velocity in exhaust air duct.	1800 FPM (550 MPM)

12.0 Technical Submittals

The successful tenderer after award of work shall furnish technical submittals for various items incorporating complete technical details prior to procurement of equipment/materials, for the approval of the Engineer-in-charge. The submittals for items mentioned in the tender document but not restricted to the following :

a.	Variable Speed Tertiary CHW Pumps
b.	Closed Expansion Tanks with built-in degasser & Dirt Separators
c.	Air Handling Units
d.	Chilled Water Cassette Units
e.	Fan Sections
f.	
g.	Ventilation fans including Axial Flow fans, Inline fans & Propeller fans
h.	Major items under piping such as self balancing pressure independent control valves, balancing valves etc.
i.	Grilles & Diffusers
j.	Insulation Material
k.	Electrical Panels
l.	VRF / Split System
m.	Any other equipment required for completion of HVAC system

Test certificates for various items shall also be submitted by the contractor

13.0 Performance Guarantee

The Contractor shall guarantee uninterrupted service and stipulated quality of performance of the installed HVAC plant. The guarantee shall be furnished in the proforma indicated in the Appendix-I. It is to be clearly understood that the specifications indicated represent minimum performance requirements for the tenderers guidance.

Taxes & Duties

All duties and taxes like Excise Duty, Local Sales Tax, Octroi, Sales Tax on works contract, VAT, Service Tax etc. shall be included in the quoted price.

Transit insurance shall be borne by the Contractor.

All the price indicated shall be F O R destination.

15.0 Fees and Permits

The Contractor shall obtain all permits /licenses and pay for any and all fees required for the installation, inspection and commissioning of the work.

Liability to Govt. Regulations

The Contractor shall be responsible and shall abide by all the Government rules and regulations pertaining to erection, testing and commissioning of complete HVAC system at site.

Any compensation towards damage/loss of property/material/ equipment or to any person

working at site shall be borne by the Contractor as per standard terms of Contract.

No escalation/ change of prices would be admissible under any circumstances.

Insurance

Insurance Policies :

Before commencing the execution of works, the Contractor, without limiting his obligations and responsibilities under this contract, shall insure against his liability for any material or physical damage, loss or injury which may occur to any property, including that of the Engineer-in-charge or a member of the general public, by or arising out of the execution of the works or in carrying out of the contract. Unless otherwise, stipulated elsewhere in this contract, it shall be obligatory for the Contractor to obtain the insurance cover under the following policies :

Contractor's All Risk Insurance Policy to cover the following :

Entire contract value including cost of materials supplied by the Engineer-in-charge, if any for the period of completion including defects liability period.

Third party insurance to cover for any damages to third party. This shall be upto the period of completion of work only.

Policy should cover Civil commotion, riots and other similar disturbances.

Policy to cover Contractor's liability under workmen's Compensation Act, 1923, Minimum Wages Act 1948, Contract Labour (Regulation and Abolition) Act 1970 and other relevant Acts listed elsewhere. This shall be for the period of completion of work.

Insurance cover against damage, theft or any other loss of all materials and equipment brought to site for which advance payment is claimed -limit of liability not less than the value of such materials at any stage of the contract.

The Contractor shall insure against all such liabilities and shall continue such insurance during the whole of the time when any persons employed by him are on the works.

The Contractor shall produce certificates of Insurance to the Engineer In charge. These certificates shall be fully executed and shall state that the policies cannot be cancelled until ten (10) days after written notice of such cancellation has been given to the Engineer-in-charge.

The Contractor shall obtain written certificates of similar certificates from all sub-contractors and thereby assume responsibility for any claims or losses to the Engineer-in-charge resulting from failure of any of the sub-contractors to obtain adequate insurance protection in connection with their work.

Failure to Insure :

If the Contractor fails to comply with the terms of this condition, the Engineer-in-charge may effect the Insurance and deduct the expenses from any moneys that may be or become payable to the Contractor or may, at his option, refuse payment of any certificate to the Contractor until the Contractor complies with this condition.

No Limit to Liability :

In addition to the liability imposed by law upon the Contractor for injury (including death) to persons or damage to property by reason of the negligence of the Contractor or his agents, which liability is not impaired or otherwise affected hereby, the Contractor hereby assumes liability for and agrees to save the Engineer-in-charge harmless and indemnifies him from every expense, liability or payment by reason of any injury (including death) to persons or damage, to property suffered through any act of omission of the Contractor, or any of his sub-Contractors, or any person directly or indirectly employed by any of them or from the conditions of the premises or any part of the premises which is in the control of the Contractor or any of his sub-contractors, or any one directly or indirectly employed by either of them, or arising in any way from the work called for by this contract.

18.0 Partial Ordering

Engineer-in-charge reserve the right to order equipment & material from any and all the alternates and/or to order high side and/ low side equipment and materials or parts thereof from one or more tenderers.

19.0 Engineering Responsibility of the system

The responsibility of system design, manufacturing, erection, working and safety will solely be responsibility of the Contractor for the parameters as mentioned in the tender documents prepared by the Engineer-in-charge.

The system after commissioning shall be handed over to the Engineer-in-charges and thereafter they will monitor the performance for standard designed (without operation of any other equipment)parameters for 30 days continuously. In case during this period the performance is not found satisfactory and rectification/ replacement, design improvement or any other change as felt necessary, will be made by the Contractor at no extra cost. Though these improvements can only be done after getting the approval from the Engineer-in-charges.

20.0 Schedule and Manner of Operations

Time being the essence of this Contract, the Contractor will be expected to furnish all labour and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract. In addition to providing a detailed time and progress schedule, the Contractor shall submit an outlined and graphic schedule of proposed procedures to the Engineer-in-charge within two days of issue of work order.

21.0 Bye Laws & Regulations

The installation shall be in conformity with the bye-laws, regulations and standards of the concerned local authorities so far as these become applicable to the installation. However,

if these specifications call for a higher standard of materials and /or workmanship than those required by the regulations and standards then these specifications shall take precedence over the said regulations and standards then these specifications shall take precedence over the said regulations and standards. If the specifications call for requirements which violate the bye-laws and regulations, the bye-laws and regulations shall govern the requirements of this installations.

Erection and Supervision :

The Contractor shall depute engineers from time to time of commencement of assembly and installation work to inspect all relevant civil construction/ fabrication and other necessary facilities to make improved action if felt necessary. However, a site engineer preferably a graduate in mechanical or electrical discipline shall be deputed at site permanently till completion of the work and shall be identified to the Client at the time of appointment at site.

All the ducting installation work shall be carried out in conformity with approved reflected ceiling plans well in advance to ensure uninterrupted working of other agencies.

23.0 Power for Construction

The Engineer-in-charge has made arrangements to provide single/ three phase power connection for construction purposes as per site conditions. The Contractor shall make his own arrangements to take metered connection from the above point. He shall at his own cost provide and install the meter and all temporary service lines as required for his use on the work and remove the same on the completion of the work.

24.0 Electrical Power and Soft Water Requirement

The tenderer shall submit with their quotation the break up of electrical power requirement for all the HVAC equipment & soft water requirement.

25.0 Sub-Contractors

As soon as practicable and before awarding any sub-contract the Contractor shall notify in writing the names of the Sub-Contractor to the Engineer-in-charge proposed for the principle parts of the work. The Contractor shall not employ any Sub-Contractor whom the Consultants finds incompetent.

26.0 Design Drawings

The drawings prepared by the Engineer-in-charge as listed under Appendix-II are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation. The Contractor shall thoroughly examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation and report to the Engineer-in- charge any discrepancy and obtain clarifications. Any changes found necessary for coordination and installation of this work with other services and trades shall be made with prior approval of the Engineer-in-charge.

27.0 Technical Data

The tenderer shall submit a comprehensive schedule of technical data and complete manufacturer's specifications for all items of equipment and material including the manufacturer's name. The technical data shall be furnished in the proforma indicated in Appendix V.

Shop Drawings

Within three days after the award of the Contract, the contractor shall furnish for the approval of the Engineer In-charge, three sets of detailed shop drawings of all equipment and materials including plant room, ducting, piping, ventilation system electrical work associated with the HVAC system required to complete the project as per Specifications and as required by the Engineer Incharge. These drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, as also the details of all related items of work by other Contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications.

If the Engineer-in-charge makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated, along with the drawings on which

corrections were made. After final approval has been obtained from the Consultant, the Contractor shall submit a further six sets of shop drawings for the exclusive use of and retention by the Engineer-in-charge. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.

- a. The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Engineer-in-charge ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved CPM charts.
- b. Samples, drawings, specifications, catalogues, pamphlets and other documents submitted for approval shall be in quaduplicate, each item in each set shall be properly labeled, indicating the specific service for which material or equipment is to be used, giving reference to the governing section and clause number of Specifications clearly identifying in ink the items and the operating characteristics data of a general nature shall not be accepted.
- c. Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are approved said approval does not mean that drawings have been checked in detail nor does it way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract.
- d. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout , all such redesign and all new

drawings and detailing required thereof, shall be prepared by the Contractor at his own cost and approved by the Engineer In-charge.

- e. Where the work of the Contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustments. If so directed by the Engineer In-charge, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Engineer-in-charge.

29.0 Co-operation /Co-ordination with other agencies

During the currency of the Contract, a number of Contractors will be at site to execute works under their respective contracts viz. structure, finishing works, electrical, lifts and other services. All these agencies will be at site at the same time. The Contractor shall offer full co-operation to, all these agencies with regard to use of materials etc. and co-ordinate the work in such a manner that the time schedules of all agencies are not adversely affected. The work shall be executed as per program approved by the Engineer In-charge. If part of site is not available, for any reason, or if there is some unavoidable delay in supply of materials stipulated by the Engineer-in-charge, the program of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.

No claim shall be entertained from the Contractor on the plea that the work has been executed in the above circumstances or under difficult conditions. It shall be the responsibility of the Contractor to enforce necessary discipline among his workers and staff to ensure smooth working at the site in spirit of co-operation and amity with all other agencies.

30.0 Construction Program & Schedule Of Operations

A tentative construction program indicating the scheduling of various activities forms an annexure to this document. The Contractor should examine this program with respect to construction logic, scheduling and duration of various activities etc. in relation to the resources available at his disposal, and suitably modify the program without extending the total duration of the job as also the completion targets for major milestones of the job and submit a modified construction program along with a firm commitment to adhere to the dates of completion of various activities. This construction program shall after scrutiny and approval of the Engineer In-charge form part of the agreement and shall be treated as a baseline schedule to monitor, determine delays in individual activities, work milestones or the overall duration of the work.

In the event of the Contractor, not submitting any modified construction program, the tentative construction program shall remain binding on the Contractor.

The Contractor shall mobilize equipment, tools, plant, scaffolding, shuttering, material, labour etc. in sufficient quantities so as to complete the work to meet the above agreed construction program. In the event of delays in the construction activities, the Contractor shall mobilize additional resources to complete the job in the specified time period and at no extra cost to the Engineer-in-charge. The Engineer-in-charge may suggest an alternative scheduling of operations, should they find it necessary to accomplish the targets and the Contractor shall accordingly mobilize additional resources at no extra cost to the Engineer-in-charge.

31.0 Electrical Installation and Cabling

The electrical works related to the HVAC system shall be carried out in full knowledge and with complete co-ordination of the Contractor. It is to be clearly understood that the final responsibility for sufficiency, adequacy, and conformity to the performance of the HVAC system shall be with the Contractor.

32.0 Testing and Commissioning

On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the Consultants without any extra cost to the Engineer-in-charge. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by competent inspecting authority or the Consultants and the Engineer-in-charge. All tests shall be carried out in the presence of the Consultants and Engineer-in-charge's representative.

33.0 Completion Certificate

On successful completion of the installation, a certificate in the approved format shall be furnished by the Contractor. The Contractor shall be responsible for getting the entire installation duly approved by the Electrical Inspector or concerned authority, if any, and shall bear the all expenses in connection with the same.

34.1 Completion Documents

- a. 5 copies of operation manuals/catalogues of all standard equipment to be furnished by the contractor immediately after commissioning of plant.
- b. 5 copies of write up on preventive maintenance, trouble shooting and operating instructions of the system alongwith as-built drawings to be supplied by the Contractor at time of commissioning.
- c. 5 sets of catalogues of all accessories such as dampers, valves, strainers, gauges, electrical components etc.

35.0 Completion Drawings

On completion of the work in all respects, the Contractor shall supply five port folios (300 x 450mm) each containing a complete set of drawings at approved scale clearly indicating complete plant room layouts, ducting and piping layouts, location wiring and sequencing of automatic controls, location of all concealed

pipings, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the air conditioning plant room, one set of these consolidated control diagrams.

36.0 Training of Engineer-in-charge's representative

Upon completion of work and conclusion of all tests, the Contractor shall furnish necessary skilled labour and helpers for operating the entire installation for a period of thirty working days of eight hours each, to enable the Engineer-in-charge's representative to get acquainted with the operation of the system. During this period, the Contractor shall train the Engineer-in-charge's representatives in the operation, adjustments and maintenance of all equipment installed.

37.0 Correction of Work before Final Payment

The Engineer-in-charge shall conduct a final inspection just before the virtual completion of the work and prepare a final list of materials, equipment and item of work which fail to conform to the contract specifications. The Contractor shall promptly replace or re-execute such items in accordance with the contract and shall bear all expenses of making good all work and the cost of all work of the other Contractor, destroyed or damaged by such replacement or removal.

If the Contractor fails to remove and replace above rejected materials, equipment/ or workmanship within a reasonable time, fixed by written notice, the Engineer-in-charge may employ and pay other persons to amend and make good such defects at the expense of the Contractor. All expenses incurred by the Engineer-in-charge in rectifying the defects including all damages, loss and expense consequent on the defects shall be recoverable from any amount due or which may become due to the Contractor.

38.0 Virtual Completion

The work shall be considered virtually complete only upon fulfillment of the procedure laid down in the preceding clause and when the Consultants and the Engineer-in-charge has certified in writing that the work has been virtually completed. The defect liability period shall commence from the date of such certificate.

39.1 Maintenance of Liability Period

Defects liability period shall commence from the date of virtual completion upon fulfillment of the procedure laid down in clause No.38. Contractor shall include incidental expenses towards necessary maintenance during defects liability period by deputing a skilled technician once in every week. The scope of such maintenance shall be for complete HVAC system but not restricted to the following:

- a. Wet Cleaning of unit filters and fresh air intake filters.
- b. Wet Cleaning of Paper fills and filters of Air washer.
- c. Total water in the air washer sump to be drained, dried and filtered with fresh water.
- d. Degreasing of kitchen exhaust duct including extract fan section by using appropriate method (once in every six months).

- e. Checking of fan belts, pulleys etc.
- f. Dry Cleaning of electrical components using air blower.

40.0 Force Majeure

The right of the contractor to proceed with the work shall not be terminated because of any delay in the completion of the work due to unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not limited to acts of God, or of public enemy, restraints of a sovereign state, floods, unusually severe weather.

41.0 Termination of the Contract by the Engineer-in-charge

If the Contractor shall be adjudged bankrupt or if he should make a general assignment for the benefit of his creditors, or if a receiver shall be appointed on account of his insolvency, or if he should persistently or repeatedly refuse to carry on the work diligently or shall fail except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials or equipment for the progress of the work, or if he should fail to make prompt payments to sub-contractors or for materials or equipment or labour or persistently disregard laws, ordinance, or instructions of the Engineer In-charge, or otherwise be guilty of a violation of any provision of the contract, or has abandoned the contract, or has failed to commence the works, or has suspended the work, then the Engineer-in-charge upon the certificate that sufficient cause exists to justify such action, may without prejudice to any other right or remedy and after giving the Contractor seven days notice in writing, terminate the employment of the Contractor and take possession of the premises and if all materials, equipment, tools and appliances there on and use these as Engineer-in-charges property for the completion of the work. In such case the Contractor shall not be entitled to receive any further payment until the work is finished. If the amount due to the Contractor for the work carried out by him as per the Contract terms shall exceed the expenses of finishing the work including compensation for additional management and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor, shall pay the difference to the Engineer-in-charge. The expense incurred by the Engineer-in-charge and the damage incurred through the Contractor's fault, shall be certified by the Engineer-in-charge and his decision on this matter shall be final and binding on the Contractor.

42.1 Delay and extension of time

In the opinion of the Engineer-in-charge the works be delayed :

- a. By force majeure.
- b. By reasons of civil commotion, or strike or lockout affecting any of the building trade.
- c. In consequence of the contractor for not having received in due time necessary instructions from the Consultant for which he shall have specifically applied in writing.
- d. By reasons of or Consultant's instructions, the Engineer-in-charge shall make a fair and reasonable extension of time for completion of the contract works.

- e. In case of such strike or lock-out, the Contractor shall as soon as possible give a written notice thereof to the Consultants, but the Contractor shall nevertheless constantly use his endeavors to prevent delay and shall do all that may reasonably be required to the satisfaction of the Engineer-in-charge to proceed with the work.

43.1 Settlement of Disputes & Arbitration

All disputes and differences of any kind whatever arising out of or in connection with the contract or the carrying out of the works (whether during the progresses of the works or after their completion, and whether before or after the determination, abandonment or breach of the contract) shall be referred to and settled by the Engineer In-charge after hearing the disputing parties. The Engineer In-charge shall state his decisions with reasons therefore. Such decisions may be in the form of a final certificate or otherwise. The decisions of the Engineer In-charge with respect to any or all of the following matters shall be final and without appeal :

- a) The variation or modifications of the design.
- b) The quality or quantity of works or the addition or omission or substitution of any work.
- c) Any discrepancy in the drawings and/or specifications and schedule of quantities.
- d) The removal and/or re-execution of any works executed by the Contractor.
- e) The dismissal from the works of any persons re-employed thereupon.
- f) The opening up for inspection of any work covered up.
- g) The amending and making good of any defects under defects liability period.
- h) Acceptability of materials, equipment and workmanship.
- i) Materials, labour, tools, equipment and workmanship necessary for the proper execution of work.
- j) Assignment and sub-letting.
- k) Delay and extension of work.
- l) Termination of contract by the Engineer-in-charge.

But if either the Contractor be dissatisfied with the decision of the Engineer In-charge on any matter, question or dispute of any kind except the matters listed, then and in any such case, either party (the contractor) may within twenty eight days after receiving notice to such decision, give a written notice to the other party through the Engineer In-charge requiring that such matters which are in dispute or difference of which such written notice has been given and no other shall be and is hereby referred to the arbitration and final decision of a single Arbitrator.

The Arbitrator, the Arbitrators or the Umpire shall have the power to open up, review and revise any certificate, opinion, decision, requisition or notice pertaining

to the matters referred to them, and to determine the same by his/their award. Upon every or any such references the cost of and incidental to the reference and award respectively shall be at the discretion of the Arbitrator or Arbitrators or Umpire who may determine the amount thereof, or direct the same to be taxes as between Attorney and Client or as between party and party, and shall direct by who and to whom and in what manner the same shall be borne and paid. The award of the Arbitrator or Arbitrators or the Umpire shall be final and binding on the parties.

44.0 Use and Care of Site

Contractor will be permitted to use without charge, the site and the areas shown in the contracts drawing for execution of work and for related activities. The contractor shall not commence any operation on such and except with the approval of the Engineer-in-charge.

All rubbish shall be burnt or removed from the site as it accumulates. All surface and soil drains shall be kept in a clean sound and workman-like state. All the areas of contractor's operation shall be cleared before returning them to the Engineer-in-charge. The contractor shall make good any damages or alternations made to areas, properly or land handed over to him before these are returned.

45.0 Safety Provisions

The contractor shall take full responsibility for the adequate stability and safety of all site operations and methods of construction, subject to provisions of excepted risks and special risks.

The contractor shall at his own expense arrange for the safety in his operations as required. Safety provisions shall be as per the latest safety manuals published by Indian Standard Institution, Statuary Rules, Regulations and Provisions of contract conditions.

46.0 Clearance of Site

The Contractor shall have to remove all malba and other unwanted materials from site of work, before handing over HVAC installation to the Engineer-in-charge. The work shall not be treated as complete in all respects unless these requirements are fulfilled by him. In the event of the Contractor failing to do so, the Engineer-in-charge shall have the right to get the site cleared at his expenses.

47.0 After Sales Services :

The HVAC Contractor shall ensure adequate and prompt after sales service in the form of maintenance personnel and spares as and when required with a view to minimizing the breakdown period. Particular attention shall be given to ensure that all spares are easily available during the normal life of the installation.

TECHNICAL SPECIFICATIONS

1.1 EQUIPMENT

1.2 CONSTANT SPEED & VARIABLE SPEED PUMPING SYSTEMS

1.2.1 Scope

The scope of this section comprise the supply, installation, testing and commissioning of constant/variable speed pumping package consisting of following:

- a. Constant/ variable Speed Pumping System.
- b. The control system shall be inclusive of the programmable logic pump controller, adjustable frequency drives, valve controller for tertiary circuit and remote sensors/transmitters. Additional items to be provided or as required to properly execute the sequence of operation shall be included.
- c. Line voltage power wiring shall be installed by the electrical contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

1.2.2 References

a.	ANSI	- American National Standards Institute
b.	NEMA	- National Electrical Manufacturers
c.	UL	- Underwriter's Laboratories Inc.
d.	ETL	- Electrical Testing Laboratories
e.	CSA	- Canadian Standards Association
f.	NEC	- National Electrical Code
g.	ISO	- International Standards Organization
h.	IEC	- International Electrochemical
i.	HIS	- Hydraulic Institute Standard
j.	IS	- Indian Standard

1.2.3 SUBMITTALS

Submittals shall include the following and shall be specific to this project. General submittals shall not be accepted.

- a. System summary sheet.
- b. Sequence of operation.
- c. Shop drawing indicating dimensions, required clearances and location and size of each field connection.
- d. Power and control wiring diagrams.
- e. System profile analysis including constant/variable speed pump curves and system curve. The analysis shall also include pump, motor and Adjustable Frequency Drive (AFD) efficiencies, job specific load profile, staging points, horse power and kilowatt/hour consumption.
- f. Pump data sheets.

1.2.4 Quality Assurance

- a) The pumping system shall be assembled by the pump supplier. An assembler of pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump supplier. The supplier shall assume "Unit Responsibility" for the complete pumping system. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system supplier.
- b) The pump and VSPS supplier must have HVAC system design experience and insight into design consideration of variable speed pumping systems.
- c) Manufacturer's facility where pumps are being manufactured shall be UL listed.
- d) Manufacturer shall be fully certified by the International Standards Organization per ISO 9001. Proof of this certification shall be furnished at time of submittal.
- e) Tenderer shall comply with all sections of this specification relating to packaged pumping systems. Any deviations from this specifications shall be clearly defined in writing at the time of bid. If no exceptions are taken at the time of bid, the supplier shall be bound by these specifications.

1.2.5 Pump Logic Controller

- a) The pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory Inc. (UL). The controller shall meet Part 15 of FCC regulations pertaining to class A computing devices. The controller shall specifically designed for constant/variable speed pumping applications.
- b) The controller shall function to a proven program that safeguards against hydraulic conditions including :
 - a. Motor overload
 - b. NPSHR above NPSHA
 - c. Pump flow surges
 - d. Hunting
 - e. End of curve
- c) The pump logic controller shall be capable of receiving up to four remote process constant/variable signals. It shall then select the analog signal that has deviated the greatest amount from its set point. This selected signal shall be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling up to eight pumps in parallel.
- d) The pump logic controller shall have provision for accepting an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.
- e) The hydraulic stabilization program shall utilize a proportional-Integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.
- f) The pump logic controller shall be self prompting. All message shall be displayed in plain English. The operator interface shall have the following features :
 - a. Multi-fault memory and recall.

- b. On-screen help functions.
 - c. LED pilot lights and switches.
 - d. Soft-touch membrane keypad switches.
- g) The readout shall be displayed in two lines. Each character shall be 0.25" high Backlit super twist type. Read out shall be capable of displaying the following values :
 - a. Differential pressure in PSIG.
 - b. Pressure in PSIG.
 - c. Flow in GPM.
 - d. Temperature in degrees F or C.
 - e. Differential temperature in degree F or C.
- h) The following communication features shall be provided to the BAS :
 - i. Remote system start/stop
 - ii. Failure of any system component
 - iii. Process variable
 - iv. AFD speed

1.2.6 Adjustable Frequency Drives

- a) The adjustable frequency drives shall be Pulse Width Modulation (PWM) type, microprocessor controlled design.
- b) The adjustable Frequency Drive (AFD), including all factory installed options, shall have UL & CSA approval.
- c) Enclosure shall be IP-55 for installation as a wall mounted or free standing depending on ampere rating. Drive shall be equipped with an input disconnect switch and fuses for ground fault protection. A hand-off-automatic switch and speed potentiometer shall be mounted on the front of the enclosure.
- d) Adjustable Frequency Drive (AFD) shall utilize a diode bridge rectifier to convert three phase AC to a fixed DC voltage. Power factor shall remain above 0.95 regardless of speed or load. AFDs employing power factor correction capacitors shall not be acceptable.
- e) IGBT's shall be used in the inverter section to convert the fixed DC voltage to a three phase, adjustable frequency, AC output. A DC line reactor shall be provided to minimize harmonic and current distortion of the input power line. AFDs not utilizing insulated gate bipolar transistors shall not be acceptable.
- f) The following customer modifiable adjustments shall be provided :
 - i. Accel time (2 to 600 seconds)
 - ii. Decel time (2 to 600 seconds)
 - iii. Minimum frequency
 - iv. Maximum frequency
 - v. V/I Ratio
 - vi. Carrier frequency
- g) Speed reference signal shall be customer selectable for :
 - i. 4-20 mA
 - ii. 0-5 VDC
 - iii. 0-10 VDC

- h) The AFD shall be suitable for elevations upto 33000 feet above sea level without derating. Operating ambient temperature shall be in the range of 100 C to 450 C. AFD shall be suitable for operation in environments up to 95% non-condensing humidity.
- i) The AFD shall be capable of displaying the following information on the door mounted operator interface :
 - i. Percent speed
 - ii. Percent load
 - iii. Fault identification

1.2.7 Sensor/Transmitters

Differential pressure sensor transmitters shall be field mounted and shall transmit an isolated 4- 20 mA DC signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have stainless steel wetted parts with two 0.25" male NPT process connections. It shall be protected against radio frequency interference and shall have watertight, NEMA 4 electrical enclosure capable of withstanding 2000 PSI static pressure with a 0.5" NPT conduit connection. Accuracy shall be within 0.25% of full span.

1.2.8 Sequence of operation

- a) The system shall consist of a pump logic controller, two duty pump/AFD set, one standby pump/AFD set, with duty-standby pump selection, automatic alteration and automatic transfer to standby pump.
- b) The pumping system shall start upon the closure of customer's contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.
- c) When the pump logic controller selector switch is in the LOCAL position, the pumping system shall operate automatically.
- d) Sensor/transmitters shall send a 4-20Ma signal to the pump logic controller, indicative of process variable condition.
- e) The technologic pump logic controller shall compare each signal to the independent, engineer/user determined set points.
- f) When all set points are satisfied by the process variable, the pump speed shall remain constant at the optimum energy consumption level.
- g) The technologic pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.
- h) As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump/motor.
- i) The redundant variable speed system shall be started through the pump logic controller.

- j) In the event of a system differential pressure failure, due to a pump, AFD overload fault, the pump logic controller shall automatically initiate a timed sequence of operation to start the redundant pump/AFD set in the variable speed mode.
- k) In the event of failure of a zone sensor/transmitter, its process variable signal shall be removed from the scan/ compare program. Alternative zone sensor/transmitters, if available, shall remain in the scan/compare program for control.
- l) The zone number corresponding to the failed sensor/transmitter shall be displayed on the operator interface of the pump logic controller.
- m) In the event of the failure to receive all zone process variable signals, the AFD shall maintain 100% speed, reset shall be automatic upon correction of the zone failure.
PUMP or AFD fault shall be continuously scrolled through the display on the operator interface of pump logic controller until the fault has been corrected and the controller has been manually reset

1.2.9 Constant Speed Pumps, Secondary Variable Speed Pumps and Tertiary Variable Speed Pumps

a. Scope

The scope of this section comprises of the supply, erection and commissioning of water pumps both constant speed & variable speed conforming to these specifications and in accordance with requirements of Schedule of Quantities.

b. End Suction/Double Section/Split Casing Pumps Type

- i. The End suction/Double suction type and size of secondary chilled/hot water pumps for air conditioning application shall be in accordance with requirement of Drawings and Schedule of Quantities. End Suction pumps shall be used upto 15HP or 1000 USGPM (Whichever is lower). Double Suction pumps shall be used for flow rates beyond 1000 USGPM.
- ii. Pump casing shall be close-grained cast iron of heavy section, Split casing type, making possible complete servicing of rotating parts without breaking piping or motor connections. Motor to pump connection shall be of the flexible coupling type. Suction passages shall be volute in form, promoting smooth entry to impeller and increased efficiency. Impeller shall be bronze (BR IS: 318 GR-LTB2) or gun metal, enclosed type, hydraulically balanced and passages smooth-finished for minimum friction and maximum efficiency. Impeller rings shall be steel protected by gunmetal sleeves. Shaft shall be supported in ball/journal bearings, grease lubricated, contained in easily removable housing. Pumps shall be fitted with an air valve, two grease lubricators, drain plug and water seal connections.
- iii. Horizontal split casing type centrifugal pump (casing to split in parallel to the shaft axis) shall be of close-grained cast iron of heavy section (CI IS: 210-FG260). For easy maintenance & low down time, pump be supplied with through bore Design & external removable bearing without removing upper (other) half of casing.
- iv. Pump internal surface shall be coated with glass flake material having Anticorrosive, Anti Galvanizing and Anti abrasive properties to smoothen internal surfaces to reduce friction thereby enhancing pump efficiency, over a sustained period of time.

- v. Motor shall be high efficiency EFF-1 type totally enclosed, fan-cooled, class-F insulation and suitable for operation on AFD. Motor shall be specially designed for quiet operation and its speed shall not exceed 1440 rpm. The motor rating shall be such as to ensure no overloading of the motor throughout its capacity range. Motor shall be suitable for 415+10% volts, 3 phase, 50 cycles, AC power supply.
- vi. Base shall be of a size suitable for the pump, motor and shaft and shall be constructed of cast iron or welded steel. Flexible coupling shall be protected by a guard mounted on the common base.
- vii. The pumps shall be installed on concrete foundation as shown in Approved-for- Construction shop drawings.
- viii. Each pump shall be provided with certified performance curves showing power absorbed and corresponding flow rates by varying the speed. The tests shall be done at factory and may be witnessed by Consultant or Owner's site representative.

Construction Pumps shall be as per IS : 1520-1660, IS : 9079, IS : 325 and shall be of the following construction :

Pump Parts	End Suction Back Pull out type / Double Suction/ Monobloc
Casing	Cast Iron EN-GJL-250
Impeller	Bronze CuSn10
Shaft	SS-304
Bearings	Heavy duty Ball/Roller
Base Plate	Fabricated MS
Flanges	Conforming to IS : 1536/1960/ANSI B-16.1 Class
Bearing Bracket	Bronze/ Cast Iron
Wearing ring	Bronze/ Cast Iron
Shaft Protection Sleeve	Bronze/ SS410
Packing	Graphite Asbestos
Max Speed	1440 RPM/2900 RPM (for Monobloc pumps)
Driver	Totally enclosed fan cooled (TEFC) squirrel cage induction motor/SPDP as
Coupling	Spacer Type/As mentioned in BOQ
Starter	Refer Schedule of quantities.

Motor rating shall have minimum of 10% margin on rated power or sufficient to meet the input power requirement at duty point.

Pump and driver shall be mounted on a single heavy design bed-plate and directly driven through flexible coupling in case of horizontal end suction back pull type pumps.

a) Capacity

Water flow rates and head of the pumps shall be in accordance with the requirements of Schedule of Quantities.

b) Pump Alignment

Split casing pumps, prior to testing shall be aligned with a dial indicator within 0.05 mm. Monobloc pumps shall be factory aligned with motor on common base, and need not be realigned at site.

All variable pumping system, pumps, motors and bases shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

Accessories and Fittings

The following accessories shall be provided with each pump among other standard accessories required:

- a. Coupling guard for end suction back pull type pumps.
- b. Lubrication fittings and seal piping if required.
- c. Test and /or air vent cocks as per manufacturer's standard.
- d. MS base frame of heavy channels duly painted with black enamel paint.
- e. Pumps shall have auxiliary connections for the above fittings. Spacer type coupling shall be of approved make.

Following fittings shall be provided with each pump among other standard fittings required:

- a. 25mm GI gland drain piping whether shown on drawings or not. Installation

Pump shall be installed as per manufacturer's recommendations. Pump-sets shall be mounted on machinery isolation cork or any other equivalent vibration isolation fitting. Concrete floating foundation shall be provided by the Owner as per approved shop drawings and specifications. The isolation pads, foundation bolts etc. shall be supplied by the Contractor.

Contractor shall however ensure that the foundation bolts are correctly embedded. Pump-sets shall preferably be factory aligned, wherever necessary, site alignment shall be done by competent persons. Before the foundation bolts are grouted and the couplings are bolted, the bed plate levels and alignment results shall be submitted to the Engineer in charge.

Testing

Tenderers shall submit the performance curves of the pumps supplied by them. They shall also check the capacity and total head requirements of each pump to match his own piping and equipment layout.

On completion of the entire installation, pumps shall be tested, wherever possible, for their discharge, head, flow rate, and BHP. Where it is not possible at least the discharge, head and B H P(as measured on the input side)shall be field tested. Test results shall correspond to the performance curves.

Painting

All constant/ variable pumping system, pumps, motors and bases shall be supplied with approved finish, Shop Coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

After completion of installation and testing, pumps, accessories and fittings shall be given two coats of approved finishing paint.

1.3 PLATE TYPE HEAT EXCHANGER

Scope

This specification covers the requirements for design, materials, fabrication and testing of Plate Type Heat Exchangers.

The heat exchanger shall be ASME/AHRI certified. Thermal Design

To maintain velocity and reduce fouling, unit shall be sized to provide 20% of the extra area then required.

Liquid velocity through the inlet and outlet ports shall be a maximum of 5 m/s, to optimize pressure drop and erosion.

Mechanical Design

- i. Frame, tie bolts, and supports shall permit the future installation of twenty (20) percent additional plates and also to ease in disassembly and cleaning of the unit.
- ii. Plates
 - a) Minimum thickness of each plate shall be 0.5 mm.
 - b) The plate nozzle connections shall be arranged to force each fluid across the plate surface in a parallel path (i.e. inlet & outlet connections shall be on same side and not diagonal).
 - c) Plate design must be adequate to withstand a hydro test pressure of 1.3 times the design pressure. Each side shall be pressurized independently during testing.
 - d) Gasket grooves must be designed such that it holds the gasket from three sides.
 - e) Plates must be supported by the carrier bar. Carrier bar surfaces that are in contact with the heat transfer plates shall be stainless steel. The plate should have provisions for self-aligning outside heat transfer area.
 - f) The guide bar shall be designed to maintain plate alignment. Guide bar shall not be used for support. Guide bar shall be stainless steel.
 - g) The first and last plates of the plate pack shall be designed to prevent fluid contact with the fixed or movable heads.

iii. Gaskets

- a) Gaskets shall be of the non-glued design.
- b) All gaskets must be elastomeric. Inelastic gaskets, such as compressed asbestos, must not be used.
- c) Gaskets shall be designed so that the gasket groove on plate is in their metallic contact from three sides.
- d) Port holes in each plate must be fully gasketed and vented to the atmosphere to force any leaks to the outside. This form of positive venting will eliminate mixing of the process fluids due to gasket failure.

iv. Fixed and Pressure Plates

- a) All nozzle connections shall be located on the fixed plate for single pass arrangement.
- b) For tie bolts of 1 inch or greater diameter, the fixed and pressure plates shall be provided with slotted holes, to facilitate assembly and disassembly of the unit.
- c) The pressure plate shall be supported by the carrier bar and guided by the guide bar.
- d) Unit design shall prevent the fixed and pressure plate from contacting the fluids circulated. Metal nozzle liners compatible with the plate material, or nozzle projections shall be provided.

v. Tie Bolts and Nuts

- a) The tie bolt length shall allow the addition of twenty (20) percent more plates.
- b) Tie bolts and nuts shall be EN18, zinc plated for improved corrosion resistance.

vi. Ports

- a) For units with studded ports, corrosion resistant stud bolts shall be provided by the manufacturer.
- b) Metal port liners shall be provided per 3.2.4 above. Construction

A. Plate heat exchanger shall be design considering the both sides as water.

B. The plate and frame heat exchanger shall consist of SS-316 plates with a minimum thickness of 0.5 mm. Each plate shall incorporate a tongue and groove interlock design with non-glued NBR gaskets. Use of epoxy or heat cured adhesives shall not be permitted. Gaskets shall have leak detection grooves vented to the atmosphere to prevent intermixing of fluids.

C. Individual heat transfer plates shall have continuous and symmetrical corrugations. Incremental / multiple pressed plates should not be used. Divided heat transfer surface shall not be used. Each circuit shall be hydro tested independently at 1.3 times the design pressure of the unit.

D. The plate and frame heat exchanger shall be guaranteed to perform to the capacities and pressure drops as indicated on the specification sheet.

- E. All material in contact with the hot and cold fluids shall be SS-316. All connections shall be studded port, designed for connection to a 150 lb flange. Studded ports shall be lined with a metal similar to the plate material.
- F. Plates must be supported by the carrier bar. The bottom guide bar shall be designed to maintain plate alignment, and shall not be used for support.
- G. Frame shall be bolted construction; welded frame assemblies are not acceptable. The fixed and movable covers, or heads, shall be fabricated of IS2062 Gr B carbon steel and be of sufficient thickness to meet requirements without the use of welded stiffeners. All steel surfaces are to be sandblasted. Frame design must allow for a minimum of 20% expansion.
- H. Tie bolts shall be zinc plated EN-18 alloy steel.
- I. The unit shall be manufactured for a pressure of 6 bar.

1.4 DOUBLE SKIN AIR HANDLING UNITS (CABINET TYPE)

Scope

The scope of this section comprises of supply, erection, testing and commissioning of double skin construction air handling units, conforming to these specifications and in accordance with requirements of drawings and schedule of quantities.

Type

The air handling units shall be double skin construction, draw-thru type comprising of various sections such as filter section, coil section, fan section and monsoon reheat section, factory assembled as elaborated in drawings and schedule of quantities.

Capacity

The air handling capacities, maximum motor HP, static pressure shall be as shown on drawings, appendices and schedule of quantities.

Housing/Casing

The housing/casing of the air-handling unit shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon the locations. The casing strength of the assembled Air Handling Unit shall be designed to meet BS EN 1886, Class 2A and the casing air leakage of the assembled Air Handling Unit shall be designed to meet BS EN 1886, Class B.

The framework shall be extruded aluminium hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.

Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 25/45 mm thick injected CFC free PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. Each component section of the Air Handling Unit shall have matching cross-sectional dimensions of the same construction showing a neat exterior along the length of the unit and a clean interior appearance to ensure even air flow through each plant item.

Marine light with switch, view window and proximity switch to be provided in the casing of each fresh air treatment unit.

Drain pan shall be constructed out of 18 gauge stainless steel with necessary slope to facilitate rapid removal of condensate water. Drain pan shall be factory insulated with minimum 9mm thick closed cell elastomeric insulation as required. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided from the drain pan in a manner that access panel can be opened without disconnecting the drain pipe connection.

The units provided with thermal break profile shall have return air mixing box with openings with suitable dampers for return air & fresh air ductwork connectivity.

Motor and Drive

Fan motors shall be high efficiency IE-02 suitable for operation on 415 + 10% volts, 50 cycles, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection and class F insulation and class B temperature rise. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM & 2800 RPM for fans below 3500 Cfm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Efficiency of motors shall be 85 % or more. As an option belt guards shall be provided with a painted metal sheet belt guard that totally encloses the drive, the guard shall be rigidly attached to the fan base support structure.

Fan

The fan shall be forward curved floor standing double inlet double width type. The wheel and housing shall be fabricated in galvanized steel construction as per manufacturer standard. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self lubricated sealed eccentric type ball bearings. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

Cooling /Heating Coils

Chilled/Hot water coils shall have 12.5 mm to 16 mm dia tubes of wall thickness not less than 24 G with aluminium fins firmly bonded to copper tubes assembled in

zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21Kg/Sqcm air pressure under water. Tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm.)

Filters

Each unit shall be provided with a factory assembled filter section containing cleanable type pre- filters of synthetic media having anodized aluminium channels. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filter face velocity shall not exceed 500 FPM. Filters shall fit so as to prevent by-pass. Holding frames shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

Accessories

Each air handling unit shall be provided with manual air vent at highest point in the cooling/heating coil and drain plug at the bottom of the coil. Besides, the following accessories may be required at air handling units, the detailed specifications are given in individual sections, and quantities separately described in the schedule of quantities.

- a. Motorized self balancing pressure independent valves located in chilled / hot water lines connecting to the coil. This valve shall be operated by the cooling/heating thermostat and shall control the flow of chilled/hot water. Refer "Automatic Controls and Instruments" for detailed specifications.
- b. Cooling/heating thermostats as per section "Automatic Controls and Instruments" shall be located in return air stream.
- c. Insulated butterfly valves/balancing valves, Y-strainer, unions and condensate drain piping upto sump or floor drain in air handling unit rooms as described in section "Piping".
- d. Dial type thermometer in the thermometer wells and pressure gauge (with cocks) within gauge ports in chilled/ hot water supply and return lines as per the section "Automatic Controls and Instruments".

Performance Data

Air handling units shall be selected for the lowest operating noise level. Technical submittal of air handling units shall be prepared for Consultants approval prior to procurement as mentioned under clause 7 under Special Conditions. Fan performance rating and power consumption characteristics shall be submitted and verified at the time of testing and commissioning of the entire installation.

Testing

Cooling/heating capacity of various air handling unit models shall be computed

from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Air flow measurements shall be carried out using air capture hood and temperature measurements by accurately calibrated thermometers by the vendor. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

1.5 FRESH AIR TREATMENT UNITS (CABINET TYPE)

Scope

The scope of this section comprises of supply, erection, testing and commissioning of double skin construction air handling units, conforming to these specifications and in accordance with requirements of drawings and schedule of quantities.

Type

The air handling units shall be double skin construction, draw-thru type comprising of various sections such as filter sections, HRW section and fan sections factory assembled as elaborated in drawings and schedule of quantities.

Capacity

The air handling capacities, maximum motor HP, static pressure shall be as shown on drawings, appendices and schedule of quantities.

Housing/Casing

The housing/casing of the fresh air treatment unit shall be in double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon the locations.

The framework shall be extruded aluminium hollow sections with thermal break profile. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.

Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 45/48 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on galvanized steel channel frame work.

Marine light with switch, view window and proximity switch to be provided in the casing of each fresh air treatment unit. Each fresh air treatment unit shall be provided with canopy. Material of construction for canopy shall be similar as that of

casing.

Drain pan shall be constructed out of 18 gauge stainless steel with necessary slope to facilitate rapid removal of condensate water. Drain pan shall be factory insulated with minimum 9mm thick closed cell elastomeric insulation as required. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided from the drain pan in a manner that access panel can be opened without disconnecting the drain pipe connection.

Motor and Drive

Fan motors shall be high efficiency EFF-1 suitable for operation on $415 \pm 10\%$ volts, 50 cycles, 3 phase, squirrel cage, totally enclosed fan cooled with class 'F' insulation & IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM & 2800 RPM for fans below 3500 Cfm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Efficiency of motors shall be 85 % or more.

Fan

The fan shall be forward curved (or as specified in Schedule of Quantities) floor standing double inlet double width type. The wheel and housing shall be fabricated in galvanized steel construction as per manufacturer standard.

The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self lubricated sealed eccentric type ball bearings. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass. Efficiency of fan should be 70% or more.

Heat Recovery Section

The Heat Recovery section shall include approved make enthalpy wheels and shall be capable of minimum recovery of 65 % of total heat, i.e both sensible and latent (each being 65%) with exhaust air being 80% of supply air. The wheel shall be made of pure aluminium foil coated with appropriate desiccant. The cross contamination between the two air streams shall be negligible. The vertical and radial run of the wheel shall be less than 1 mm per meter of diameter. The wheels shall have non contact labyrinth seals for effective sealing between the two air streams.

Heat Recovery Wheel shall conform to the following

specifications : The substrate :

The substrate or wheel matrix shall be of pure aluminum foil so as to allow quick and efficient uptake of thermal energy and sufficient mass for optimum heat transfer. Maximum sensible heat recovery shall be achieved at a relatively low rotational speed of 20 to 25 RPM.

The substrate shall not be made from any material which is combustible or supports

combustion. The Desiccant :

The desiccant shall be high efficiency with 3 Angstrom sieve capable of keeping the cross contamination to absolute minimum and should also ensure the exclusion of contaminants from the air streams, while transferring the water vapor molecules.

The desiccant of sufficient mass should be coated with non masking porous binder adhesive on the aluminum substrate so as to allow quick and easy uptake and release of water vapor. A matrix with desiccants impregnated in non metallic substrates, such as synthetic fibre, glass fibre, etc. shall not be accepted.

The weight of desiccant coating and the mass of aluminum foil shall be in a ratio so as to ensure recovery of both sensible and latent heat simultaneously over the operating range.

Rotor :

With optimum heat and mass through matrix formed by desiccant, of sufficient mass, coated on an aluminum foil, the rotor should rotate at lower than 20 to 25 RPM, thereby also ensuring long life of belts and reduced wear and tear of seals.

The rotor shall be made of alternate flat and corrugated aluminum foil of uniform width.

The rotor honeycomb matrix foil should be so wound and adhered as to make a structurally very strong and rigid media which shall not get cracked, deformed etc. due to change of temperature or humidity.

The rotor having a diameter upto 2800 mm shall have spokes to reinforce the matrix. From 2000 mm diameter upwards, the option of a special wing structure, to prevent the rotors from wobbling or deforming due to the successive pressure differentials, will be available.

Sectioned wheels, with pie segments, capable of being assembled in the field, shall be available as an option, above 2000 mm in diameter.

The surface of the wheel/rotor should be highly polished to ensure that the vertical run out does not exceed + 1 mm for every 1 metre diameter, thereby ensuring, negligible leakage, if labyrinth non contact seals are provided, and minimal drag, if contact wiper seals are provided.

The radial run out also shall not exceed + 1 mm for every 1 meter diameter, thereby minimizing the leakage/drag on the radial seals, and minimize the fluctuation in the tension of the drive belt.

The number of wraps (of alternative corrugated and flat foil) for every inch of rotor radii shall be very consistent so as to ensure uniform air flow and performance over the entire face in the air stream. Flute height and pitch will be consistent to a very tight tolerance to ensure uniform pressure drop and uniform airflows across the rotor face.

The rotor shall be a non clogging aluminum media, having a multitude of narrow aluminum foil channels, thus ensuring a laminar flow, and will allow particles upto 800 microns to pass through it.

The media shall be cleanable with compressed air, or low pressure steam or light detergent, without degrading the latent recovery.

The Cassette / Casing

The recovery wheel cassette/casing shall be manufactured from tubular structure

to provide a self supporting rigid structure, complete with access panels, purge sector, rotor, bearings, seals, drive mechanism complete with belt.

The rotor/wheel should have a field adjustable purge mechanism to provide definite separation of airflow minimizing the carryover of bacteria, dust and other pollutants, from the exhaust air to the supply air. It shall be possible, with proper adjustment, to limit cross contamination of that of the exhaust air concentration.

Cooling Coils

Chilled water coils shall have 12.5 mm to 16 mm dia tubes of wall thickness not less than 27 G (0.41mm thick) with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21Kg/Sqcm air pressure under water. Tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm.)

Filters

Each fresh air treatment unit (FATU) shall be provided with pre-filters, fine filters and carbon filters having specifications as elaborated in sub head "filters"

Performance Data

Fresh air treatment units shall be selected for the lowest operating noise level. Technical submittal of fresh air treatment units shall be prepared for Consultants approval prior to procurement as mentioned under Special Conditions. Fan performance rating and power consumption characteristics shall be submitted and verified at the time of testing and commissioning of the entire installation.

Testing

Cooling capacity of various fresh air treatment unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the HRW. Air flow measurements shall be carried out by an anemometer and temperature measurements by accurately calibrated thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

1.6 FAN COIL UNITS

1.6.1 Concealed Type

Fan coil units shall be of horizontal/vertical design and suitable for overhead/floor installation and necessary ductwork. The unit shall comprise of multirows deep chilled water coil made out of copper tubes of dia not less than 9.6mm OD having tube thickness not less than of 25 G. The cooling coil shall be complete with aluminium fins of minimum 0.2 mm thickness arranged to have a maximum fin spacing of 5 fins/cm and pressure tested for hydraulic pressure of 21 Kg/Sq.cm.

Fan deck shall comprise of twin centrifugal blowers made out of 14 gauge aluminium sheet & fractional horse power motor of appropriate motor rating. The blower assembly should be easily openable having provision of wing nuts. Filter media shall be of aluminium mesh in multi layer with extruded aluminium frame. The fan coil units should have provision for incorporating these filters either at the bottom or back depending upon the requirement.

Drain pan shall be of single piece deep drawn stainless steel construction and

insulated with 13mm thick EPDM closed cell elastomeric insulation material exhibiting class "O" properties. The outer skin of the tray shall be single piece molded FRP. Drain connection shall be of 32mm dia. Side, top and bottom panels shall be of 18 gauge die formed galvanized steel sheet and shall incorporate linear adjustable holes for overhead suspension for horizontal units. The fan coil units shall be provided with factory insulated auxiliary drain pan. The fan coil unit shall be factory assembled and tested for desired output. Noise level shall not exceed 35 db.

1.6.2 Finished Type

Fan coil units shall be of vertical design and suitable for wall mounting installation. The units shall comprise of multi-rows deep chilled water coil made out of copper tubes of dia not less than 9.5 mm ID having tube thickness not less than of 26 G. The cooling coil shall be complete with Aluminium fins of minimum 0.16 mm thickness arranged to have a minimum fin spacing of 5 fins/cm and pressure tested for hydraulic pressure of 21 Kg/Sq.cm.

Fan deck shall comprise of dynamically balanced, single cross flow (tangential flow) fan impeller made out of multiple HIP sections sonic welded together with staggered runner blades in alternate sections, to minimize air in take noise. The housing shall be integral with the body of the unit and made out of ABS plastic, with a motor of fractional horse power having appropriate rating. The motor will be permanently lubricated to minimize maintenance requirements.

The blower assembly shall be on one side coupled with the motor directly and on the other side, supported on a bush bearing for a low noise operation. The blower assembly should be easily accessible. Filter media shall be of non-woven, moulded HDPE mesh, corrugated to enhance the filtration area and reduce pressure drop. Filters shall be slide in / slide out type and located just inside the casing behind the return air grille.

The body of Fan Coil unit shall be made out of ABS, fully moulded (not fabricated). The drain pan shall also be of FRP material duly insulated with closed cell elastomeric insulation. Drain connection should be towards the bottom of the unit on the rear side.

The unit should have Horizontal as well as vertical louvers to deflect the air as required. The unit should be equipped with a remote control complete with a PCB, sensor and micro processor controller. Noise level shall not exceed 40 db.

1.6 FILTERS

1.6.1 Viscous Metallic Filters

Viscous metal filter shall be all metal, washable type. The filter media shall be composed of layers of crimped GI wire mesh. The velocity over face of filter shall not exceed 90 MPM. and pressure drop shall not exceed 5mm for 50mm thick filter. The filter shall be of GI and suitable for mounting as required at site.

1.6.2 Synthetic Fibre Filters (EU-3)

Synthetic fibre filter shall be constructed out of 50mm deep non-woven synthetic fibre replaceable media secured with anodized ductile aluminium mesh on one side & 40 sieve HDPE mesh on the other side. All the layers to be dully stiched together & to be housed in 18G Aluminium anodized frame. The filter element shall have 11 folds/Rft. The filter shall have an efficiency of 90% down to 10 microns when tested as per BS: 2831 standard. It shall be suitable for operation under 100% Relative Humidity & 120 degree C temperature conditions. The velocity over the face of filter shall not exceed 105 MPM and the pressure drop

across the filter shall not exceed 3 mm WG for 50mm thick filter. The filter frame shall be suitable for mounting in air handling unit as required at site.

1.6.3 Minimum Efficiency Reporting Value Parameters (MERV-13)

ASHRAE Standard 52.2 Minimum Efficiency Reporting	Composite Average Particle size Efficiency, Percentage in Size Range , um		
	Range1 0.30 – 1.0	Range 2 1.0 –	Range 3 3.0-
01.	n/a	n/a	E3 < 20
02.	n/a	n/a	E3 < 20
03.	n/a	n/a	E3 < 20
04.	n/a	n/a	E3 < 20
05.	n/a	n/a	20 < E3 < 35
06.	n/a	n/a	35 < E3 < 50
07.	n/a	n/a	50 < E3 < 70
08.	n/a	n/a	70 < E3
09.	n/a	E2 < 50	85 < E3
10.	n/a	50 < E2 <	85 < E3
11	n/a	65 < E2 <	85 < E3
12	n/a	80 < E2	85 < E3
13	E1 < 75	90 < E2	90 < E3
14	75 < E1 < 85	90 < E2	90 < E3
15	85 < E1 < 95	90 < E2	90 < E3
16	95 < E1	95 < E2	95 < E3

1.6.4 Microvee Filters : (EU-7)

Fine filters shall be designed to remove particles down to 3 microns as per BS: 6540 standard.

Filter shall comprise of aluminium sheet duly anodized. Filter element shall be made out of non-woven synthetic supported by anodized ductile aluminium mesh on one side & HDPE mesh not less than 40 sieve size on the other side with 11 folds/Rft of filtration area. All the layers to be dully stitched together. All sides to be sealed with ductile epoxy resin and filters shall be cleanable type using water/detergent. Rubber gaskets to be provided on the flange. Filter element shall be specially treated with antifungal and bacterial reagent to prevent growth of micro-organisms shall be screwed into the frame by means of an aluminium clamp patti and brass screws. They shall comprise of housing made from MS angles/flats epoxy coated of size suitable to receive the required number of filters to handle specified Cfm for each AHU. All filters shall be installed in same plane. No zigzagging shall be allowed by means of threaded bolts.

1.6.5 HEPA Filter :

These filters shall remove particles greater than 0.3 microns with an efficiency of 99.99% when tested with cold DOP test. Filter shall comprise of specially treated glass fiber media, aluminium media separators housed in an aluminium sheet frame provided with double turned flanges and dosed cell neoprene gaskets. The housing shall be designed to install the hepa filter in the terminal location in RCC slab ceiling. It shall be suitable for mounting the HEPA filter. Housing assembly shall comprise of :

- a) Bottom MS tee frame.
- b) Top MS angle frame.
- c) Clamping device for filter tightening.
- d) Provision for connecting manometer across the filter.
- e) Provision for top flexible PVC based connector.

MS tee frame shall be mounted flush on the bottom surface of ceiling. It shall be securely welded at site to top MS angle frame which will be supported by brick masonry up stand all around the slab opening. The contractor shall ensure that the inner surface of the opening is smooth plaster finished and treated with epoxy paint by civil contractor. The top MS angle frame shall have provision to fix SS angle cleats by means of bolts. Cleats shall contain SS press down bolts with lock nuts. Flexible Rexene connectors shall be of suitable size to enable easy insertion and removal of HEPA filter into the terminal opening. The Rexene shall be screwed to supply air duct and MS angle frame in up stand by means of MS clamp patties. All MS components shall be epoxy painted.

1.7 INDUSTRIAL FANS

1.7.1 Centrifugal fans :

Centrifugal fans shall be of high Efficiency forward/backward curved approved make DIDW of specified Class and arrangement complete with access door, squirrel-cage induction motor, V belt drive, belt guard and vibration isolators. Type, direction of discharge / rotation, and motor position shall be as per the Approved for Construction shop drawings.

- a. Housing :

Housing shall be constructed out of heavy gauge galvanized steel sheet as per manufacturer's standard. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene/ asbestos packing should be provided through out split joints to make it air tight.

18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

b. Fan Wheel :

Fan Wheel shall be backward-curved non-overloading type. Fan wheel and housing shall be statically and dynamically balanced.

Fan outlet velocity shall not exceed 1800 FPM (548 MPM) and maximum fan speed shall be 1000 RPM.

c. Shaft :

Shaft shall be constructed of steel, turned, ground and polished.

d. Bearings :

Bearings shall be of the sleeve/ball-bearings type mounted directly on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil grease pack pillow block type.

e. Motors :

Fan motor shall be suitable for 415 + 10% volts, 50 cycle, 3 phase power supply, squirrel -cage, TEFC two speed IP-55 motor, provided with class B insulation, and of approved make. Motor name plate horsepower shall exceed brake horsepower by a minimum of 10%. Motor shall be designed specially for quiet operation and motor speed shall not exceed 1450 rpm. The fan and motor combination selected for the particular required performance shall be of the most efficient (smallest horse power) so that noise level is lowest.

f. Drive

Drive to fan shall be provided through belt with adjustable motor sheave and standard belt guard. Belt shall be of the oil resistant type.

g. Vibration Isolation :

MS base shall be provided for both fan motor, built as an integral part, and shall be mounted on a concrete foundation through vibration isolators of approved make, cushy foot mountings. The concrete foundation shall be atleast 15 cm above the finished floor level, or as shown in approved for construction shop drawings.

1.7.2 INLINE FANS

Inline fan shall incorporate approved make SISW direct driven Centrifugal Fan with TEFC (IP-44) motor. The fan assembly shall be encased in a sheet metal housing of 22 gauge GSS and with necessary inspect on cover with proper gasket assembly. The fan material shall be galvanized

sheet steel. Flanges shall be provided on both sides of the Inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being communicated to other equipments connected to the Inline fan. Motor shall be single phase/three phase as per duty conditions.

All single phase fans shall be provided with speed regulator while all three phase fans shall be provided with opposed blade damper in GSS construction at fan outlet for air balancing.

1.7.3 PROPELLER FANS

Propeller type, Ring/Diaphragm mounted fans shall be equipped with a TEFC phase motor with the impeller mounted directly on the shaft. The blades shall be die formed steel. The fan shall be fitted with gravity type louvers. The speed of fan shall not exceed 900 RPM. The fan speed can go upto 1400 RPM only incase of fans having diameter of 305 mm.

Installation

- a. The Contractor shall supply all foundation bolts, base frame wherever required, vibration eliminators etc. and shall ensure that all the above accessories are placed securely in proper position while the foundation is cast.
- b. Vibration eliminators shall be provided with an efficiency of not less than 80% wherever necessary.
- c. Fan inlet and outlet connections shall be with flexible canvas connections wherever necessary.

Testing

All the fans shall be tested for performance and the following test results shall be furnished :

- a. Air flow rate in CFM.
- b. Static pressure at the fan supply end.

Painting

On completion of the erection and testing, the outside of the fans shall be painted with two coats of Synthetic Enamel paint of approved colour over and under coat of primer.

1.7.4 AXIAL FLOW FANS :

Fans shall be Tube axial type of approved make, complete with motor mount, belt driven (or direct driven) and vibration isolation type suspension arrangement as per approved for construction shop drawings. The fan shall be complete with the following :

- a. Casing :

Casing shall be constructed out of heavy gauge sheet steel. Fan casing, motor mount shall be of welded steel construction. Motor mounting plate shall be minimum 20 mm thick and machined to receive motor flange. Casing shall be provided with wide hinged door which opens easily for removal of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided.

Casing shall have flanged connection on both ends for ducted applications.

Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Casing shall be bonderized, primed and finish coated with enamel paint.

Vertically mounted fans shall also be installed in the same manner, however, fans shall be equipped with thrust bearings.

b. Rotor :

Rotor hub blades shall be cast aluminium construction. Blades shall be die formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Tip clearance between impeller and fan casing should be 1% of diameter. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

c. Motor :

Motor shall be high efficiency EFF-1 of approved make, squirrel cage, totally enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for $415 \pm 10\%$ volts, 50 Hz, 3 phase power supply, provided with class H insulation. Motor name plate horse power shall exceed brake horse power by a minimum of 15% . Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter 300mm, and 1440 RPM for fans with impeller diameter 300mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit. The motor should withstand fire upto 2 hours at 250 deg C.

d. Drive :

Drive to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of the oil resistant type.

Dedicated smoke spill fans shall be provided with direct drive motors with Class "H" protection capable of withstanding 250 deg C temperature for 2 hours. Entire fan assembly shall be tested and approved by Exova Warrington Fire in accordance with BSEN: 12101- C/2002 standard for "Powered Smoke & Heat exhaust ventilator for smoke control system" as specified in schedule of quantities.

e. Vibration Isolation :

The assembly of fan and motor shall be suspended from the ceiling by vibration isolation suspension of rubber in shear type of approved make.

f. Accessories :

The following accessories shall be provided with all fans.

- i. Outlet cone for static pressure regain.
- ii. Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities.

Fans shall be factory assembled and shipped with all accessories factory mounted and fan shall be AMCA certified for sound & air performance.

1.8 EXTRACT AIR SCRUBBER FOR KITCHENS

Supply, Installation, Testing and Commissioning of Exhaust Air Scrubber each comprising of extract air intake section, electrostatic precipitation technology based dry type air cleaner to remove Oil, Smoke & fumes from the exhaust air, fan section with floor standing backward curved DIDW centrifugal fan/s, TEFC squirrel cage induction motor, belt drive package. Fan section casing shall be of at least 16 gauge galvanized sheet complete with provisions of separate GI sheet enclosure to locate the motor in hot air stream free area (applicable for kitchens). The fan section shall be re-inforced with access panel as required.

The fan shall be backward curved floor standing double inlet double width type as described under industrial fans. The wheel 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 impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (610 MPM). Fan housing with motor shall be mounted on a common steel base inside the air handling housing on anti vibration springs mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

Fan shall be driven by an energy efficient electric motor, EFF-1 as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be atleast 20% over limit load plus transmission losses.

Fan motor shall be suitable for operation on 415+10% volts, 50 cycles, 3 phase, AC power supply and shall be TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors 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 the oil- resistant type.

Electrostatic Precipitator Section:

Electrostatic precipitator section shall be made of 16 gauge galvanized sheet, High bake epoxy powder coated, Washable type aluminum mesh pre-filter, Washable type aluminum mesh post filter, Stainless steel spiked ionizers to create high voltage DC field, aluminum collector plates which should be alternatively

charged positive & negative with large collecting area with 14" deep cell, to work as magnet for charged smoke & oil particles.

Average efficiency of 90-95% in single pass as per DOP test method. Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 micron through solid state power supply. Collector cell should be of permanent type and slide out facility for easy removal for cleaning. Operating Voltage: 220V/1Ph/ 50Hz, Power consumption: 50 watts each unit. Ionizing Voltage: 12.5 – 13.0 kVDC, Collector Cell Voltage: 6.0 – 6.5 kVDC, System should be fitted with interlock switch for safety, The system should be able connected to a fan section to achieve airflow of 500 FPM across the air cleaner. The filter should have a constant pressure drop.

1.9 Air Washers

Scope

The scope of this section comprises of supply, installation, testing and commissioning of packaged type Air washers of specific capacity set forth in the " Schedule of Quantities".

Packaged air washer shall be complete with GI casing suitably braced made out of atleast 1.6mm thick galvanized steel sheet. The airwasher section complete with sump shall be made out of SS-304A grade, 1.25mm thick stainless steel sheet with bolted construction having suitable stiffeners and FRP lining on the joints. The bottom tray shall be made out of 16 gauge GI with 1mm FRP lining from inside. The casing shall be of bolted construction designed for outdoor installation. The entire fan section shall be coated with bitumen from inside. The centrifugal fans shall be coated with epoxy paint to avoid moisture abuse.

The packaged air washer shall be complete but not restricted to the following :

- a. 50mm thick aluminium wire mesh filters at the air intake.
- b. 200mm thick cellulose based paper fills of imported origin. It shall provide extended and sufficient wetted surface to provide a water absorbing efficiency of 90% with air velocity not exceeding 500 FPM (2.44 M/Sec).
- c. FRP water header with equidistant slits for uniform water distribution over the paper fills.
- d. Drain, overflow, make-up and quickfill connections with 20mm float valve of commercial grade brass.
- e. Suction screen constructed out of brass and shall be of sufficient area to maintain velocity not exceeding 25Cms/sec.
- f. All interior and exterior GI piping with valves and fittings to connect the water circulating pumps including 'Y' strainer etc.
- g. Cabinet type supply air fan section shall be completely factory assembled and tested of approved manufacture.

Casing shall be of heavy gauge galvanized sheet, ribbed and re-inforced with access panels as may be required.

The fan shall be forward curved floor standing double inlet double width type of imported origin. The wheel 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 speed not exceeding 1000 RPM. Variable pitch pulley shall be provided to affect reduction in speed in winter if required. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of anti vibration flexible joints made out of imported fire retardant fabrics with extruded aluminium frame/flange on both sides. The centrifugal fans shall be epoxy coated in the factory prior to delivery.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be atleast 10% over limit load plus transmission losses.

Fan motors shall be suitable for operation on $415 \pm 10\%$ volts, 50 cycles, 3 phase, AC power supply and shall be TEFC squirrel cage induction type totally enclosed fan cooled with IP-

55 protection. Motors 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 the oil-resistant type.

h. The inside of the cabinet to be insulated with TF quality 25mm thick thermocole filled with bitumen and finished with bitumen coat on chicken wire mesh.

i. Vibration isolators for pumps and centrifugal fans.

j. Pumps

a) 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.

b) The pump shall be provided with single phase, self tripping starter of North West make.

k. Limitation

The air velocity limits are as follows :

a) Velocity across cooling pads shall not be exceeding 2.44 M/s (500 FPM).

b) Velocity at fan outlet shall not be exceeding 10.16 M/s (2000 FPM).

1.10 FAN FILTER UNITS

The scope of this section comprises of supply, installation, testing and commissioning of packaged type Fan Filter Units (FFU) of specific capacity set forth in the "Schedule of Quantities".

The housing/casing of the FFU shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon size of the FFU, location & access available.

The framework shall be extruded aluminum hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.

Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre- painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 25 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminum hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on galvanized steel channel frame work.

Marine light with switch, view window and proximity switch to be provided in the casing of each FFU. Factory Fabricated Plenums shall be provided as shown in design drawings.

The fan shall be forward/backward curved, floor standing, double inlet double width type. The wheel 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/spider and self lubricated sealed eccentric type ball bearings.

The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (10.1 MPS). Fan housing with motor shall be mounted on a common steel base inside the air handling housing on anti vibration springs mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 20% over limit load plus transmission losses.

Fan motors shall be suitable for operation on 415+10% volts, 50 Hz, 3 phase, AC power supply and shall be EFF1, TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors 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 the oil-resistant type.

Fan Filter units should be provided with necessary viscous metallic filters as mentioned under subhead filters.

1.11 EXTRACT FAN SECTION

The scope of this section comprises of supply, installation, testing and commissioning of packaged type Extract Fan Sections (EFS) of specific capacity set forth in the "Schedule of Quantities".

The housing/casing of the EFS shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon size of the EFS, location & access available.

The framework shall be extruded aluminum hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.

Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre- painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 25 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminum hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on galvanized steel channel frame work.

Marine light with switch, view window and proximity switch to be provided in the casing of each EFS. Factory Fabricated Plenums shall be provided as shown in design drawings.

The fan shall be forward/backward curved, floor standing, double inlet double width type. The wheel 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/spider and self lubricated sealed eccentric type ball bearings.

The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (10.1 MPS). Fan housing with motor shall be mounted on a

common steel base inside the air handling housing on anti vibration springs mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be atleast 20% over limit load plus transmission losses.

Fan motors shall be suitable for operation on 415+10% volts, 50 Hz, 3 phase, AC power supply and shall be EFF1, TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors 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 the oil- resistant type. Provisions of separate GI sheet enclosure to locate the motor in hot air stream free area to be made (applicable for kitchen extract fan sections only).

1.12 Dx-SPLIT PACKAGES

Scope

The scope of this section comprises supply, installation, testing and commissioning of self contained air cooled split type air conditioning units each comprising of an outdoor and single/multi indoor units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

Outdoor Unit

Outdoor unit shall be an air cooled condensing unit suitable for out door installation conforming to the following specifications.

Unit Base & Casing

Base panel shall be constructed out of fabricated steel structure of adequate size. Casing panels shall be of 1.2 mm thick, welded construction, removable type to provide easy access to equipment and shall be bonderized and painted. Casing shall be complete with discharge outlets, grilles, space for refrigeration equipment, fans, cooling coil etc.

Compressor

Compressor shall be of multi-cylinder hermetic /scroll type complete with drive and motor, dynamically balanced removable cylinder sleeves, oil return check valves, suction and oil strainers, discharge and suction shut-off valves, sight glass etc. Compressor and motor assembly shall be installed on a spring mounted floating platform to provide quiet vibration less operation. Compressor shall be provided with overload protection switch.

Condenser

Condenser shall be air cooled in copper tube & aluminium fins construction. Condensers shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied.

Condenser Fan

Fan shall be preferably propeller type suitable for fractional horse power drive with IP-55 protection.

Indoor Unit

The indoor unit shall be basically a fan coil unit suitable for floor/wall/ceiling installation with ABS plastic moulded/ sheet steel enclosure duly baked enamel painted, housing cooling coil of copper tubes and corrugated aluminium fins.

Cooling coil

Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM.

Fan Section

The fan housing shall incorporate centrifugal, dynamically balanced blower/s directly coupled with fractional horse power motor to ensure noise free operation.

Filters

Filters shall be cleanable, synthetic fibre filters of approved make. Velocity through filters shall not exceed 105 Meters per minute and pressure drop through filters shall not exceed 5 mm of WG.

Insulation

Indoor unit shall be factory insulated with minimum 6 mm thick closed cell elastomeric insulation towards thermal/acoustic treatment.

Drain pan shall be insulated with minimum 6mm mm thick closed cell elastomeric insulation. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to prevent condensation.

Condensate drain piping around the indoor unit shall be insulated with minimum 6mm thick closed cell elastomeric insulation preferably in tubing form.

Refrigerant Piping

The copper refrigerant piping shall be carried out neatly to connect outdoor and

indoor unit/s and shall run along with wires/cables. The refrigerant piping associated with ductable units shall be carried out using hard drawn copper pipes & ready made copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves at the end of condenser.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 21Kg/ Sqcm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.

All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities.

To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polyshield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

1.13 VARIABLE FREQUENCY DRIVES

Scope

This section describes the type of frequency converter to be supplied for fan/pump speed control. The drive shall not be a general purpose product, but should exhibit features acknowledging engineered design applicable to HVAC industry.

The drives shall exhibit IP-55 protection unless otherwise captured in BOQ.

The manufacturer shall demonstrate a continuous period of manufacture and development for at least 25 years.

The frequency converter shall be supported locally by the manufacturer who will provide full technical support, spares holding and trouble shooting capability from his own local facility. A training course shall be organized by the manufacturer for the consultant / contractor / maintenance engineers.

The manufacturer shall provide full technical detail of the product, with catalogues, dimension drawings, weights etc. and each drive shall be provided with a full technical manual.

Equipment supplied must conform to recognized International Standards and be manufactured to ISO 9001, BS 5750 part 1 & 2 and carry the CE Mark on EMC Compliance.

Frequency converters shall be suitable for use in either a 'Stand Alone' mode, complete with all necessary protection or as part of centrally controlled system via a Serial Communication Loop to the main Building Management System (BMS) via in-built RS 485 port.

Technical Requirement

The frequency converter (FC) shall convert Local Voltage $V \pm 10\%$, 3 Phase, 50/60 Hz utility power supply to an adjustable output voltage and frequency. The FC must be capable of delivering full value of fundamental true RMS output voltage to the motor equal to the mains input voltage to the FC at full load and speed. In the event the FC cannot meet this requirement an oversized motor at least one frame size higher must be selected. The FC manufacturer must document this capability.

The voltage to frequency ratio shall be suitable for fan control. It should not be possible to set a constant V/F ratio, to prevent damage to connected equipment and to optimize energy usage.

The FC shall work in conjunction with any IEC standard design motor and shall not require the motor to be de-rated, or cause the motor temperature to rise above the class 'B' rise expected on normal mains operation. The Motor Shall not require an external blower even at slow speed running.

When selecting the FC, care shall be taken to ensure that protection against electro fluting of motor bearings and/or damage to the motor windings shall be provided. This shall be provided by the inclusion of :

- a) Insulated motor bearings
- b) Soft switching IGBT's in the FC
- c) LC Filters fitted to the FC

The FC shall use AMA (Automatic Motor Adaptation) techniques so that operators do not have to input motor characteristic and ensuring proper motor operation, optimize motor performance, improve start capabilities and compensate for motor cable variances.

The FC shall be capable of controlling parallel motors of mixed ratings, and allow disconnection of any machine whilst running without causing tripping. The FC shall be capable of running with no motor connected for service functions.

The FC shall be fully tested at the converter manufacturers works, including motor loading. Certificates of Compliance should be available on request.

The FC shall be of sufficient capacity to provide a quality wave form so as to achieve full output torque of the motor, without causing additional heat rise.

The operating conditions shall include:

- a) Minimum efficiency at 100% load- 96%
at 20% load - 92%
- b) Rated input voltage (local voltage) $\pm 10\%$, 3 phase, 50/60 Hz ± 2 Hz.
- c) Working ambient temperature range -10°C to $+45^{\circ}\text{C}$, humidity to 95% RH, and vibration of 0.7G.RMS in 3 directions
- d) Output frequency range - 0.5 to 1000 Hz.
- e) Output voltage range 0 to full mains input voltage, 3 phase even at full mains voltage - 10% input.
- f) The drive shall allow connection of motors one frame size larger and 4 sizes smaller than the nominal converter rating.
- g) VFD shall be limited to 110% of rated current for 60 seconds and 160% torque for 0.5 seconds
- h) The FC shall accept 0-10 VDC, 4-20 mA, or resistive inputs as a control signal.
- i) The FC shall provide two output relays to provide signals including - ready, run, tripped, and be programmable for other selected information. Two analogue outputs of 4-20 mA or 24 VDC shall be programmable to transmit speed or other parameters to the BMS In addition, 2 x digital outputs shall provide 24Vdc to signal choice of 27 conditions to the BMS.
- j) The FC shall log and display "Total kW-hrs consumed" and "Total Hours Run" by the motor without additional instrumentation and the facility to "Reset".
- k) 20 preset speeds shall be available (programmable values) for duties

- such as night setback, smoke extract and morning boost settings.
- l) The FC shall provide 4 skip frequencies of adjustable bandwidth to overcome mechanical or air resonance.
 - m) A parameter lock shall be incorporated to prevent unauthorized resetting of parameters.
 - n) The FC shall be capable of running from an external DC source during periods of mains interruption.
 - o) Drive acoustic noise shall not exceed 65 dB A at full load and 60 dB A at 50% load.
- Drive Design Requirements

The FC shall contain as standard within its enclosure DC Link filtering with both inductive and capacitive elements to control the mains borne harmonics. The document 'Electrical Supply Industry Recommendation G 5/3 limits for harmonic currents in the UK or IEEE519, 1992 shall be used for the basis of calculation of THD for the point of common coupling. On request, the FC manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, etc. feeding the FCs to allow this calculation to be made.

The FC shall comply with EMC(Electromagnetic compatibility) (RFI Control) document EN55011 as an integral part of its design, incorporating EMC/ RFI Filters to meet both EN55011 Class 1A (150metres) and Class 1B (50 metres). It shall conform to immunity standard IEC 801 parts 2-5. Must carry the CE Mark of Compliance.

The drive shall be capable of automatically reconnecting to a spinning fan, forward or reverse running, without tripping, following mains interruption or on transfer from bypass running.

The FC design shall comprise of a diode input bridge, fixed voltage DC link section with both inductors and capacitors to form a filter, and inverting bridge comprising IGBT's (Insulated Gate BiPolar Transistors) . All equipment must be housed within the FC enclosure.

The inverting bridge shall be controlled by a 32 bit processor and ASIC's (Application Specific Integrated Circuits) to produce a VVC. Plus (Voltage Vector Controlled) enhanced PWM waveform naturally resulting in full motor voltage, torque and sinusoidal current of mains supply quality in the motor circuit. Other forms of current source or 6 pulse converters shall not be acceptable.

The FC shall protect itself against input transients to VDE0160 class W2; loss of mains phase (3 phase measurement); loss of motor phase (3 phase measurement); grounding of any output phase; loss of speed reference (runs at last setting/preset speed/close down-programmable).

The FC shall use overriding frequency fold back control techniques to prevent damage in the event of excessive load during either running or starting.

The FC shall model the motor in its software to predict motor overheating without the use of thermistors in the motor. When overheat is predicted, an alarm or automatic shutdown shall be initiated.

The FC shall exhibit near unity fundamental power factor at all loads and speeds, and should not require the addition of external A.C./D.C. line reactors for power factor improvement, harmonic control or prevention of zero voltage notching.

The output circuit shall be of such a design, as to allow unlimited switching of the motor circuit, at any load/speed without causing damage to the IGBT output stage and without needing auxiliary control switching.

FC shall have self adjusting modulation frequency control from 2.0 KHz to 14 KHz. The control form shall be such as to allow the FC to deliver full output at all times without derating, by optimizing the switching frequency dependent on the output load.

Full galvanic isolation between power and control components shall be incorporated to ensure compliance with VDE 0160 PELV (Protective Extra Low Voltage) to prevent damage to BMS interface and ensure operator safety. Short circuiting of the control terminals shall not damage the control card.

The FC shall include an AEO (Automatic Energy Optimization) circuit to continuously adjust the voltage to frequency ratio and optimize the motor magnetizing current based on the actual

torque requirement of the motor at different speeds to optimize motor energy consumption and prevent heating of motor at low speeds.

The design shall include a full 2 zone, 2 setpoint PID controller as standard to provide closed loop control direct from upto 2 signal transmitters without the need for external signal conditioning.

The FC shall not exhibit an inrush current when a 'start' signal is given, and current must not exceed 110% at any time to prevent damage to connected equipment.

The FC design shall include a motor preheat circuit to prevent condensation forming in the motor during shutdown periods.

The FC shall not be damaged if it is energized with a 'start' signal without a motor connected. The FC shall provide as standard:

- a) Heat sink over-temperature protection.
- b) Under-voltage protection.
- c) Over-voltage

protection. Display

to be in selectable

language.

The Local Control Panel (keypad of FC) of FC shall display in 4 line alpha-numeric characters in plain English language, the following operating parameters :

- a. Energy consumed in KW-Hr.
- b. Power consumed by motor in kW
- c. Run time of motor in Hours.
- d. Current drawn by the motor in Amperes.
- e. Voltage applied to motor terminals by FC in Volts
- f. DC link voltage in Volts
- g. Output Frequency in Hz.
- h. Percentage of maximum output frequency in %.
- i. Motor Speed in RPM
- j. Thermal Load on Motor in %

1.14 AIR CURTAINS

Air curtains shall be vertical down throw type and shall comprise of twin centrifugal blowers, statically and dynamically balanced, designed for noiseless and continuous operation, motor etc. The enclosure shall be factory fabricated out of 18 gauge aluminium/CRCA sheet duly powder coated. The outlet shall be carefully designed to create laminar draft providing an invisible air curtain at critical junction isolating clean and semi-clean areas or as required

1.15 Dx-SPLIT TYPE AIRCOOLED VARIABLE REFRIGERANT FLOW PACKAGES

Scope

The scope of this section comprises of supply, installation, testing and commissioning of self contained air cooled split type variable refrigerant flow packages each comprising of an outdoor and multiple indoor ductable/non-ductable units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.

Outdoor Unit

Outdoor unit shall be factory assembled, good for outdoor installation, constructed out of heavy gauge MS panels with weather proof painting. The units shall be factory wired with necessary controls duly tested prior to dispatch conforming to the following specifications.

- a) All outdoor units shall consist of minimum two scroll compressors, preferably one with inverter drive, capable to operate even when one compressor is unserviceable.
- b) Outdoor units above 16 HP shall consist of minimum two separate inverter driven compressors.
- c) The units shall be provided with duty cycling arrangement for multiple inverter compressors.
- d) The outdoor unit shall be modular in design to facilitate installation one after another close to each other. Preference would be given to compact units having smaller footprint.
- e) Outdoor units should be rugged of anti-corrosion design.
- f) The outdoor unit shall comprise of sub cooling feature to effectively use the entire coil surface through proper circuit/bridge in order to prevent flushing of refrigerant owing to large length of piping.
- g) The condensing unit shall be provided with state-of-the-art microprocessor based control panel.

The outdoor unit shall be provided with Aero spiral design fan exhibiting low noise

level characteristics complete with aero fitting grille to facilitate spiral discharge of airflow to effect reduction in pressure losses. The fan should be capable to respond to external static pressure of 5mm.

The condensing unit shall be designed to facilitate fail safe operation when connected to multiple indoor units.

Following safety devices shall be integral part of the outdoor unit:

- High pressure switch
- Fan drive overload protection switch
- Fusible plug

Overload relay including overload protection for inverter driven compressor.

Scroll Compressor

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

The compressor shall be capable of functioning with inverter control as well. The inverter driven compressor shall preferably be with reluctance DC inverter for higher efficiency and reliability.

Condenser

Condenser shall be air-cooled type, suitable for outdoor installation and shall be suitable for operating at 46 deg C db and 24 deg C wb temperatures. Condenser shall be in copper tube & aluminium fin construction. Condenser coil shall be of minimum 4 rows deep and the fin spacing shall not exceed 2mm. The maximum face velocity across the coil shall not exceed 215 MPM. The condenser frame shall be constructed from heavy duty galvanized steel.

The condenser fan/s shall be of propeller type with 900 RPM variable voltage electric motor complete with IP-55 protection. Motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive. The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.

Anti Corrosion Protective Treatment associated with Condensing Units, piping, Joints and U bends & refrigerant piping between outdoor and indoor units.

All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent polymer coating for protection against corrosion from ambient air pollution.

Two coats of protective coating shall be applied. Each coat shall have dry film thickness of 35 micron or more. The coating shall be strong, flexible and durable. It shall have good adhesive and abrasion resistance. It shall be resistant to moisture, UV, acid, alkali and other chemicals and capable of functioning between -250 C and 1500 C.

The polymer shall be obtained by the mixing of base / monomer with a hardener / polymerizer. It may brush applied or with the use of a suitable gun.

Indoor Units

The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications.

Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities. Each unit shall be provided with electronic control valve to modulate flow of refrigerant through the cooling coil responding to the space heat load variations.

Each indoor unit shall consist of PID controller for maintaining design room conditions besides microprocessor based thermostat for cooling/heating. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user.

The ceiling mounted 2 way/ 4 way cassette type indoor units shall comprise of an attractive moulded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind. Each cassette type indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.

The hi-wall indoor units shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above.

Ceiling mounted ductable indoor units shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of duct work. The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.

Cooling coil

Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sqcm air pressure.

Fan Section

The fan associated with non ductable indoor units shall be dual suction, aerodynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.

Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.

Filters

Filters shall be as per ASHRAE standards . The filters shall also be high efficiency long life

,cleanable, synthetic fibre media of approved make. Velocity through filters shall not exceed 105 MPM.

Commissioning Filters (Only Pre-filters)

Each indoor unit shall be provided with one set of commissioning filters. The

filters shall be replaced with pre-filters after commissioning of the system.

Insulation

All indoor unit shall be factory insulated with minimum 9 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment.

Drain pan shall be insulated with minimum 9mm mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.

Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.

Refrigerant Piping

The copper refrigerant piping shall be carried out neatly enclosed between two cable trays to connect outdoor and indoor unit and shall run along with wires/cables suitable for R410a refrigerant. The refrigerant piping shall be carried out using hard drawn copper pipes & ready made copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using

soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. All pipe sleeves shall be sealed with fire retardant sealant. The refrigerant circuit shall include liquid line and gas shut-off valves besides expansion valve at the end of condenser. The refrigerant piping shall be carefully sized with necessary headers and should consist of accessories including Y-joints.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 350 psig. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 500 μ and held for another 24 hours prior to commencement of gas charging.

All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.

All joints of refrigerant pipes shall be identified & marked with paint/tape indicating joints.

The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities. To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polyshield coating.

Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

The recommended wall thickness of copper pipes being used for VRF application using high pressure refrigerant, R 410 a, is as under:

Copper Pipe Outer dia (mm)	Copper tube wall thickness (mm)
	Minimum requirement
Dia 6.4	0.8
Dia 9.5	0.8
Dia 12.7	0.8
Dia 15.9	1
Dia 19.1	0.8
Dia 22.2	0.8
Dia 25.4	0.88
Dia 28.6	0.99
Dia 31.8	1.10
Dia 34.9	1.21
Dia 38.1	1.32
Dia 41.3	1.43

CENTRALIZED REMOTE CONTROLLER, TOUCH SCREEN TYPE

A multifunctional compact centralized controller shall be provided with the system.

The Graphic Controller must act as an advanced air conditioning management system to facilitate complete control of VRF air conditioning equipment, It should be user friendly through its touch screen, icon display and color LCD display.

It shall be able to control up to several groups of indoor units with the following

functions : Starting/stopping of Airconditioners as a zone or group or individual unit. Temperature setting for each indoor unit or zone.

Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

Monitoring of operation status such as operation mode & temperature setting of individual indoor unit, maintenance information and trouble shooting information.

Display of air conditioner operation history.

Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall comprise of wide screen user friendly color LCD display and can be wired by a non polar 2 wire transmission cable upto a distance of 1 km away from indoor unit.

UNIFIED ON/OFF CONTROLLER

Unified ON/OFF controller shall be supplied as optional accessory.

The controller shall be able to control minimum 15 groups, each group containing maximum 16 indoor units or 128 indoor units with the following functions :

On/Off as a zone or individual unit.

Indication of operation condition of each group. Select one of 4 operation modes.

SCHEDULE TIMER

A schedule timer shall be supplied as an optional accessory.

The timer shall be able to set operation schedule for all indoor units.
The timer shall be able to set 8 pattern of schedule combined with centralized

controller.

1.16 Closed Expansion Tank with built-in Degasser

A pressurization unit for heating and chilled water systems is consists of:

1. Two pump control unit with incorporated automatic water make-up,
2. Total deaeration for heating and chilled water systems
3. One or more expansion bladder tanks which are operated at atmospheric pressure (without pre- charge).

The water compartment of the bladder inside the expansion tank is provided with an automatic air- vent and non-return device at the top side in order to prevent air ingress from the atmosphere. Moreover the spill line of the pressurization unit shall be provided with a standard expansion vessel which is pre charged with nitrogen and which has a volume of minimum 80 liters but may be sized to a bigger volume based on the recommendations by the manufacturer.

The control unit is a two pump and two spill valve unit for maintaining pressure control. The two stainless steel multistage pumps act as duty/standby/assist with automatic run time changeover

sequence. Both pumps are provided with individual adjustable soft start/stop function.

The unit will be also provided with two electrically actuated fail-safe spill ball valves with duty/standby/assist function. Due to the self-optimizing feature of the spill valves, the operation function is not affected by dirt volume collected in the inlet strainers or other causes which might influence the flow in the spill line. The use of solenoid valves and/or mechanical valves for the unit spills function is not allowed.

A safety relief valve which is set to 5 bar is included to act as a pressure safeguard for the bladder expansion vessels which must have a design pressure of 6 bar.

This safety relief valve is exclusively provided for the above-indicated purpose and is not to be considered as a safety relief for the connected HVAC system which must be equipped with proper safety relief valves, which are adapted to the maximum, allowed system pressure.

The unit shall be mounted on a pivotable base permitting an easy assembly on site and is provided with inlet strainers/ pump check valves and lock shield ball valves. In this way individual isolation and replacement of pumps and spill valves is made possible without necessity for unit operation interruption.

The device should have an EC marking and is particularly suitable for use in surroundings where a low sound level is required.

The system pressure is monitored by a control unit with a microprocessor and which is featuring the possibility to display operation indications in 16 different languages. The control is reading the system pressure via a pressure transducer and is keeping the pressure within close tolerance limits of ± 0.2 bar to the pressure set point.

The microprocessor control is mounted in a pre-wired cabinet, which has IP 54 protection class and is provided with a main isolation switch. On the LCD screen, operation mode, failures, water volume of the expansion vessel and system pressure are indicated in plain text. LED's indicate the functioning of pumps, actuated spill valves, solenoid fill valve, low water level plus error message.

The control features a parameter and error memory. This way it is possible to display chronologically the last 20 error messages with indication of date and time. The control as standard is provided with two volt free contacts (common fault, minimum water level). Via a RS485 cable interface it is possible to transfer complete operation information to a BMS.

The degassing of a partial flow of the installation water is processed according to an optimised time schedule with selectable degassing programs. After a period of continuous degassing (adjustable and depending on the system water content) at the start up, the control switches automatically to an economic mode (interval degassing).

Connection to the water mains for make-up is possible via a prefabricated assembly with water meter and BA-type backflow preventer (RPZ valve) or by means of an extra set with water meter, break tank and fill pump which is driven by the control.

When the water make-up is activated, an error message will be triggered if the water make-up cycle goes over a time limit and/or if the number of make-up cycles is exceeded over a given period. This will result in an error message in both cases and interruption.

In case the water supply line is fitted with a contact water meter, also the total added water volume is indicated on the display and an error message is activated in the event of overshooting the maximum make-up volume (added up). This is also the case when the established input make-up quantity is exceeded against an input volume in one filling cycle, or if the make-up system

because of malfunction lets water through without being activated by the control.

1.17 Dirt Separator

Dirt Separators - Furnish and install In-Line type flanged steel Dirt Separator suitable for maximum pressure of 1000 Kpa (10 bar) and 110 deg C operating temperature and sized for the full capacity / flow.

The entering velocities not to exceed 1.2 meters per second at specified flow rate. Units specifically designed for high velocity systems may have an entering velocity of up to 3.0 meters per second. The separator must confirm to design as per Pressure Equipment Directive PED (97/23/EC) standards.

The core element is a tube mesh construction and the flow to be guided through an area with a greater cross-section than the connection dimensions in order to reduce the flow. The ensuing turbulence caused by the tube mesh causes heavy dirt particles to move to the bottom of the vessel from where they can be drained out. The Dirt separator shall be able to remove effectively dirt particles down to 5 microns.

1.18 Vacuum Degasser

The vacuum degasser shall be robust construction. It should work on pressure differential deaeration principle. It shall be installed as a bypass to the main Chilled water line and shall be used for removal of dissolved gases from water to make the water absorptive in order to prevent corrosion as well as remove air locks from the most distant ends of the CHW pipeline. The Degasser shall be of Plug & play type & shall be able to demonstrate automatic operation. The degasser shall be provided with a make-up water connection to refill the chilled water pipeline with degassed water to compensate the volume of vented gases. The Degasser shall be able to exhibit automatic operation & shall be intelligently able to switch itself off when the pipeline achieves desired pressure and degassed level of water. It should be provided with a Multi-stage Centrifugal pump. The Degasser shall be of Carbon Steel with a Brass Automatic Air vent and should degas the volume from 150 to 300 CuM holding capacity.

2.1 PIPING

Scope

The scope of this section comprises the supply, laying, erection, testing and commissioning of pipes required for this project.

2.2 Chilled and Condenser Water Piping

All piping laid shall be as follows:

Pipe Size	Material	Joints & Fittings	Sealing Material
Upto 40mm	M S tube Heavy Class IS : 1239/ 1964	(i) Screwed/Wel (ii) Unions (iii) Slip-on flanges	i) Non-hardening (ii) Lubricant (iii) 3 mm, 3 ply rubber
50mm to 200mm	M S tube Heavy Class IS : 1239/ 1964	(i) Welded fittings (ii) Slip-on flanges (iii) Screwed flanges for	----- ----- 3 mm, 3 ply rubber
200mm to 350mm	E R W Welded pipes IS : 3589/ 1966 (6mm thick)	(i) Welded (ii) Slip-on flanges	----- 3 mm, 3 ply rubber insertion.
350mm and above	E R W Welded pipes IS : 3589/ 1966	(i) Welded (ii) Slip-on flanges	----- 6 mm, 3 ply rubber insertion.
Thickness of Wall of			
250mm to 450mm		400mm dia 900mm dia	6 mm 8 mm
1000 mm to		1200mm dia	10 mm

Pipe threads shall be to IS:554/1955 and flanges to IS:1536/1960

- 2.3 All piping shall be black steel unless otherwise stated. Pipes shall be given one primary coat of red-oxide paint before being installed. Pipes shall be sloping towards drain points.
- 2.4 Fittings shall be new and from reputed manufacturers, fittings shall be of malleable casting of pressure ratings suitable for the piping system. Fittings used on welded piping shall be of the

weldable type. Flanges shall be new and from standard manufacturers. Supply of flanges shall include bolts, washers gaskets, etc., as required.

- 2.5 Tee-off connection shall be through reducing tees, wherever possible. Otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- 2.6 All equipment and valve connections shall be through flanges (welded or screwed for galvanized steel).
- 2.7 All welded piping is subject to the approval of the Consultants and sufficient number of flanges and unions shall be provided.

2.
7

GATE VALVE	16	50	150/PN 16	SOCW	GATE RESILIENT PVC BODY & BONNET VITON-A GATE PTFE PACKING VANTON FLEX-PLUG

Gate valves /wafer type butterfly valves shall be provided as required or as shown in the applicable shop drawings conforming to the following specifications:

Size	Construction	Ends	Type
12mm to 25mm	Gun Metal	Screwed Female	Gate valve
32mm and	Body-cast iron, IS 210 Gr FG260	Butterfly valve	Over

Seat - The resilient lining integrally molded Black EPDM, Replaceable type vulcanized on hard Back-up Disc – SG Iron(Nylon coated/SS) IS : 1865, SG 400/12
& BS : 2789 Gr 420/12
Shaft - SS-420 (hardened) Rating PN-16

BUTTERFLY VALVE	110	160	150/PN 16	FF	BUTTERFLY, WAFER PVC BODY & DISC 316SS SHAFT LEVER OP VITON SEAT CHEMTROL BT SERIES OR EQUIV.
CHECK VALVE	16	50	150/PN 16	SOCW	CHECK, BALL, PVC BODY & BALL VITON O-RING SEALS UNION CONN. ENDS TO BODY, CHEMTROL BC SERIES OR EQUIV. CHECK, BALL, PVC BODY & BALL VITON O-RING SEALS UNION CONN. ENDS TO BODY, CHEMTROL BC SERIES OR EQUIV.
BALL VALVE	16	50	150/PN 16	SOCW	BALL FULL PORT PVC BODY & BALL PTFE SEATS VITON SEAL UNION CONN. ENDS TO BODY, CHEMTROL TU SERIES OR EQUIV. BALL FULL PORT PVC BODY & BALL PTFE SEATS VITON SEAL UNION CONN. ENDS TO BODY, CHEMTROL DE SERIES OR EQUIV. BALL FULL PORT PVC BODY & BALL PTFE SEATS VITON SEAL UNION CONN. ONE END, DIRECT TO BODY, OPP. END, CHEMTROL SE SERIES OR EQUIV.
	75	-	150/PN 16	FF	
GASKET	16	160	125	FF	GASKET FLAT RING 1/8" THK HYPALON 40 TO 70 TYPE A SHORE DUROMETER FUL. FACE PER ANSI B16.21
BOLTS	16	160	-	-	MACHINE BOLTS CS ASTM A 307 GR B WITH HEX NUT ASTM A 194 GR 2H

Gate valves shall conform to IS : 780/1969, flanges to IS : 1536 or as required. Valves shall have non-rising spindles unless otherwise specified and shall be suitable for 21 Kg./Sq.cm test pressure. Tail pieces shall be used where required.

Butterfly valves shall conform to BS : 5155, MSS SP 67 & API 609 and designed to fit without gaskets between mating flanges. The valves shall be suitable for flow in either direction and seal in both directions. The valve shall be of integral moulded design.

2.8 Check valves shall be provided as required as shown on the drawings and conform to the following specifications :

Size	Construction	Ends
12mm to 65mm	Gun Metal	(i) Screwed Female
75mm and Over	Disc : GI Gun	(ii) Flanged

Wafer type spring loaded check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Air release and clean out plugs shall be provided and valves shall be suitable for 21 Kg./Sq.cm test pressure.

- 2.9 Strainers shall be preferably of the approved Pot type with C.I. or fabricated steel bodies designed to the test pressures specified for the gate valves. Strainers shall have removable bronze screen with 3mm perforations and a permanent magnet. Strainers shall be provided with flanges or threaded sockets as required. The strainers shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe. All strainers shall be provided with equal size isolating gate valves with rising spindles so that the strainer may be cleaned without draining the system. Strainers shall be provided on the suction side of each pump; and inlet side of heat exchanger equipment wherever shown in the drawings.

- 2.10 uPVC condensate drain pipe:

ITEM	RANGE	SCHE	FACING	DESCRIPTION
	FROM TO			
PIPE	16 160	80		PIPE uPVC PLAIN END ASTM D1785 GRADE PVC 1120
FLANGE	16 160	150/PN 16	FF	SW FLANGE STD FIN SCH=80 PVC ASTM- D2467 uPVC 1
FITTINGS	16 160	150/PN 16	SOCW	MATERIAL & DIM PER ASTM- D2467 uPVC 12452-B
CAP SCREW	16 50	80	SCRD	CAP MATERIAL & DIM PER ASTM-D2467 uPVC 12452-B

- 2.11 Underground systems shall be buried in a trench of not less than 600 mm deeper than the top of the pipe & not less than 450mm wider than the combined OD of all piping systems. A minimum thickness of 600mm of compacted backfill over the top of the pipe is desirable. Trench bottom shall have a minimum of 150mm of sand, pea gravel or specified backfill material, consolidated to suit operating weight & to act as a cushion for the piping.
- The outer protective insulation jacket shall be seamless, extruded, black, uv resistant, high- density polyethylene (HDPE). The minimum thickness of the HDPE jacket and PUF shall be as follows:

No.	MS Pipe dia.	PUF Thickness	Thickness of HDPE Cladding
1.	20 mm	29	2.5
2.	25 mm	36	2.5
3.	32 mm	31	2.5
4.	40 mm	36	2.5
5.	50 mm	37	3.0
6.	65 mm	39	3.0
7.	80 mm	43	3.0
8.	100 mm	40	3.2
9.	125mm	39	3.5
10.	150 mm	53	4.4
11.	200 mm	63	5.0
12.	250 mm	57	6.3
13.	300 mm	58	7.0
14.	350 mm	64	7.8
15.	400 mm	68	8.8
16.	450mm	77	9.8
17.	500mm	50	11.1
18.	550mm	65	11.1
19.	600mm	83	12.5
20.	650mm	58	12.5
21.	700mm	82	13.0
22.	750mm	104	15.0
23	800mm	79	15.0

2.11 Refrigerant Piping

All refrigerant piping shall be carried out with copper heavy duty pipes. All fittings for the refrigerant piping shall be of the brazing type.

Valves shall be as follows :

Size	Material	Type
Upto 16mm dia	Bras	Packless
20mm to 100mm	s	Packed and
dia Over 100mm	Bras	seated Packed

Strainers shall be of brass, complete with bronze screen and permanent magnet. Strainers shall be provided with isolating valves and valved by-pass. Strainers shall be installed up-stream of all solenoid valves etc. and as shown on the drawings. All horizontal lines shall be pitched to 12mm for every 3 metres in the direction of refrigeration flow. All necessary loops and bends shall be provided to ensure proper return of oil to the compressor. All piping shall be adequately

supported and isolated from the supports by means of suitable vibration isolators.

Refrigeration suction lines shall be insulated as specified in section 'INSULATION'.

Expansion valves shall be complete with remote bulb external equalizer port and external super-heat adjustment. Expansion valves of ten tones and above shall be pilot operated. Bull's eye and liquid line solenoid valve shall be provided in the line preceding the expansion valve.

2.12 Piping Installation

The drawings indicate schematically the size and location of pipes. Pipes runs and sizes may, however, be changed to meet the site conditions. The Contractor on award of the work, shall prepare detailed working drawings showing the cross section, longitudinal section, detail of fittings, locations of isolating drain and air valves etc. They must keep in view the specific openings in buildings and other structures through which the pipes are designed to pass.

2.12.1 Piping shall be properly supported on or suspended from stands, clamps, hangers etc., as specified and as required. The tenderer shall adequately design all the brackets, saddles, clamps, hangers etc. and be responsible for their structural integrity. Flanged end caps at all headers shall be provided for inspection and cleaning.

2.12.2 Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamp are of dissimilar material, a gasket shall be provided in between. The fitting shall resist rusting and shall be leak free.

Spacing of pipe supports shall not exceed the following :

Pipe Size (mm)	Spacing
3 to 12	1.2
19 to 25	1.8
32 to 150	2.4
150 and above	3.0

Pipe hangers shall be fixed on walls and ceiling by means of metallic dash fasteners.

2.12.3 Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 12mm thick ribbed rubber pad or any other approved resilient material. Where pipes pass through the terrace floor, suitable curbing shall be provided to prevent water leakage. Risers shall also have a

suitable concrete pipe support at the lowest point.

- 2.12.4 Pipe sleeves of 50mm on larger diameter shall be provided wherever pipes pass through well and the annular spaces filled with felt and finished with retaining rings.
- 2.12.5 Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 1.80mm metal sheet shall be provided between insulation and the clamp saddle or roller extending at least 150mm on both sides of the clamp, saddle or roller.
- 2.12.6 Piping work shall be carried out with minimum disturbance to the other works being done at the site. A program of work shall be chalked out in consultation with the engineer.
- 2.12.7 Piping layout shall take due care for expansion and contraction in pipes.
- 2.12.8 All pipes using screwed fittings shall be accurately cut to the required sizes and threaded in accordance with IS: 554/1955 and burrs removed before laying. Open ends of the piping shall be blocked to avoid entrance of foreign matter. Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
- 2.12.9 Air valves shall be provided at all high points in the piping system for venting. Valves shall be of the double float type, with GM/CI body, vulcanite balls, rubber seating, etc. Air valves shall be of the sizes specified and shall be associated with an equal size gate valve with rising spindle.

Mains	Air Valves
Upto 100mm dia	25 mm dia
100mm to 300mm dia	32mm dia
Over 300mm dia	50mm dia

Discharge from the air valves shall be piped through an equal sized GI pipe to the nearest drain of floor waste or as shown.

- 2.12.10 All buried chilled water pipes shall be cleaned and coated with zinc chromate primer, bituminous paint and insulated as specified under section "Insulation", than wrapped with two layers of RP tissue each layer laid in bitumen.
- 2.12.11 Drain shall be provided at all low points in the piping system and shall be of the

following sizes : Mains

Drains

Upto 300mm dia
Over 300mm dia

25mm dia
40mm dia

Drains shall be provided with gate valves of equal size with rising spindle. Drains shall be piped through equal size G.I . pipe to the nearest drain or floor waste or as shown on the drawings. Piping shall be pitched towards drain points.

2.13 Pressure Gauges

- 2.13.1 Pressure gauge shall be not less than 100mm dia dial, glycerin filled all parts including siphon made in copper alloy & stain less steel SS 304 grade construction and of appropriate range and be complete with shut off gauge cocks, isolating valves etc. duly calibrated before installation.
- 2.13.2 Pressure gauge shall be provided at the following locations and as indicated on the drawings :
- a) Supply and return of chillers and condensers
 - b) Suction and discharge of pumps
 - c) Inlet and outlet of hot water generators or any other location as shown in the "Approved for Construction" Shop drawings.
- Care shall be taken to protect pressure gauges during pressure testing.

2.14 Thermometers

Thermometers shall be V-form industrial type with range of scales as 32-77 degree F (0-25 degree C) for cooling applications of cooling only, and 30-212 degree F (0-100 degree C) for heating applications duly calibrated. Body shall be of aluminium alloy, anodized gold colored surface against aggressive vapor. The casing shall be adjustable type to take any reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Graduation of scale shall be 1 degree in both readings. Thermometer shall be suitable for 1/2 FPT connections. Thermometers for chilled water pipe line shall be provided with long brass stem to facilitate ease in removal without damaging the insulation. MS socket to be welded on pipes shall also be provided with the thermometer.

Thermometers shall be provided at the following locations and as indicated on the drawings :

- a) On supply and return of chillers , condensers and hot water generators.
- b) On supply and return at air handling units.
- c) On discharge of CHW and CDW pumps.

2.15 Insulation

Pipe shall be insulated as required or as shown on the drawings and in accordance with specifications given in section 'INSULATION' .

2.16 Vibration Elimination

Piping installation shall be carried out with vibration elimination fittings wherever required.

2.17 Suction Guide

Suction Guide shall be installed at the inlet of each pump and rated for 16 bar operating pressure. Suction Guide shall have SG iron/MS body, outlet guide vanes, removable SS Strainers and fine mesh SS start-up strainer. The connecting flanges shall be raised face type.

Each Suction Guide shall be provided with ½" dia ball type blow down valve.

The vendor shall inspect the strainer prior to start-up of the pump and shall clean the fine mesh brass strainer after short running period. Space shall be provided for removal of strainer.

2.18 Test Points

Test Points shall also be provided at different locations in the water pipe line to facilitate pressure measurement.

Test Point shall be of brass construction, ¼" BSP with NEOPRENE sealing bushes and shall be provided with screwed cover.

2.19 Testing

- 2.19.1 All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure but not less than 7 Kg/Sqcm 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 Engineer.
- 2.19.2 Additional piping required subsequent to the above pressure test should be tested again either for entire length or part there of in the same manner.
- 2.19.3 Systems may be tested in sections and such sections shall be securely capped.
- 2.19.4 The Consultants shall be notified well in advance by the contractor of his intention to test a section of piping and all testing shall be witnessed by the Consultants or his authorized representative.
- 2.19.5 The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due to air bound connections, the Contractor shall rectified the defective connections. He shall bear all the expenses for carrying out the above rectification including the tarring- up and re-finishing of floors, walls etc. as required.
- 2.19.6 No insulation shall be applied to piping until the completion of the pressure testing to the satisfaction of the Engineer.

- 2.19.7 The Contractor shall provide all materials, tools, equipment, instruments, services and labor required to perform the test, and shall ensure that the plant room and other areas are cleaned up and spilled over water is removed.

2.20. Painting

After the piping has been installed, tested and run for atleast ten days of eight hours each, the piping shall be given two finish coats, 3 mils each as follows :

Services	Flow	Colour
Condenser water	Supply and Return	As approved by the Consulting Engineer
Chilled water	Supply and Return	-do-

The direction of flow of fluid in the pipes shall be visibly marked in white arrows or as directed by the Consultants.

3.1 AIR DISTRIBUTION

3.2 SCOPE

The scope of this section comprises of supply, fabrication, installation and testing of all sheet metal ducts and supply, installation, testing and balancing of grilles, registers and diffusers, in accordance with these specifications and the general arrangements shown on various drawings.

MATERIAL

- i) All ducts shall be fabricated either from Galvanized Sheet Steel (GSS) conforming to IS: 277 or aluminium sheets conforming to IS:737. The steel sheets shall be hot dip galvanized with MAT finish with coating of minimum 120 grams per square meter (GSM) of Zinc, GI sheets shall be lead free, eco friendly and RoHS compliant.
- ii) The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

Longest side (mm)	Minimum sheet thickness	
	For GSS	For Aluminium

750 mm and below	0.63	0.80
751 mm to 1500 mm	0.80	1.00
1501 mm to 2250 mm	1.00	1.50
2251 mm & above	1.25	1.80

(iii) Thickness of sheet for Round Ducts

Diameter of duct, mm	Thickness of Sheet, mm	
	GI sheets	Aluminium Sheets
150 to 500	0.63	0.80
501 to 750	0.80	0.80
751 to 1000	0.80	1.00
1001 to 1250	1.00	1.50
1251 and above	1.25	1.80

- iv) All sheet metal connections, partitions and plenums required for flow of air through the filters, fans etc. shall be at least 1.25 mm thick galvanised steel sheets, incase of G.I. sheet ducting or 1.8 mm thick aluminium sheet, in case of aluminium sheet ducting and shall be stiffened with 25 mm x 25 mm x 3 mm angle iron braces.

- v) Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended upto date.
- vi) Aluminium ducting shall normally be used for clean room applications, hospitals works and wherever high cleanliness standards are functional requirements.

Associated Items

Supply/ return air outlets, F.A. grilles and accessories shall be constructed from extruded aluminium sections.

Flanges for matching duct sections, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.

Application	Duct Width	Angle size
Flanges	Upto 1000 mm	35 mm x 35 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	50 mm x 50 mm x 3 mm
Bracings	Upto 1000 mm	25 mm x 25 mm x 3 mm
-do-	More than 1000 mm	40 mm x 40 mm x 3 mm
Support angles	Upto 1000 mm	40 mm x 40 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	Size and type of RS section shall be decided in

Hanger rods shall be of mild steel and of at least 10 mm dia for ducts upto 2250 mm size, and 12 mm dia for larger sizes.

All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium - aluminium alloy. Self tapping screws shall not be used.

3.3 CONSTRUCTION

3.2.1 Ducts

3.2.1.1 Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 "Specifications for metal air ducts", unless otherwise deviated in these General Specifications.

3.2.1.2 The interior surfaces of the ducting shall be smooth.

3.2.1.3 All the ducts upto 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 mm longest side, and 300 mm centres for ducts above 600 mm size shall be provided for stiffening.

- 3.2.1.4 As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.
- 3.2.1.5 Flanged joints shall be used at intervals not exceeding 2500 mm. Flanges shall be welded at corners first and then riveted to the duct.
- 3.2.1.6 Stiffening angles shall be fixed to the sides of the ducts by riveting at 1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6 m from joints for ducts of size larger than 1500 mm. Bracings for ducts larger than 1500 mm can alternatively be by diagonal angles.
- 3.2.1.7 Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.
- 3.2.1.8 All factory fabricated duct shall be supplied in L sections, the length of any piece shall not be more than 1800 mm for duct with longest side of cross section as 600 mm and above and 3000 mm for rest.
- 3.2.2 Air Outlet and Inlets (Supply and Return)
- 3.2.2.1 All air outlets and intakes shall be made of extruded aluminium sections & shall present a neat appearance and shall be rigid with mechanical joints.
- 3.2.2.2 Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminium sheet. Louvers may be spaced 18 mm apart.
- 3.2.2.3 Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.
- 3.2.2.4 Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

- 3.2.2.5 Towards fire protection, all kitchen extract ductwork shall be fabricated out of 18 gauge GSS and coated with approved fire retardant surface treatment (on internal and external duct surface) preferably sprayed at factory prior to dispatch in order to capture the flanges, corners and internal joints. These ducts should be finished off with 50mm thick mineral wool on the external surface the duct, enveloped in 0.1mm thick Aluminum foil, and joints sealed off with Aluminum tape.

3.3 READYMADE SPIGOTS

Spigots shall be readymade, circular in shape, fabricated out of 22 gauge galvanized steel sheet through spinning process. The spigot shall be provided with a circular opening with a cylindrical neck with grooves to facilitate fail safe flexible duct connection.

Spigot shall have circular flange all around which shall be screwed to the main rigid ductwork.

Readymade gaskets shall be provided between circular flange and surface of rigid ductwork with pre-conceived round opening, and sealant applied to prevent leakage of air.

3.4 Duct Installation

All ducts shall be installed generally as per the drawings and in strict accordance with approved for construction shop drawings prepared by the contractor.

- a. The contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. This work shall meet with the approval of the Engineer In-charge in all its parts and details.
- b. All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the buildings, whether or not the same are shown on the drawings. Where it becomes necessary to avoid beams or other structural work, plumbing or other pipes, and or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained as approved or directed by the Engineer In-Charge.

- c. If a duct can not be run as shown on the drawing, the contractor shall install the duct between the required points by any path available, subject to the approval of the Engineer In-Charge.
- d. All duct work shall be independently supported from building elements or as required by the Engineer In-Charge. All horizontal ducts shall be rigidly and securely supported, in an approved manner, within hangers formed of GI threaded rod arrangement of appropriate size as per duct size, with hot dipped galvanized (HDG) perforated channel under the ducts. The distance between two successive supports shall not be greater than 2 meter center to center. All vertical duct work shall be supported by structural members at each floor.
- e. Ducting on top of the ceiling shall be supported from the slab above, or from beams with the help of adequate strength dash fasteners, after obtaining approval of the Architect/ Consultant. In no case shall a duct be supported from the ceiling hangers or be permitted to rest on a hung ceiling.
- f. All metal work in dead or closed down spaces shall be erected in time to occasion no delay to other contractors in the building.
- g. All ducts shall be totally free from vibration under all conditions of operations. Whenever duct work is connected to fans, that may cause vibrations in the duct, ducts shall be provided with two flexible connections located close to the unit in mutually perpendicular directions. Flexible connection shall be constructed of fire resistant flexible double canvas sleeves at least 100mm deep, secured properly and bolted at both ends. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.
- h. The two mating flanges of the ducts being joined with each other shall be made air tight by providing 2mm thick foam rubber insertion fixed on both mating flanges by means of good quality adhesive . Rubber strip shall also be provided between bottom surface of duct and angle iron at each duct support to avoid metal to metal contact.
- i. All openings in ductwork for collars, spigots etc. shall be provided using nibbling machine/s only.

3.5 VOLUME CONTROL DAMPERS

- a. All dampers shall be multiblade type of robust construction of galvanized steel and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.
- b. Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.
- c. Dampers shall be placed in ducts and at each supply air collar, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

3.6 FIRE CUM SMOKE DAMPERS

3.6.1 BARE DAMPERS

- a. All supply and return air ducts/return air spaces at AHU room crossings and at all floor crossings shall be provided with approved make motorized fire and smoke dampers of at least 90 minutes fire rating as certified by CBRI Roorkee, India as per clause 10 of UL:555-1995. These dampers shall be multi-leaf type –Ruskin.
- b. Fire damper blades and outer frame shall be formed out of 1.6mm (16G) galvanized steel sheet of length as mentioned in the approved for construction shop drawings titled as AHU Room Blow Up. The damper blade shall be pivoted on both ends using chrome plated spindles in self-lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16 gauge galvanized sheet steel. For preventing smoke leakage, metallic compression side seals shall be provided. Dual side linkage shall be provided for better structural stability. The construction of the fire damper shall allow maximum free area to reduce pressure drop and noise in the air passage. In normal position damper blade shall be held in open position with the help of a 220 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.
- c. For wall mounted fire dampers retaining MS angles duly painted with black enamel paint shall be supplied and installed by HVAC Contractor as per established installation procedure. Whereas the fire damper is also to be used for Smoke management (Smoke and fire damper) the same shall

be as per UL-555 S-Class-II.

- d. Every motorized fire damper/ Smoke and fire damper shall be tested for in the factory and will be certified by the manufacturer in form of the test certificate.
- e. Fire damper shall also be supplied with spring locked fusible link rated for 720 C (UL stamped) to close fire damper in event of rise in duct temperature.
- f. For fire dampers/ smoke fire dampers of size higher than one approved by certifying agency the damper shall be supplied in multiple units of size not exceeding the tested damper by CBRI. All the multiple units shall be housed in a common factory fitted sleeve.
- g. The fire dampers shall be mounted in fire rated wall with a duct sleeve 400mm/500mm long depending upon the wall thickness. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of galvanized sheet shall be 18 gauge.
- h. The damper shall be installed in accordance with the installation method recommended by the manufacturer.

3.6.2 **ACTUATORS**

The actuator shall be maintenance free direct coupled spring return type suitable to work on 24 V electric supply. The torque rating of the actuator shall exceed at least by 15% over torque required to open/ close the damper. The selection of actuator size shall be the responsibility of the manufacturer of the fire damper. Spring return time shall be 20 seconds or less at ambient temperature. Other features of the damper actuator shall be as under:

- a. Actuator shall have tamper proof housing with IP-54 protection rating.
- b. Actuator shall have mechanical integrity of at least one hour at 9000 C.
- c. Actuator shall have minimum 60000 safe position at rated torque. It shall be capable to withstand temperature of 750 C for 24 Hrs.
- d. Actuator shall have electronic over load or digital sensing circuit to prevent damage to actuator.
- e. Should be capable of changing direction of rotation by changing mounting orientation.

- f. Actuator shall have manual over ride facility.

Damper actuator shall be such that it should close the damper in the event of power failure automatically & open in the same manner in case of power being restored.

3.6.2 CONTROL PANEL

The Control panel shall be supplied by damper manufacturer fitted on damper compatible with damper actuators. The control panel shall have at least following features:

- a. Power on lamps with 230 V/ 24 V Transformer.
- b. Damper close and open indication.
- c. Reset push button.
- d. Push button for manual running of actuator for periodic inspection.
- e. Auxiliary contacts 24V & 230V.
- f. Contact points to receive signal from smoke detector/fire alarm panel.
- g. Additional terminal shall be provided to have signal (audio or visual) in central control room.

The control panel shall receive 230 V A/C supply & interconnecting wiring between control panel and actuator shall be carried out using fire proof cables.

The Contractor shall ensure that all electrical connections are suitably terminated. The HVAC Contractor shall also check continuity of electrical circuit as recommended by the manufacturer. Fire damper inspection door will be provided in AC duct to facilitate access to the system.

3.7 SUPPLY AIR REGISTERS

- 3.7.1 Supply air registers shall be of approved make and of mild steel construction with individually adjustable bars. Supply air registers shall be double deflection type, with removable key-operated volume control dampers. The outer frame should be made out of 20 gauge and louvers of 24 gauge MS sheet.

- a. All registers shall be selected in consultation with the Consultants.

Different spaces shall require horizontal or vertical face bars and different width of margin frames.

- b. All registers shall have a soft, continuous rubber gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers shall not be less than 80 percent.
- c. Registers shall be adjustable pattern as such grille bar shall be pivot able to provide pattern with 0 to 100 degree horizontal arc and up to 30 degree deflection up or down. Bars shall hold deflection settings under all conditions of velocity and pressure.
- d. Bars longer than 450 mm shall be reinforced by a set back vertical member.
- e. Registers shall be given a rust inhibiting prime coat and factory applied enamel finish of approved color.

3.7.1.1 SUPPLY AIR DIFFUSERS

Diffusers shall be of approved make and of mild steel construction, square in shape with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Consultant.

All supply air diffusers shall be equipped with removable key-operated volume control dampers. Anti-smudge ring may be required in specific applications. The outer shell and diffusing assembly shall be made out of 18 gauge and 24 gauge MS sheet respectively.

3.7.1.2 EXTRUDED ALUMINIUM GRILLES& DIFFUSERS

3.7.1.3 RECTANGULAR/ SQUARE CEILING DIFFUSERS

Rectangular/square ceiling diffusers shall be fabricated out of extruded aluminium sections powder coated in colour approved by Engineer In-charge. The four directional air flow diffuser shall consist of outer ring fixed to duct collar with concealed screws. Foam gasket shall be provided between outer ring and suspended ceiling.

The central core shall be clip fixed to the outer ring. Opposed blade volume control damper in extruded aluminium construction shall be fixed to the neck of diffuser. The damper shall be adjusted after removing the central core. The diffuser shall be equipped with anti-smudge ring.

In case of grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a flexible round duct.

3.7.1.4 PLAQUE DIFFUSER

The Plaque diffusers shall be constructed out of Extruded Aluminium powder coated sections is designed to integrate with suspended ceiling arrangement preferably grid type.

The diffuser shall consist of a rear pan and a removable heavy gauge front flat panel attached to the rear pan through spring loaded locking posts. The flat panel may be removed whenever need arises to facilitate adjustment of the damper for air balancing.

The front panel shall be aerodynamic in appearance, rigid and preferably in single piece construction and free from any welding or forming blemishes.

The horizontal air discharge pattern shall be 3600type. Blank off baffles shall be provided to obtain one, two or three way blow pattern if specifically asked for in the "Schedule of Quantities". Diffusers shall be provided with following accessories:

- I. Opposed blade damper
- II. Spigot to facilitate round duct connection at neck.

The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.

3.7.1.5 SWIRL DIFFUSER

The diffuser face shall consist of fixed radically arranged air control blades. The supply air pattern shall permit specifically arranged internal air guidance elements or guide vanes. Such elements are not required for return/extract versions.

Due to the rotary swirling motion of the air discharge, induction of room air occurs very quickly, resulting in decay of supply air velocity and temperature differential.

In order to stabilize horizontal discharge, all sizes must be mounted flushed with the suspended ceiling. The minimum height between floor & the diffuser face should be 2.6 M or less. The face plate shall be square. The supply air versions shall be supplied with top/side entry spigot with lip seals and Volume Control Damper.

The diffuser face shall be fabricated out of 1.2 mm thick galvanized steel sheet, pretreated and powder coated white. The spigot shall also be of 1.2 mm thick galvanized steel sheet & lip seal of soft rubber.

The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.

3.7.1.6 MULTISLOT LINEAR DIFFUSER

Linear ceiling diffuser shall be multislot type. The diffuser shall be fabricated out of extruded aluminium sections. Each slot shall be 19mm wide. Each slot shall be equipped with air flow direction control louver mechanically fixed. Integral sliding type hit & miss type volume control damper in extruded aluminium construction shall be provided for each slot for fine control of air flow in supply air portion only. The damper shall be fabricated out of anodized extruded aluminium sections.

Other sections of ceiling diffuser shall be powder coated in color & shade approved by the Engineer In-charge.

The linear diffuser shall be fixed in to a plenum chamber with concealed screws. Side end pieces or corner pieces shall be provided if required.

3.7.1.7 MULTI LOUVERED GRILLES

For supply air double louvered grilles in extruded aluminium construction shall be provided with individually adjusted louvers along with volume control damper in extruded aluminium construction. The louvers shall be pivoted in Nylon bushes for smooth operation for return air grilles similar to supply air as described above will be provided but without volume control dampers. These grilles shall be painted as per approved powder coated shade.

3.7.1.8 LINEAR GRILLES

Linear Grilles shall be fabricated out of extruded aluminium sections. Flanges shall be of 1.3mm thick extruded aluminium. Louvers shall be of extruded aluminium sections 3.7mm thick at the front and

2.2 mm at the rear with 15 degree deflection strong enough to withstand site abuse during installation. The sample of grille shall have to be got approved by the consultants before delivery. The linear grilles shall be provided with removable/fixed internal core.

All sections of linear grille shall be powder coated in color/shade approved by the Engineer In-Charge.

The linear grilles shall be fixed into a plenum chamber having GI spacers with concealed screws. End pieces or corner pieces shall be provided as required.

3.7.1.9 FRESH AIR ARRANGEMENTS

Extruded aluminium construction duly anodized (20 microns and above) fresh air louvers with bird screen and extruded construction dampers shall be provided in the clear openings in the masonry walls of the air handling rooms having at least one external wall. Louvers, damper, pre-filters, ducts and fresh air fan, if required with speed regulator shall be provided as shown on drawings and in schedule of quantities. Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intake shall be as per the schedule of quantities.

3.7.1.10 AIR TRANSFER DOOR GRILLE

Air transfer grilles in extruded aluminium construction shall be provided at the door of pantry and toilets wherever required. The air transfer grille shall be complete with matching rear flange. The grilles shall be anodized or powder coated in color and shade as approved by the Engineer In-Charge.

3.7.1.11 Pre-insulated Flexible Ducts

3.7.1.12 General:

The scope of this section comprises supply, installation, testing and commissioning of flexible ducting conforming to these specification and in accordance with requirements of drawings and schedule of quantities.

3.7.1.13 Type:

3.7.1.14 Un-Insulated Flexible ducts

Wherever required, uninsulated flexible ducts shall be made of double lamination, 0.05 mm thick aluminum foil followed by a layer of fire retardant metalized polyester film permanently bonded to a coated spring steel wire helix. Ducts shall be of "tear and puncture resistant" in construction.

3.7.1.15 Insulated Flexible Ducts

Wherever insulated flexible ducts are incorporated in design, inner core of such an assembly should be made of fibre glass reinforced double layer of metalized polyester film laminate permanently bonded to a coated spring steel wire helix. Blanket of fibre glass insulation exhibiting resistance of R-3.6 (RSI – 0.64 m²K/W) having density not less than 16 Kg/CuM and thickness of 25 mm shall be wrapped over the inner core & covered with "tear and puncture" resistant outer jacket cum vapour barrier made out of preferably 0.05 mm thick aluminum foil.

The pre-insulated flexible duct shall comply with UL 181, BS 476 part VI & Part VII besides Class

'1' followed by Class 'O'.

3.7.1.16 Installation:

Care must be taken to install all the flexible ducts in fully extruded position and bends made with adequate radius as per manufacturer's recommended practices.

3.8 Hangers and Supports

The flexible duct must be installed fully extended to produce optimum results.

The maximum allowable sag, between any two adjacent suspension points, should not exceed 50 mm per meter.

The distance between any two adjacent suspension points may vary from 150 cm to 300 cm, depending upon the type of flexible duct in use.

Flexible ducts mounted above suspended ceiling should always be independently supported. Ducts mounted in these locations are susceptible to damage whenever ceiling panels need to be periodically interchanged, unless separately supported.

3.9 Bending Radius

All bends should be made as large as possible and should have a radius of not less than the diameter of the duct in use. This reduces unfavorable pressure losses and is particularly important for metal based products which are more susceptible to stress rupturing. Double bends should be avoided, however if un-avoidable, ensure that each radius is not less than $R = 2 \times D$.

3.10 Flexible Duct to Conventional Duct Connection

Extra care should be taken when making connection to fixed conventional ducts, etc., and ensure that they do not become too stressed. An additional support is recommended to obviate this potential problem. Readymade circular galvanized sheet steel spigots of approved makes shall be used to make such connections.

Metal based flexible ducts are particularly prone to fracturing due to stress caused as a result of sharp connection.

Connections to ceiling illumination "Low Pressure Plenums" should be served in the most direct manner similar to that described for conventional ducts.

Too many bends, when connecting to "Low Pressure Plenums" and / or any other type of air

supplying component, may result in excessive pressure loss and the generation of noise.

Longer Length Installation

In the event where extreme length of flexible ducts is to be installed, round duct connectors made of galvanized sheets of at least 30 cm long should be used to connect the duct at every distance of 10 meters. Use metal or galvanized hangers as recommended to support the point

where connections are made. Light railing is a good alternative hanging support when using long length of flexible ducts.

3.11 Direct Contact with other services

It should be emphasized that the flexible ducts must not be in direct physical contact with un- insulated heating or hot process pipes. If in the event where such situation can not be avoided, additional 1" thick insulation should be wrapped around pipes that are in contact with the pre – insulated flexible ducts.

3.12 Back Draft Dampers/ Pressure Relief Dampers:

The back draft dampers can be flange or duct mounted in either vertical or horizontal applications. Frame shall be constructed of 18 G G.I. with welded mitered corners and concealed reinforcing brackets. The damper is opened by air pressure differential and closed by gravity. Blades shall be at least 26 G fitted with rubber gasket to avoid rattling noise. All blades shall be fitted to a common linkage in such a manner so that all blades shall lift up and down in similar fashion.

Pressure relief damper shall cater preset pressure value.

3.13 TESTING AND BALANCING

After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks.

Before painting the interiors, air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.

The entire air distribution system shall be balanced using approved anemometer. Air quantities at the fan discharge and at various outlets shall be identical to, or less than 5 percent in excess of, those specified and quoted. Leakage in each air distribution system shall be within 3 percent so that supply air volume at each fan shall be identical to , or no greater than 3 percent in excess of, the total air quantity measured at all supply outlets served by the fan. Branch duct adjustments shall be made by volume or

splitter dampers. Dampers shall be permanently marked after air balancing is complete so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted to the Consultants for scrutiny and approval, and six copies of the approved report shall be provided with completion documents.

4.1 **INSULATION**

SCOPE

This chapter covers the requirements of thermal insulation for chilled water / hot water piping, pumps and tanks, duct work ,and acoustic lining in duct work and weather maker rooms. This does not cover exposed roof insulation and under deck insulation work.

MATERIAL-TYPES

The insulation material to be used for various applications shall be any of the following, as required:

- i) For insulation of water piping, pumps and tanks: -
 - a) Expanded polystyrene (T.F.Quality)
 - b) Resin bonded glass wool
 - c) Polyvinyl Nitrile (Closed cell rubber foam)
 - d) XLPE (Closed cell cross linked polyolefin foam)

Expanded polystyrene (T.F.Quality) shall be used for pipe insulation like inside the

A.C. plant room, exposed to outside or burried in ground. In the case of expanded polystyrene (TF quality), Resin bonded glass wool the pipe insulation should be in rigid sections in two halves and preformed to fit snugly on to pipes (upto pipe sizes for which the preformed sections are manufactured by the manufacturer of insulation). For higher pipe sizes insulation slabs shall be used.

Resin bonded glass wool is to be used for piping inside the building due to its fire retardant properties, for considerations of fire safety.

Polyvinyl Nitrile (Closed cell rubber foam) available in tube shapes for sliding on to the small dia. pipes can be used if successfully tested for fire retardant properties.

However, all shall need to be covered with vapour barrier and cladding with aluminium sheet.

- ii) For Insulation of duct work: -
 - (a) Resin bonded glass wool.
 - (b) Polyvinyl Nitrile (Closed cell rubber foam)
- iii) For acoustic lining of duct work and AHU rooms: -
 - (a) Resin bonded glass wool.
 - (b) Resin bonded mineral wool.
- iv) For suction line, Chilled water pipe and Chiller insulation: -
 - (a) Expanded Polysterene (T.F.Quality)
 - (b) Polyvinyl Nitrile (Closed cell rubber foam)
- (v) For double skin AHUs:
 - (a) Polyurethane foam (PUF insulation)

MATERIAL SPECIFICATIONS

The insulation material shall satisfy the following requirements: -

- v) For thermal application on pipes.

Material	Minimum Density (Kg/cu.	Maximum Thermal conductivity (K.cal/ hr. degree C/m at 10 Deg C mean temp.)
Resin bonded glass	32	0.031
Expanded polystyrene (TF)	20	0.035
Polyvinyl Nitrile foam	55	0.034

- vi) For thermal insulation of ducts:

Material Minimum Density(Kg /cu.m)	Resin bonded glass wool	24
	Polyvinyl Nitrile foam	40

Fibre Glass Insulation used for duct insulation shall be factory faced with aluminium foil on one side reinforced with kraft paper & fused to the insulation material.

Polyvinyl Nitrile foam Insulation used for duct insulation shall be factory faced with aluminium foil on one side.

vii) For acoustic lining:

Application	Thickness	Material	Minimum Density (Kg./Cu. M)
Duct	25 mm	Resin bonded glass wool	32
AHU room	50 mm	Resin bonded glass wool/ Mineral wool	32/ 48

viii) The specification for resin bonded glass wool insulation & resin bonded mineral wool insulation shall conform to IS 8183 as amended upto date. The specification for expanded polysterene shall conform to IS-4671 as amended upto date.

ix) Expansion tank Insulation

Expanded polystyrene insulation of density not less than 20kg per cu.m. shall be used.

INSULATION THICKNESS

The thickness of insulation shall be as indicated below unless specified otherwise in the tender specifications.

For pipe insulation (for chilled water as well as hot water application

Pipe Size (mm) Glass fibre /Exp. Polystyrene (mm)

150 & below	50
Above 150	75

For Duct insulation

Application	Fibre glass (mm)
Thermal for AC area	12.5
Thermal for Non AC area	25
Acoustic	25

For room acoustic

lining Resin bonded 50 mm
Resin bonded mineral wool 50 mm

For pumps :
Expanded polystyrene TF quality 50 mm

Chiller Insulation

Thickness of polyvinyl rubber insulation used for chiller insulation shall not be less than 19mm.

Expansion tank

Thickness of expanded polystyrene (TF quality) insulation used shall not be less than 50mm.

APPLICATION OF INSULATION ON PIPES (including suction line insulation)

- (i) The surface to be insulated shall be first cleaned and a coat of zinc chromate primer shall be given. The insulation shall be fixed tightly to the surface with cold setting adhesive CPRX compound. All joints shall be staggered and sealed. The second layer of insulation wherever required shall be similarly applied over the first layer.
- (ii) Pipes shall be preferably pre insulated at factory, meeting the requirement or the insulation shall be finished at site as under:
 - (a) For pipes laid inside the building, the insulation over the pipe work shall be finished with

0.63 mm thick aluminium sheet cladding over a vapour barrier of 120 gm/ sq.m. polythene sheet with 50 mm overlap and tied down with lacing wire and complete with type 3, grade-I roofing felt strip (as per IS 1322 as amended upto date) at the joints..

- (b) For pipes outside the building laid above ground the finishing over the pipe insulation shall be finished with 0.63 mm G S sheet cladding over a vapour barrier of 120 gm/sq.m polythene sheet with 50mm overlap and tied down with lacing wire and complete with type 3 grade I roofing felt strip applied by means of cold setting CPRX compound..
- (c) For pipes outside the building laid under ground the insulation shall be covered with 500 gauge polythene faced hessian, (the polythene facing outwards), with 50 mm overlap. All joints shall be sealed with bitumen. A layer of 0.50 mm x 20 mm G.I. wire mesh netting shall be provided over it butting all joints and it shall be laced down with GI wire, sand cement plaster (1:4) 20 mm. thick shall be provided in 2 layers of each 10mm and shall be water proofed by applying hot bitumen & fixing tar felt over the plaster. It shall be finally finished with a coat of hot bitumen.) In case of factory pre insulated pipes, buried underground, a water leakage sensing wire shall also be provided, to detect the location of water leakage at later date.
- (d) In case of factory pre insulated pipes, all joints shall be properly insulated at site as per recommendation of manufacturer
- (iii) All valves, fittings, strainers etc. shall be insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

APPLICATION OF INSULATION ON PUMPS

Expanded polystyrene (TF quality) 50mm thickness shall be sandwiched between two aluminium sheets of 0.5mm thickness and properly clamped to pump in two semicircular sections.

APPLICATION OF INSULATION ON EXPANSION TANK

Insulation of expansion tank shall be expanded polystyrene (T.F.Quality) of thickness not less than 50mm. It shall be applied as under

- i. Surface shall be thoroughly cleaned with wire brush and rendered free from all dust & grease.
- ii. The two layers of hot bitumen shall be applied.
- iii. The insulation slabs will then be fixed in one layer and joints shall be sealed with hot bitumen.
- iv. The insulation slab then shall be covered with 0.63 mm x 19mm G.I. wire mesh netting which shall be fixed to insulation with brass / G.I. nails.
- v. The insulation shall then finally be finished with aluminium cladding of thickness not less than 0.5mm.

APPLICATION OF INSULATION (THERMAL) ON DUCT

The surface of duct on which the external thermal insulation is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

Two coats of cold compound adhesive (CPRX compound) shall be applied over the duct. (Any other adhesive recommended by the manufacturers may also be used with the approval of the Engineer-in-charge).

APPLICATION OF DUCT LINING (ACOUSTIC INSULATION)

Where specified in the tender specifications, ducts shall be lined internally with acoustic insulation as detailed below:

The Inside surface of duct on which the acoustic lining is to be provided shall be thoroughly cleaned with wire brush and rendered free from all dust and grease.

Then 25 x 25 sq.mm section of minimum 1.25 mm thick G.I. sheet shall be fixed on both ends of the duct piece.

The insulation slabs shall then be fixed between these section of ducts using CPRX adhesive compound and stickpins.

The insulation shall then be covered with Reinforced plastic/ fibre glass tissue with proper overlap, sealing all joints so that no fibre is visible.

The insulation shall finally be covered with minimum 0.5 mm thick perforated aluminium sheet having perforations between 20-40%.

APPLICATION OF ACOUSTIC LINING IN AHU ROOMS

The wall/ roof surface should be thoroughly cleaned with wire brush.

A 610x610 mm frame work of 25mm x50mm x50mm x50mm x25mm shape channel made of 0.6mm thick G.S.S. shall be fixed to walls leaving 610mm from floor by means of raw plugs in walls and dash fasteners in ceiling. Similar frame work shall also be fixed on ceiling by means of dash fasteners.

Resin bonded glass wool/ mineral wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper.

Aluminium perforated sheet having perforation between 20-40% of thickness not less than 0.8mm shall be fixed over the entire surface neatly without causing sag/ depression in between and held with screws. Sheet joints should overlap minimum 10mm.

Aluminium beading of 25mm wide and thickness not less than 1.00 mm shall be fixed on all horizontal/ vertical joints by means of screws.

MEASUREMENT OF INSULATION

- a) Pipe insulation shall be measured in units of length along the centre line of the insulated pipe. The linear measurements shall be taken before the application of the insulation. For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the centre line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

- b) Duct insulation and acoustic lining shall be measured on the basis of surface area along the outer surface (ref IS14164 of 2008) of insulation thickness. Thus the surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of ducting including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.

5.1 ELECTRICAL INSTALLATION

5.2 Scope

The scope of this section comprises of fabrication supply, erection, testing and commissioning of electrical control panels, wiring and earthing for all components of the HVAC system.

5.3 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 Local Fire Insurance Association and Indian Standard code of practice No. IS : 732- 1963 (revised) including Indian Electricity Rules 1956.

5.4 Wiring System

All power wiring shall be carried out with 650/1100 volts grade PVC insulated, aluminum/copper conductor cables as per "Schedule of Quantities", sized for starting current and continuous running current carrying capacity and by applying proper derating factor.

5.5 Motor Control Centre

a. Construction Features :

Motor Control Centre (MCC) shall comprise of all the switch gears as detailed in bill of quantities and design drawings. All the switch gears including the bus bar chamber on the same board shall be of the same manufacturer for facility of interchangeability. The motor control shall be metal enclosed sheet steel cubicles, indoor type, dead front, floor mounting type fabricated out of 14 gauge CRCA sheet steel. Removable gland plates shall be 3mm thick sheet. The size of the gland plate shall be sufficient enough to accommodate all cable sizes. The control panel shall be totally enclosed, completely dust and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. The panel shall be in IP-54 enclosure. All doors and covers shall be fully gasketed with foam rubber and/or rubber strips and shall be lockable. All mild steel sheets used in the construction of control panels 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 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. A base channel of 75mmx40mmx5mm thick shall be provided at the bottom.

Knockout holes of appropriate size and member shall be provided in the MCC in conformity with the location of incoming and outgoing cables.

Facility shall be provided for the entry of all types of cables from bottom or top of control panel as per site requirements. Panel shall have independent vertical & horizontal Bus Bar alleys & cable alleys accessible from front as well as back of the panel.

Bus bar chamber shall be made out of sheet steel of thickness not less than 2mm with detachable covers on all sides. The joints shall be continuous welded. The detachable covers shall be secured to the box with sufficient number of cadmium plated iron screws to ensure dust tightness. Bus bar chamber of size upto 900 mm shall have detachable end cover so that the same can be extended.

b. Bus Bars :

Bus bar shall be made out of wrought aluminium alloy or electrolytic copper Grade E91 as the case may be of sufficient cross section so that a current density 100 Amps/Sqcm in case of aluminium and 150Amps/Sqcm in case

of copper is not exceeded at nominal rating. The cross section of neutral bus-bar will be the same as that of the phase bus-bar of capacity upto 200Amps. The neutral bus bar should not be less than half the cross section of that of phase bus bar beyond 200Amps. The bus-bars should be suitably insulated with heat-shrinkable PVC sleeving and colour coded. Connections to bus-bars shall be made by the bolting arrangement by the aluminium alloy or the forged brass nuts and bolts, ensuring that the current density of the bus-bars at the point of connection does not exceed permissible limit and there is no heat due to bimetallic contact.

Minimum clearances between bus-bar throughout the panel shall be 32mm between phases and 25mm between phase to earth. Danger plate of approved shape and size be provided on each switch board without any extra charge. The bus-bar shall be supported on DMC/SMC and shall be rated for a fault level of 50KA for 1 sec & temperature rise on full load not to exceed 45 C above ambient i.e, total of 85 C.

5.6 Selection of components in MCC

Contractor shall use only one make of component for ease in maintenance and interchangeability. The rating of other components i.e, contactor, fuse, circuit breaker, overload relay, single phasing preventer etc. shall be as recommended in these specifications.

5.7 Selection of Cables/Wires

The size of cables and wires for individual connection to outgoing MCCB/SFU/Isolator shall be suitably rated. Above 100 Amps. Solid links shall be used.

All power wiring shall be carried out with 650/1100 volt grade PVC insulated aluminium/copper conductor cables/wires sized for starting current and continuous rating of motors after applying derating factor as per the "Schedule of Quantities".

5.8 Cable Compartments

Cable compartment of minimum size of 400 x 400 mm or as shown in drawings shall be provided in the boards for termination of all incoming and outgoing cables entering from bottom or top. Adequate supports shall be provided in cable compartment to support cables. All incoming & outgoing switch terminal shall be brought out to the spring loaded terminal blocks in cable compartments and identified accordingly.

All the outgoing connections shall be brought on spring loaded (Elmex Type CSLT-1) terminals in the cable-alley. Minimum size of terminals for control

and power wiring shall be 2.5 & 10 Sqmm respectively. No cable, however shall be terminated in to the switch/isolator/ MCCB/contactor/over load relay, under any circumstances.

5.9 Meters and Indications

All meters shall be housed in a separate compartment or as shown in design drawings and accessible from front only. Lockable doors shall be provided for the metering compartment. All switches, contactors, push buttons, push button stations, indicating lamps shall be distinctly marked with a small description of the service fed.

5.10 Painting

Entire sheet metal works shall undergo seven tank process including passivating, sprayed with a high corrosive resistant primer and baked in oven. The finishing treatment shall be of two coats of synthetic enamel paint of approved colour & shade.

Degreasing : Concentration of chemical : 5% - 7% &

40 deg C Derusting : Concentration of chemical : 25%

Phosphatising : Concentration of chemical : 3.5% & 40-50

deg C Passivation : Concentration of chemical : 0.05% -
0/1% & 60-70 deg C

Two coats of zinc chromate primer should be applied after the above processing before baking in oven.
Wherever necessary filler putty is applied to make the surface smooth.
Properly rubbed surface is to be given a coat of surface and baked in oven.

5.11 Testing

Motor control centre shall be tested at manufacturer's works. The test certificates shall be got approved before dispatch of MCC to site.

5.12 Instrument Compartment

All instrument shall be flush mounted 144 mm square & suitably scaled. Instrument chamber should have sufficient space. Indicating lamps should have minimum 50mm space between them. They shall be accessible for testing and maintenance without any danger of accident and contact with live parts of circuits breaker and bus bar.

5.13 Control Cables and Terminals

All control wiring shall be with minimum area of 1.5 Sqm copper conductor. These shall be ferruled coded and identified at both ends as per IS specifications. A horizontal wire way shall be provided along the length of panel for taking the control wiring from one section to another control wiring when terminated, shall be terminated on the terminal block and identified for the duties to be performed. Each terminal shall be separately identified. Minimum 10% spare terminals shall be provided on every terminal block.

5.14 Other Components

5.13.1 Moulded Case Circuit Breaker (MCCB)

The MCCB (moulded case circuit breaker) shall conform to the latest IEC 947-2 & IEC 947- 3–1989. The Service Short Circuit Breaking Capacity (Ics at 415VAC) should be as specified at the required level.

The MCCB shall be Current Limiting type and comprise of Quick Make – Break switching mechanism, preferably Double Break Contact system, arc 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 stresses. All MCCBs shall be capable of defined Variable overload adjustment. All MCCBs rated 200Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall over ride all other commands. The MCCB shall employ maintenance free double break contact system to minimize the let thru' 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 thru energy curves. The MCCB shall not be restricted to Line/ Load connections.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IEC947-3 indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection .

5.13.2 Miniature Circuit Breaker (MCB)

Miniature Circuit Breaker shall comply with IEC898 – 1996. The Miniature circuit breakers (MCB) shall be quick make and break type for 230 / 415 VAC 50 Hz application with thermal magnetic releases for over current and short

circuit protection. The Breaking capacity shall not be less than 10 KA at 415VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Energy Class–3). MCBs shall be classified (B,C,D as per the IEC 898 standards) 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.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection . All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

5.13.3 Switch Fuse Units

- a. High rupturing capacity fuse (HRC Fuse) shall carry ISI mark on it and shall be rated for duty as indicated on the drawing/schedule of Quantities. The rating of HRC fuse shall be as per the rating of motor/equipment. The rating of fuse shall be selected so as to provide discrimination.
- a. The switch fuse units shall be three pole double break action with switched neutral. All switch fuse units shall be provided with the hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is 'ON' position and also to prevent energizing the switch when the door is not properly secured. All contacts shall be silver plated and alive parts shall be shrouded. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall have rupturing capacity of not less than 31 MVA at 415 volts. All switch fuse units shall be provided with visible indicators to show that they are in 'ON or OFF' position. All switch units shall be of AC-23 category.

5.13.4 Motor Starter

The Motor Starter shall be a combination starter consisting of motor protection circuit breaker and suitable contactor for remote starting.

- a. Motor protection circuit breaker
The motor protection circuit breaker must comply to the latest IEC 947-4 and the corresponding IS 13947-4. The motor protection circuit breaker should be suitable for AC3 duty at 415V. The motor protection circuit breaker should offer built in coordinated overload and short circuit protection. The motor protection circuit breaker should have

built in single phase / phase loss preventor. The motor protection circuit breaker should offer separate ON/OFF indication and Fault signal contacts which should be wired onto the panel for indication. The motor protection circuit breaker should offer Type 2 coordination along with the contactor.

b. Contactors

The contactor should be suitable for AC3 duty at 415V and should comply to the latest IEC 947-4 and the corresponding IS 13947-4. The contactor should have minimum 10 x IE rated making / breaking capacity as per the latest standard. The

same should be suitable for Type 2 coordination along with motor protection circuit breaker. The contactor should have Class H insulation for the coil to prevent heating and to facilitate frequent start / stop function without heating.

5.13.5 Earth Leakage CB/ Residual Current CB

The ELCB/RCCB shall comply with IEC 1008. The ELCB/RCCB shall current operated independent of the line voltage. ELCB / RCCB shall work on the principle of core balance transformer. The ELCB / RCCB shall be rated for current sensitivity of a Min of 30mA and a Max of 300mA at 240 / 415VAC. The terminals shall be protected against finger contact to IP20 degree of protection. The ELCB / RCCB shall have a minimum of 20,000 electrical operations.

Testing Provision for the Earth Leakage Circuit Breaker

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 and the operating handle shall move to the "OFF" position.

5.13.6 Air Circuit Breaker (ACB) :

The ACB shall conform to IEC 947-2-1989 & IS 13947 (Part –2). The Service Short Circuit Breaking Capacity shall be as specified and equal to the Short circuit Withstand Values. The ACB shall be provided for controlling the incoming supply feeder or as required and specified in schedule. Shall be available in 3 or 4 pole with modular construction, fixed or draw out, manually or electrically operated versions as specified. ACB shall be capable of providing short circuit, overload and earth fault protection (in absolute values) if required, through microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/ EMC requirement as per the standard.

The breaker should have 3 distinct positions – SERVICE / TEST/ ISOLATED within the cubicle. It should be possible to withdraw the breaker for testing with the door closed. Safety interlock must be provided to prevent the ACB from falling out in a fully withdrawn position. The ACB shall be provided with

a door interlock. The contacts should be copper and silver plated only with a feature of contact wear inspection indicating the life of the contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts.

All electrical closing of breaker should be with Electrical motor wound stored energy spring closing mechanism with Mechanical indicator to provide. ON/ OFF status of ACB.

For all ACBs the Operating handle should be provided for charging the spring in continuous action. The spring shall be released with ON / OFF push button command in one operation at the correct speed independent of operator speed. A direct mechanical coupling should indicate the ACB in ON or OFF position thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. One set of NO / NC potential free contacts to be provided for operation on Building Management System. All accessories like shunt, under voltage motorized mechanism etc shall be front mounted, requiring no adjustments and can be fitted at site.

The manufacturer shall provide details of opening time and alvaniz with temperature to ensure discrimination and proper selection for feeders protection. All ACBs of 4000 A and above shall be a single ACB and Tandem operated will not be acceptable.

5.13.7 SAFETY FEATURES :

1. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
2. It should not be possible to interchange two circuit breakers of two different thermal ratings.
3. There should be a provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism.
4. Earthing bolts must be provided on the cradle or body of fixed ACB. Arc Chute covers should be provided wherever necessary.
5. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, voltmeter and ammeter of size not less than 96mm x 96mm, selector switches, fuses for potential circuit and current transformers.
6. It should 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.

5.13.8 PROTECTIONS

1. The Electro magnetic and thermal release or Microprocessor based unit should be provided on circuit breaker for short circuit , over current and earth fault protection with adjustable settings.
2. Specific LED indications should be provided for over current and earth fault operation.
3. Relays should be CT operated through shunt trip for short circuit and earth fault protection.
4. Under voltage relays should be provided.
5. Minimum 6 NO and 6 NC auxiliary contacts shall be provided on each breaker. The contacts shall be rated 5 Amps.
6. Rated insulation voltage is 1000 volts AC.

5.13.9 Push Button Stations

Push button stations shall be provided for manual Start & Stop of equipment. Push button shall have ON & OFF indicating lamp in red and green colour. Push button shall be fabricated in 16 gauge sheet steel.

These station shall be factory fabricated. ON & OFF operations shall be carried out from front without opening the door. One set of NO & NC contact shall be provided in push button station as spare.

5.13.10 Toggle Switch

The toggle switch shall be of minimum 5 Amps rating.

5.13.11 Thermal Overload

The relay shall be factory calibrated, sealed and suitable for an ambient temperature at site or 50 deg C whichever is higher.

It should provide reliable and accurate protection against overload, single phasing and locked rotor conditions. Relays are to be provided with :

- (a) Trip alarm contact
- (b) Trip lever for testing I Auto reset facility

Rated insulation voltage shall be 660 volts AC.

5.14 Instruments

a. **General :**

The specifications hereinafter laid down shall cover all the meters and instruments.

b. Instrument Transformers

(i). Current Transformers

Current transformers shall be in conformity with IS : 2705 (Part I,II,III & IV) in all respects. All current transformers used for medium voltage applications shall be rated for 1 KV. However, the rated secondary current shall be 5 A unless otherwise specified. The acceptable minimum class of various applications shall be as given below : Measuring : Class 0.5 to 1 Protection : Class 10 p

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 35 MVA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identifications of poles. Current transformers shall be provided with earthing terminals, for earthing chassis frame work and fixed part of the metal casing (If any). Each CT shall be provided with rating plate indicating the following :

- i. Name and make
- ii. Serial Number
- iii. Transformation Ratio
- iv. Rated Burden
- v. Rated Voltage
- vi. Accuracy Class

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat & clean manner.

c. Potential Transformers

Potential transformers shall be provided if specifically called for potential transformers shall comply with the requirements of IS : (Part I,II,III) in all respects.

d. Measuring Instruments

i. General

Direct reading electrical instruments shall be in conformity with IEC-51, BS:89 or IS :1248. The accuracy of direct reading shall be 1.0 for voltmeters and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The meters shall be suitable for continuous operation between -10 deg C and +50 deg C. All meters shall be of flush mounting type with square pattern. The meter shall be enclosed in a dust tight housing . The meters shall be provided with white dials and black scale markings. The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside.

ii. Ammeters

Ammeters shall be of moving-iron type. The moving part assembly shall be with jewel bearings. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks. The ammeters shall be manufactured and calibrated as per the latest edition of IS: 1248 or BS:89. Ammeters shall be instrument transformer operated, and shall be suitable for 5 A secondary.

Upto 30 Amps the ammeter shall be direct operated without current transformer on one phase only. Beyond 30 Amps the ammeter shall be CT operated with selector switch.

iii. **Voltmeters**

Voltmeters shall be of moving-iron type. The range for 400 volts, 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.

5.15 **Earthing**

a. **General**

All non-current carrying metal parts of the electrical installation shall be earthed as per IS-3043. All metal conduits, trunking, cable sheathes, switchgear, distribution boards and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to control panel. Earthing shall meet the requirements of IER 1956.

b. **Earthing Conductor**

All earthing conductors shall be of high conductivity copper as specified and shall be protected against mechanical damage and corrosion. The size of the earth conductor shall not be less than half of the largest size of the current carrying conductor. The connection of the earth continuity conductor of earth and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable clamps made of non ferrous metals. Incoming power supply along with earthing upto MCC/AHU control panel shall be provided by other agency. The panel shall be earthed to building main earthing. The motor shall be double earthed to the panel.

The earthing shall be done with wires/flat as under :

S.No.	Equipment	Size of Earth Wire/Strip	
		GI	Copper
01.	Motors Upto 5 HP	2 Nos 8 SWG	2 Nos. 14 SWG
02.	Motors Upto 15 Hp	2 Nos 8 SWG	2 Nos 12 SWG
03.	Motors Upto 30 HP	2 Nos 4 SWG	2 Nos. 8 SWG
04.	Motors Upto 50 HP	2 Nos Flat	2 Nos. 4 SWG
05.	Motors above 50 HP	2 Nos 32x6mm Flat.	2Nos. 25x3mm

AHU electrical panel shall generally be wall mounted type. Above stated specifications shall also stand good where applicable. The AHU motor shall be double earthed with two independent earth conductors as per the Indian Electricity Rules & Regulations-1956.

5.16 **Medium Voltage Cable**

a. **Type**

Medium voltage cables shall be aluminium/copper conductor, PVC insulated, PVC sheathed and steel wire armored or steel tape armored construction.

b. **Rating**

The cable shall be rated a voltage of 660/1100 volts.

c. **Construction**

The conductors shall be made of electrical purity aluminium 3/4 or H temper/copper. The conductor shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanized compound.

Armouring shall be applied over the inner sheath of bedding. Over the armouring a tough outer sheath of PVC sheathing shall be extruded. The armouring shall be of single layer, alvanized steel round wire or flat strip. Wire armour should be used for cable dia over inner sheath upto 13mm and strip armour to be used for higher dia.

The outer sheath shall bear the manufacturer's name and trade mark at every meter length.

d. **Core Identification**

Cores shall be provided with the following colour scheme of PVC insulation: Core 1 : Red/Black/Yellow/Blue

Core 2 : Red & Black

Core 3 : Red, Yellow & Blue

Core 4 : Red, Yellow, Blue & Black

e. **Current Rating**

The current ratings shall be based on the following conditions :

i. Maximum conductor : 70 deg C

ii. Ambient Air temperature : 43 deg C

iii. Ground temperature : 30 deg C

iv. Depth of laying : 75 CM

f. **Short Circuit Rating**

Short circuit ratings for the cables shall be as specified in IS: 1554-Part I.

g. **Selection of Cables**

The cables shall be suitable for effectively earthed A/C system 415 volts, 3 Phase 50 Hz.

Cables have been selected considering the conditions of the maximum connected load, switch rating ambient temperature, grouping of cables and the allowable voltage drop. However, the contactor shall recheck the sizes before the cables are ordered and brought to site. Discrepancy if any, shall be brought to the notice of Consultant.

h. **Laying of Cables**

For laying of cables along building steel structure and technological structures the cables shall be taken by clamping with MS saddles screwed to the MS flat welded to the structure. MS saddles and flats are to be galvanized after fabrication so that there is no rusting during maintenance period.

For laying cables along concrete walls, ceiling etc . The cables shall be taken by clamping with MS saddles screws to the MS flat welded on to the inserts. Where inserts are not available the saddles shall be directly fixed in the wall using rowl steel plugs of sufficient capacity and MS flat spacers of minimum 2mm thick.

The MS saddles shall be spaced at an interval, not more than 500mm both for horizontal and vertical runs. However, at the bends, it shall be spaced within 300mm and where terminating to the equipment/junction box the cable shall be clamped immediately before such terminations. In the area prevailing with corrosive atmosphere, PVC saddles instead of MS saddles shall be provided.

Underground cables shall be laid not less than 750mm below ground. The width of the trench shall be 300mm minimum for single cable. For additional cables additional width of 150mm for each cable is to be added. The sand should be spread in trench as under.

The cushion of sand to be provided below and above the cable joint boxes etc must not be less than 80mm i.e, total depth of sand shall be 160mm minimum. The sand should be spread in trench as under.

i. After laying the cable in trench 80mm of sand should be put over the cable. The cable should then be lifted and placed over the

sand bed and the balance 80mm of sand put over it.

- ii. Where cable is laid in rocky situation extra thick cushioning of sand as may be decided by site in charges shall have to be done without any extra cost.

Filling of trenches shall be done after the sand cushioning and laying of tiles/bricks are carried out to the satisfaction of the engineer.

5.17 Cable Trays

- i. Trays shall have suitable strength and rigidity to provide adequate support for all cables.
- ii. Shall not have sharp edges, burrs or projections injurious to cable insulation.
- iii. Shall be adequately protected against corrosion.
- iv. Shall include fittings factory fabricated or other suitable means for change of direction and elevation in run.

5.17.1 Installation of Trays

Trays shall be installed as complete system supported properly and rigidly from the building structure.

Each run of cable tray shall be completed before the installation of cables.

Cable trays shall be accessible.

Non combustible solid barriers shall be used for segregating the cables of different systems on the same cable tray. Cable trays shall be grounded by 2 Nos earth strips. Trays shall not be used as equipment grounding conductor.

5.18 Testing

- a. Cables shall be tested as per the requirements of IS 1554. The tests shall be incorporate routine test and acceptance tests. Type test certificate shall be furnished whenever demanded.

B Tests shall be carried out at site and submitted to project authorities.

5.19 Cable Identification Tag

Suitable cable identification tag shall be placed along the route of cable at every 10 meters and bends. The tags shall be of size 150mmx100mmx2mm aluminium sheet. It shall be punched with similar details as given below.

Cable from	MCC or AHP-1
Cable to	CDWP-1 or CT-1
Size of cable	2 Nos 3Cx 6 Sqmm.

5.20 Drawings

Shop drawing for MCC/control panels and wiring of equipment showing the route of cables shall be got approved by the Consultants before starting the fabrication of panel and starting the work.

6.1 AUTOMATIC CONTROLS AND INSTRUMENTS

a. Scope

The scope of this section comprises of the supply, erection, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with the drawings and schedule of quantities.

b. Type

All automatic controls and instruments shall be of approved make as described in the various sections of these specifications.

6.2 Automatic Controls :

Automatic controls required for various types of machines have been described in the various sections of these specifications and shown on the drawings. The individual safety controls and selected automatic controls, may be installed within the machines by the manufacturers before shipment. However, the following automatic controls, if not already installed on the machines, may be installed at site by the Contractor, as indicated in schedule of quantities. Sleeper/ Rotary/ Ball Valves shall be not acceptable. Both valve & actuators should be of same make. Characteristics of valves shall be of equal percentage type.

- a. Automatically balanced combination valves for air handling & fan coil units. Valve shall be 2 way combined valve of PN 16 rating for flow limitation, controlling flow & Controlling Differential Pressure. The features shall facilitate dynamic balancing and water flow modulation at variable loads.

Valve should be of linear control characteristics and should be of pressure independent self balancing type.

Valve should be equipped with electronic modulating actuator which can accept either of "4-20 mAmps / 0-10 V DC" signals. Operating voltage for actuator shall be 24 V AC. Alternatively, Valve shall be equipped with electronic on/off actuator with 230V AC power supply for fan coil installation.

Differential Pressure controller should ensure 100% valve authority on all part loads. Actuator shall be able to work against maximum closing pressure of 6 bar.

Measuring nipples should be provided to measure / verify actual pressure drop at site in order to optimize Pump head.

b. Flow Switches

Flow Switches shall be provided in condenser water outlet and chilled water outlet at the water chilling machines, and at the water cooled condensing units as shown on drawings and as indicated in schedule of quantities. Flow switch shall prevent the compressor from starting unless the water flow is established in water lines.

c. Digital Thermostats

Thermostats for AHUs/ TFAs/ FCUs should be Digital on/off OR Modulating Type for Actuating 2 way or 3 way Valves (On-off/Modulating). Thermostats shall be heating/ cooling type. Thermostats should display Room Temp and Set point simultaneously which is easy to read from atleast 6-8 feet distance.

Thermostats should have Fan Speed Control Switch (Low-Med-High-Auto). Auto Mode should be able to save energy by automatically reducing the Fan Speed when Room Temp Achieves Set Point.

LCD Display should be available in Blue or Green Backlit for ease in viewing the Room Temperature and Set point. Thermostats should work on 230V power supply for on-off models and 24V for Modulating Thermostats. The User Settings should be retained in Thermostat Memory in case of Power Failure.

The Switching Relays should be separately wired and should be mounted inside the Junction Box, so that the Thermostat front is sleek in mounting. Thermostat Thickness should be 17mm or less.

Thermostats should have Energy Savings Feature with dual set point which can be interlocked with Occupancy Sensor or Hotel Key Card input. This should be indicated in the LCD Display in the mode it is being operated. This Programming should be possible by Facility Management Personnel.

Thermostats should be similar or equivalent to Honeywell Halo Series Digital Thermostats Model T6861 (on/off) or T6865 (modulating) version.

d. Airstat

Airstat may provided, as shown on drawings and included in schedule of quantities, within air handling unit containing electric strip heaters or reheat coils to prevent heaters from energizing unless the air flow is established.

6.3 Instruments :

Instruments required for different types of machines have been described in the various sections of these specifications and shown on the drawings. Following instruments may be provided in accordance with the specific requirements.

a. Thermometers

Thermometers shall be V-form industrial type with range of scales as 32-120 degree F (0-50 degree C) for cooling applications of cooling only, and 32-212 degree F (0-100 degree C) for heating applications duly calibrated. Body shall be of aluminium alloy, anodized gold coloured surface against aggressive vapours. The casing shall be adjustable type to take any reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Graduation of scale shall be 1 degree in both readings. Thermometer shall be suitable for 1/2 FPT connections. Thermometers for chilled water pipe line shall be provided with long brass stem to facilitate ease in removal without damaging the insulation. MS socket to be welded on pipes shall also be provided with the thermometer.

Thermometers shall be provided at the following locations and as indicated on the drawings :

- a) On supply and return of chillers, condensers and hot water generators.
- b) On supply and return at air handling units.
- c) On discharge of CHW and CDW pumps.

b. Pressure Gauges

Pressure Gauges shall be Fiebig or approved equal, installed on suction and discharge ends of pumps, chilled water supply and return at air handling units, inlet and outlet of chillers and condensers, as required. Gauges to be installed at suction end of pumps shall be compound type with 150mm dia having a range, 75cm-10Kg/Sqcm (30"- 150 psi) mercury vacuum and pressure. Discharge sides gauges at pumps and at all other locations shall be 150mm dia having a range, 0- 10 Kg/Sqcm (0-150 psi) pressure. Gauges shall be connected to the pipes by 6mm diameter copper tubing through 6mm dia. Shut-off-cocks, required for gauge protection during testing.

c. Room Thermometers

Room thermometers shall be Taylor or approved equal, dial type, wall-hung temperature indicators, of appropriate range for cold stores and deep freezers, in accordance with the drawings and schedule of quantities.

d. Electronic Thermometers

Electronic Thermometers shall be of approved make electronic operated Digital Temperature Indicator in accordance with the drawing and as indicated in the schedule of quantities. The display shall be 3-5 digit liquid Crystal Display. The thermometer shall consist of fully solid state integrated circuits. The thermometer shall have front LED 'ON' indication and automatic low battery indication. The resolution shall be 0-1 degree centigrade. Thermometer shall be complete with suitable electronic sensor to accurately sense the temperature with sensor housed in suitable airwell/ thermowell for air temperature/water temperature measurement. The thermometer shall be suitable for operation on 9 V DC/230 V AC. The display unit shall be housed in attractive sheet metal cabinet with prominent display of conversion charts of deg F & C on front plate. Thermometer shall be complete with separable socket type interconnecting cables of 2m length suitable for installation within a radius of 2m of the thermowell or air sensing point. Thermometers may be installed at chilled water supply and return at air handling units, supply and return at chillers and condensers, hot water supply and return at hot water heat exchangers as shown on the drawings. Range of scales shall be 30 degree F-120 degree F (0-50 degree C) for cooling application, and 30 degree - 212 degree F (0-100 degree C) for heating applications.

6.4 Calibration and Testing :

All automatic controls and instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and their accuracy shall be guaranteed by the manufacturer. All automatic controls and instruments shall be tested at site for accuracy and reliability before commissioning the installation.

GUARANTEE PROFORMA FOR HVAC INSTALLATION

1. The Contractor shall furnish the following guarantee:

" We warrant that everything supplied by us including all components fitted into the equipment manufactured by others also, shall be in all respects free from all defects and faults in material, workmanship and manufacture and shall be of the highest grade and quality to acceptable standards for all materials of the type ordered and shall be in full conformity with all the specifications, drawings or samples if any and we shall be fully responsible for its efficient performance. This guarantee shall survive inspection for acceptance and payment for the equipment and installation, but shall expire (except in respect of the complaints notified to us) 12 months from the date of issue of completion certificate by the Engineer In-Charge. The complaints, workmanship, manufacturer or performance of any of the equipment or part/parts thereof shall be notified by fax within 12 months from the date of issue of such completion certificate".

2. The Contractor shall replace such of these parts which require replacement under these conditions free of cost, charge and expenses to the purchaser. In addition, the Contractor shall be responsible for a period of 12 months from the date of issue of completion certificate for any defect that may develop or appear under the conditions provided by the Contractor or use thereof arising from faulty material design or workmanship in the equivalent or any part thereof or faulty installation of the equipment by the Contractor but not otherwise and shall correct such defects within one week from the date of notification at his own cost when called upon to do so by the purchaser who shall state in writing in what respect the portion is faulty.
3. Any faulty component replaced or renewed under the clause shall also be guaranteed for a period of six months from the date of such replacement or removal of until the end of the above mentioned period whichever is later.
4. If defects are not rectified within a reasonable time as mentioned in the written notice, the Engineer In-Charge shall proceed to do so at the Contractor's risk and cost without prejudice to any other right thereof.

SIGNATURE AND STAMP OF THE CONTRACTOR

DATE :

APPENDIX-II

HVAC TENDER DRAWINGS

DRG. No.	DRAWING TITLE
BLOCK-1	
HVAC-01	HVAC LAYOUT- GROUND FLOOR PLAN , BLOCK-1
HVAC-03	HVAC LAYOUT- 1st FLOOR PLAN , BLOCK-1
HVAC-04	HVAC LAYOUT- 2nd FLOOR PLAN , BLOCK-1
HVAC-05	HVAC LAYOUT- 3rd FLOOR PLAN , BLOCK-1
HVAC-06	HVAC LAYOUT- TERRACE FLOOR PLAN , BLOCK-1
HVAC-07	VRF SCHEMATIC LOW SIDE, BLOCK-1
BLOCK-2	
HVAC-01	HVAC LAYOUT- GROUND FLOOR PLAN , BLOCK-2
HVAC-02	HVAC LAYOUT- INTERMEDIATE FLOOR PLAN , BLOCK-2
HVAC-03	HVAC LAYOUT- 1st FLOOR PLAN , BLOCK-2
HVAC-04	HVAC LAYOUT- 2nd FLOOR PLAN , BLOCK-2
HVAC-05	HVAC LAYOUT- TERRACE FLOOR PLAN , BLOCK-2
HVAC-06	VRF SCHEMATIC LOW SIDE, BLOCK-2
BLOCK-3	
HVAC-01	HVAC LAYOUT- GROUND FLOOR PLAN , BLOCK-3
HVAC-02	HVAC LAYOUT- 1st FLOOR PLAN , BLOCK-3
HVAC-03	HVAC LAYOUT- 2nd FLOOR PLAN , BLOCK-3
HVAC-04	HVAC LAYOUT- 3rd FLOOR PLAN , BLOCK-3
HVAC-05	HVAC LAYOUT- 4th FLOOR PLAN , BLOCK-3
HVAC-06	HVAC LAYOUT- 5th FLOOR PLAN , BLOCK-3
HVAC-07	HVAC LAYOUT- 6th FLOOR PLAN , BLOCK-3
HVAC-08	HVAC LAYOUT- 7th FLOOR PLAN , BLOCK-3
HVAC-09	HVAC LAYOUT- 8th FLOOR PLAN , BLOCK-3
HVAC-10	HVAC LAYOUT- 9th FLOOR PLAN , BLOCK-3
HVAC-11	HVAC LAYOUT- 10th FLOOR PLAN , BLOCK-3
HVAC-12	HVAC LAYOUT- 11th FLOOR PLAN , BLOCK-3
HVAC-13	HVAC LAYOUT- 12th FLOOR PLAN , BLOCK-3
HVAC-14	HVAC LAYOUT- TERRACE FLOOR PLAN , BLOCK-3
HVAC-01	HVAC LAYOUT- GROUND FLOOR PLAN , BLOCK-3
HVAC-02	HVAC LAYOUT- 1st FLOOR PLAN , BLOCK-3
HVAC-03	HVAC LAYOUT- 2nd FLOOR PLAN , BLOCK-3
HVAC-04	HVAC LAYOUT- 3rd FLOOR PLAN , BLOCK-3
HVAC-05	HVAC LAYOUT- 4th FLOOR PLAN , BLOCK-3
HVAC-06	HVAC LAYOUT- 5th FLOOR PLAN , BLOCK-3
HVAC-07	HVAC LAYOUT- 6th FLOOR PLAN , BLOCK-3

HVAC-08	HVAC LAYOUT- 7th FLOOR PLAN , BLOCK-3
HVAC-09	HVAC LAYOUT- 8th FLOOR PLAN , BLOCK-3
HVAC-10	HVAC LAYOUT- 9th FLOOR PLAN , BLOCK-3

DRG. No.	DRAWING TITLE
HVAC-11	HVAC LAYOUT- 10th FLOOR PLAN , BLOCK-3
HVAC-12	HVAC LAYOUT- 11th FLOOR PLAN , BLOCK-3
HVAC-13	HVAC LAYOUT- 12th FLOOR PLAN , BLOCK-3
HVAC-14	HVAC LAYOUT- TERRACE FLOOR PLAN , BLOCK-3
HVAC-15	CHW SCHEMATIC LOW SIDE, BLOCK-3
BLOCK-4	
HVAC-01	HVAC LAYOUT- GROUND FLOOR PLAN , BLOCK-4
HVAC-02	HVAC LAYOUT- 1st FLOOR PLAN , BLOCK-4
HVAC-03	HVAC LAYOUT- 2nd FLOOR PLAN , BLOCK-4
HVAC-04	HVAC LAYOUT- 3rd FLOOR PLAN , BLOCK-4
HVAC-05	HVAC LAYOUT- 4th FLOOR PLAN , BLOCK-4
HVAC-06	HVAC LAYOUT- 5th FLOOR PLAN , BLOCK-4
HVAC-07	HVAC LAYOUT- 6th FLOOR PLAN , BLOCK-4
HVAC-08	HVAC LAYOUT- 7th FLOOR PLAN , BLOCK-4
HVAC-09	HVAC LAYOUT- 8th FLOOR PLAN , BLOCK-4
HVAC-10	HVAC LAYOUT- 9th FLOOR PLAN , BLOCK-4
HVAC-11	HVAC LAYOUT- 10th FLOOR PLAN , BLOCK-4
HVAC-12	HVAC LAYOUT- 11th FLOOR PLAN , BLOCK-4
HVAC-13	HVAC LAYOUT- 12th FLOOR PLAN , BLOCK-4
HVAC-14	HVAC LAYOUT- TERRACE FLOOR PLAN , BLOCK-4
HVAC-01	HVAC LAYOUT- GROUND FLOOR PLAN , BLOCK-4
HVAC-02	HVAC LAYOUT- 1st FLOOR PLAN , BLOCK-4
HVAC-03	HVAC LAYOUT- 2nd FLOOR PLAN , BLOCK-4
HVAC-04	HVAC LAYOUT- 3rd FLOOR PLAN , BLOCK-4
HVAC-05	HVAC LAYOUT- 4th FLOOR PLAN , BLOCK-4
HVAC-06	HVAC LAYOUT- 5th FLOOR PLAN , BLOCK-4
HVAC-07	HVAC LAYOUT- 6th FLOOR PLAN , BLOCK-4
HVAC-08	HVAC LAYOUT- 7th FLOOR PLAN , BLOCK-4
HVAC-09	HVAC LAYOUT- 8th FLOOR PLAN , BLOCK-4
HVAC-10	HVAC LAYOUT- 9th FLOOR PLAN , BLOCK-4
HVAC-11	HVAC LAYOUT- 10th FLOOR PLAN , BLOCK-4
HVAC-12	HVAC LAYOUT- 11th FLOOR PLAN , BLOCK-4
HVAC-13	HVAC LAYOUT- 12th FLOOR PLAN , BLOCK-4
HVAC-14	HVAC LAYOUT- TERRACE FLOOR PLAN , BLOCK-4
HVAC-15	CHW SCHEMATIC LOW SIDE, BLOCK-4

INTERNATIONAL CODES AND STANDARDS

Apart from the specific equipment standards and specifications, the following broad certifying agency / standards will be considered while designing the system :

- 1.1 ASHRAE – American Society for Heating, Refrigerating and Air-conditioning Engineers.
- 1.2 SMACNA – Sheet Metal and Air Conditioning Contractors National Association or Indian Standards –1982 Edition or IS277/655 Standards.
- 1.3 UL - Underwriter’s Laboratory , USA.
- 1.4 AMCA - Air Movement & Control Association, International.
- 1.5 AHRI - Air-conditioning Heating & Refrigeration Institute
- 1.6 ANSI - American National Standards Institute
- 1.7 CSA - Canadian Standards Association
- 1.8 ISO - International Standards Organization
- 1.9 IEC - International Electrochemical Commission
- 1.10 EUROVENT - European Certification Program
- 1.11 UL - Underwriter’s Laboratory , USA.
- 1.12 SMACNA – Sheet Metal and Air Conditioning Contractors National

Association or Indian Standards –1982 Edition or IS277/655 Standards.

- 1.13 ASHRAE – American Society for Heating, Refrigerating and Air-conditioning Engineers –ASHRAE 62.1 -2010 Ventilation for Acceptable Indoor Air Quality.
- 1.14 AMCA - Air Movement & Control Association, International.
- 1.15 IEC - International Electro technical Commission

LIST OF BUREAU OF INDIAN STANDARDS CODES

IS : 277 - 1992	Galvanized steel sheet (Plain & corrugated) wire for fencing.
IS : 554 - 1985 (Reaffirmed 1996)	Dimensions for pipe threads where pressure tight joints are required on Metal air ducts.
IS : 655 - 1963 (Reaffirmed 1991)	
IS : 694 - 1990 (Reaffirmed 1994)	PVC insulated (HD) electric cables for working voltage upto and including Code of practice for electrical wiring.
IS : 732 - 1989	
IS : 780 - 1984	Sluice valves for water works purposes.
IS : 822-1970 (Reaffirmed 1991)	Code of procedure for inspection of welds.
IS : 1239 (Part - I) - 1990	Mild steel tube
IS : 1239 (Part - II) - 1992	Mild steel Tubular and other wrought steel pipe fittings.
IS : 1255 – 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating
IS : 1554 - 1988 (Part – I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including
IS : 1897 - 1983(Reaffirmed 1991)	Copper bus bar / strip for electrical Purposes
IS : 2379 - 1990	Color code for the identification of pipelines.
IS : 2551 - 1982	Danger notice plate
IS : 3043 – 1987	Code of practice for earthing.
IS : 3103 – 1975 (Reaffirmed	Code of practice for Industrial Ventilation

IS : 3837 – 1976 (Reaffirmed 1998)	Accessories for rigid steel conduit for electrical wiring.
IS : 4736 – 1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes.
IS : 4894 - 1987	Centrifugal Fan.
IS : 5133 -1969 (Part-I) (Reaffirmed 1998)	Boxes for the enclosure of electrical accessories.
IS : 5312 (Part-I) -1984 (Reaffirmed 1998)	Swing - check type reflux Non return valves for water works
IS : 5424 – 1989 (Reaffirmed 1998)	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and identification of conductors
IS : 6392 - 1971(Reaffirmed 1988)	Steel pipe flanges.
IS : 8623 – 1993	Low voltage switchgear and control gear Assemblies (Requirement for type / partly type tested assemblies)
IS : 8623 - 1993	Bus Bar trunking system(Part - II)
IS : 8828 - 1996	Circuit Breakers for over current Protection For house hold and industrial applications
IS : 9537 - 1981(Part II)	Rigid Steel Conduits for electrical wiring
IS : 10810 - 1988	Methods of test for cables.
IS : 13947-1993 (Part-I)	General rules for low voltage switch gears and control
IS : 13947-1993 (Part-II) IEC 947 – 1	Circuit Breakers
IS : 13947 - 1993 (Part-III)	Switches, dis connectors and fuse for low voltage switch gear and control gear.
IS : 13947 - 1993 (Part-IV)	Low voltage switch gear and control Gear for contactors and
IS : 13947 – 1993 (Part-V)	Control Circuit Devices.

IEC

Relevant Sections.

NBC

National Building Code

ISHRAE

Indian Society for Heating,
Refrigerating and Air-conditioning
Engineers – ISHRAE1997 Edition .

I.S. SAFETY CODES

IS : 659 – 1964 (Reaffirmed 1991)	Safety Code for Air Conditioning.
IS : 660 – 1963 (Reaffirmed 1991)	Safety code for Mechanical Refrigeration.
IS : 3016	Code of Practice for Fire Precautions in Welding and Cutting operations.
IS : 818	Code of practice for Safety and Health Requirements in Electrical & Gas Welding and cutting operations.
IS : 5216–1982 (Part-I) (Reaffirmed 1990)	Guide for safety procedure and Practices in electrical work.
IS : 3696	Safety Code for Scaffolds and Ladders.

PROFORMA FOR SCHEDULE OF TECHNICAL PARTICULARS

Pump Sets

Variable Speed Pumping System

- I. Pump Logic Controller
 - a. Make
 - b. Country of origin
 - c. Model
 - d. Standard applicable
 - e. Interface with BMS
 - f. Radio Interference Standards
 - g. Power Supply
- II. Automatic AFD Bypass/Manual Bypass
 - a. Make
 - b. Country of origin

- c. Model
- d. Type
- e. Motor Rating (HP)
- f. Rated Current
- g. Type of enclosure

III. Adjustable Frequency Drive

- a. Make
- b. Country of origin
- c. Type
- d. Motor Rating (HP)
- e. Rated Current
- f. Slip Compensation
- g. Pid Controller
- h. Fault Indication
- i. Historic Fault & Parameter Lock
- j. Key & Display

IV. Differential Pressure Sensor/Transmitter

- a. Make
- b. Country of origin
- c. Model
- d. Type
- e. Construction Material
- f. Max. Static Pressure
- g. Power Supply
- h. Degree of Protection

Air Handling Units

- a. Manufacturer
- b. Model
- c. Type of Unit
- d. Overall dimension (mm)

- e. Noise Level
- f. Material and thickness of casing
- g. Material and thickness of drain pan
- h. Operating Weight (Kg)
- i. Type of Bearing

Centrifugal Fans

- a. Manufacturer
- b. Model
- c. Type of fan
- d. Fan speed (RPM)
- e. No. of fans
- f. Fan wheel diameter (mm)
- g. Drive arrangement
- h. No. of belts in case of belt driven.
- i. Material and thickness
of fan wheel and blades
- j. Material and thickness of housing

- k. Fan outlet area (SqM)
- l. Outlet velocity (MPM)
- m. Total air quantity (CMH)
- n. Static pressure at outlet (M of water)
- o. Whether statically and dynamically balanced
- p. Type of bearings.
- q. Limit load HP

Motor For AHU

- a. Manufacturer
- b. Type
- c. Electrical Characteristics
- d. Motor Speed (RPM)
- e. Method of Starting
- f. Starter Manufacturer

AHU Cooling Coil

- a. Manufacturer

- b. Type
- c. Material of tubes
- d. Material of fin
- e. Tube diameter
- f. Tube thickness
- g. Fin thickness
- h. Method of bonding of tube and fins
- i. No. of fins/cm
- j. No. of rows deep
- k. Total tube surface outside (SqM)
- l. Test pressure
- m. Coil face area
- n. Water flow rate (US GPM)
- o. Velocity of Water across coil (MPS)
- p. No. of circuits
- q. Pressure drop in coil (M of water)

Air Filter For AHU

Pre- Filter For AHU

- a. Manufacturer
- b. Type of filters
- c. Filter medium
- d. Material of frame work and its thickness (mm)
- e. Face area (SqM)
- f. Face velocity across filters (MPS)
- g. Pressure drop across filters (M of water)
- h. Efficiency

Electrical Strip Heaters

- a. Manufacturer
- b. Type
- c. Material of sheath
- d. Material of fins
- e. Power rating (KW)

- f. Surface temperature of the Element when tested in still air At 20 deg C ambient

Controls for Air Handling Units

- a. Combined Pressure independent Valves
 - i. Make
 - ii. Model
 - iii. Modutrol Motor Make
 - iv. Modutrol Motor Model
 - v. Voltage of Motor
 - vi. Transformer
 - vii. Selected Cv
 - viii. Valve Linkage Make and Model

b. Thermostats For AHU

- i. Make
- ii. Model
- iii. Range
- iv. Differential

v. Temperature Settings

vi. Electrical Characteristics

FRESH AIR TREATMENT UNITS

- a. Manufacturer
- b. Model
- c. Type of Unit
- d. Overall dimension (mm)
- e. Noise Level
- f. Material and thickness
of casing
- g. Material and thickness
of drain pan
- h. Operating Weight (Kg)

Centrifugal Fan

- a. Manufacturer
- b. Model
- c. Type of fan

- d. Fan speed (RPM)
- e. No. of fans
- f. Fan wheel diameter (mm)
- g. Drive arrangement
- h. No. of belts in case of belt driven.
- i. Material and thickness
of fan wheel and blades
- j. Material and thickness of housing
- k. Fan outlet area (SqM)
- l. Fan Outlet velocity (FPM)
- m. Total air quantity (CMH)
- n. Static pressure at outlet (M of water)
- o. Whether statically and dynamically balanced
- p. Type of bearings.

Motor For FATU

- a. Manufacturer
- b. Type
- c. Electrical Characteristics
- d. Motor Speed (RPM)
- e. Method of Starting
- f. Starter Manufacturer

FATU Cooling Coil

- a. Manufacturer
- b. Type
- c. Material of tubes
- d. Material of fin
- e. Tube diameter
- f. Tube thickness
- g. Fin thickness

- h. Method of bonding of tube and fins
- i. No. of fins/cm
- j. No. of rows deep
- k. Total tube surface outside (SqM)
- l. Test pressure
- m. Coil face area
- n. Water flow rate (US GPM)
- o. Velocity of Water across coil (MPS)
- p. No. of circuits
- q. Pressure drop in coil (M of water)

Air Filters For FATUs

Pre-Filters

- a. Manufacturer
- b. Type of filters
- c. Filter medium
- d. Material of frame work and its thickness (mm)

- e. Face area (SqM)
- f. Face velocity across filters (MPS)
- g. Pressure drop across filters (M of water)

Fine Filters

- a. Manufacturer
- b. Type of filters
- c. Filter medium
- d. Material of frame work and its thickness (mm)
- e. Face area (SqM)
- f. Face velocity across filters (MPS)
- g. Pressure drop across filters (M of water)

Carbon Filters

- a. Manufacturer
- b. Type of filters
- c. Filter medium
- d. Material of frame work and its thickness (mm)
- e. Face area (SqM)

- f. Face velocity across filters (MPS)
- g. Pressure drop across filters (M of water)

Controls for FATUs

- a. Combined Pressure Independent Valves

- i. Make
- ii. Model
- iii. Modutrol Motor Make
- iv. Modutrol Motor Model
- v. Voltage of Motor
- vi. Transformer
- vii. Selected Cv
- viii. Valve Linkage Make and Model

- b. **Thermostats For AHU**

- i. Make
- ii. Model
- iii. Range

iv. Differential

v. Temperature Settings

vi. Electrical Characteristics

OPERATING DATA FOR AHUs

AHU NO.	AIR QTY. (Cfm)	COIL AREA (Sft)	COIL FACE VEL. (FPM)	OUTLET VEL.(FPM)	No. OF ROWS	MOTOR RATING (HP)

Fan Coil Units

- a. Manufacturer
- b. Capacity (TR)
- c. Air quantity (Cfm)
- d. Type of finish
- e. Material/Gauge
 - i Casing
 - ii. Interior Chassis
 - iii. Drain Pan And Insulation
 - iv. Copper Tubes

- v. Aluminium Fins
- f. Fins spacing per Inch
- g. Rows
- h. Coil Face Area (SM)
- i. Type of Filter
- j. Dimensions of FCUs
- k. Motor make
- l. Motor rating (HP)
- m. Electrical characteristics
- n. Motor speed (RPM)
- o. No. of speeds
- p. Efficiency (%)

Controls for Fan Coil Units

- a. Motorized Valves For FCUs
 - i. Make
 - ii. Model

- iii. Make of Motor
- iv. Diameter of valve
- v. Selected Cv
- vi. Electrical characteristics
- vii. Transformer Provided

b. Thermostats for FCUs

- i. Make
- ii. Model
- iii. Range
- iv. Differential
- v. Temperature Settings
- vi. Electrical Characteristics
- vii. Fan speeds and settings

Extract Fan Sections & Fan Filter Units

- a. Manufacturer
- b. Model
- c. Type of Unit

- d. Overall dimensions (mm)
- e. Noise Level
- f. Material and thickness of casing
- g. Type of paint & primer for casing
- h. Operating Weight (Kg)
- i. Type of filters for FFU
- j. Thickness of filters for FFU
- k. Filter face velocity
- l. Filter Efficiency (%)

Centrifugal Fans

- a. Manufacturer
- b. Type of fan & Model
- c. Fan speed (RPM)
- d. No. of fans
- e. Fan wheel diameter (mm)

- f. Drive arrangement
- g. No. of belts in case of belt driven.
- h. Material and thickness of fan wheel and blades
- i. Material and thickness of housing
- j. Fan outlet area (SqM)
- k. Outlet velocity (FPM/MPM)
- l. Total air quantity (CMH/CFM)
- m. Static pressure at outlet (M of water)
- n. Whether statically and dynamically balanced ?
- o. Type of bearings.
- p. Efficiency(%)

Motor

- a. Manufacturer
- b. Type
- c. Electrical Characteristics
- d. Motor Speed (RPM)

- e. Method of Starting
- f. Starter Manufacturer
- g. Efficiency(%)

CASSETTE TYPE SPLIT UNITS :

- a. Manufacturer
- b. Country of origin
- c. Model of Indoor Unit
- d. Model of outdoor unit
- e. Compressor Model
- f. Compressor make & type
- g. Nominal Capacity
- h. Actual Capacity at 35C ambient temp.
- i. Compressor maximum speed
- j. Coil Tube dia, thickness & rows deep
- k. Tube Material
- l. Fin Material

- m. Bonding of fins
- n. Fin Spacing
- o. Coil face velocity (MPM/FPM)
- p. Coil Face Area (SqM/Sft)
- q. Sheet metal enclosure material and thickness
- r. Type of blower & quantity
- s. Drain Pan insulation type & thickness.
- t. Acoustic lining :
 - i. Insulation material
 - ii. Re-inforcement material
- u. Type of vibration eliminators
- v. Air Quantity of indoor unit (CMH/CFM)
- w. Type of Blower Motor
- x. Blower Motor Horse Power
- y. Range of working voltage
- z. Rated speed (RPM)

Tube Axial Flow Fan

- a. Make
- b. Model
- c. Type Confirming to
- d. Air quantity at operational speed (CuM./HR)
- e. Static pressure (mmWG)
- f. Velocity Pressure (mmWG)
- g. Total Pressure (mmWG)
- h. Speed (RPM)
- i. Size (diameter)
- j. Motor rating
- k. Class of Insulation  
- l. Type of motor  
- m. Speed of Motor
- n. Conforming to

- o. Max.-Temp. over and above
- p. Type of starter
- q. Noise Level
- r. Static/Dynamic weights
- s. Efficiency(%)

Inline Fans

- a. Manufacturer
- b. Motor Characteristics
- c. Whether speed regulator provided for single phase fans
- d. Whether Bird Screen provided
- e. Whether Gravity Louvers provided
- f. Efficiency(%)

Propeller Fans

- a. Manufacturer
- b. Motor Characteristics
- c. Capacitors Provided

- d. Speed Regulator
- e. Gravity Louvers
- f. Single Phase Preventor
- g. Back Draft Damper
- h. Bird Screen
- i. Wire guard.
- k. Efficiency(%)

MS Water Piping

- a. Make
- b. Material for pipes.
- c. Pipe wall thickness

Valves Make and Material

- a. Gate Valve
- b. Globe Valve
- c. Check Valve
- d. Balancing Valve
- e. Butterfly Valve
- f. Ball Valve
- g. Ball Valve with Strainer
- h. Pot strainer
- i. 'Y' Strainer

Ducting

- a. Make of GI sheet
- b. Grade of coating
- c. "K" value at 10 degree C mean temp.
- d. Thickness
- e. Manufacturer of ductwork

Grilles, Diffusers and Dampers

Make, Material and Gauge of following items :

- a. Fire Dampers
- b. Grilles : i. Extruded aluminium
ii. Mild Steel
- c. Diffusers : i. Extruded aluminium
ii. Mild Steel
- d. Duct Dampers
- e. Fresh air arrangement

Variable Frequency Drives

- a. Manufacturer
- b. Country of Origin
- c. Type

Insulation

A. Duct Acoustic Lining

- a. Material
- b. Manufacturer
- c. Density
- d. Thermal Conductivity
- e. Thickness

B. Thermal Insulation of Ducts

- a. Material
- b. Manufacturer
- c. Density
- d. Thermal Conductivity
- e. Thickness

c. Exposed Duct Thermal Insulation

- a. Material
- b. Manufacturer
- c. Density
- d. Thermal Conductivity
- e. Thickness

Electrical Accessories

Make of the following :

- a. AHU Panels
- c. MCCBs
- d. MCBs
- e. Change Over Switch
- f. Star Delta Starter
- g. Direct On Line Starter
- h. Contactors/Over |Load Relays
- i. Current Transformers

- j. Single Phase Preventors
- k. Push Buttons
- l. Ammeter And Voltmeter
- m. Indication Lamps
- n. Power Cables
- o. Control Cables & Wires

APPENDIX-VII

**PROFORMA FOR TEST RESULTS and NOTES ON TEST INSTRUMENTS
and CAPACITY COMPUTATIONS**

S.No.	Item	Test Results
1.	Ambient conditions -----	D.B.Temp. - degree C W.B.Temp. - degree C R.H - %
2.	Compressors -----	R PM Refrigerant gas suction pressure - Kg/Sq.cm Refrigerant gas discharge pressure - Kg/Sq.cm Oil pressure - Kg/Sq.cm
3.	Compressor -----	RPM - Voltage - Volts Current - a. at 100% load - degree C b. at partial load - 1 - Amps 2 - Amps 3 - Amps
4.	Water Chillers -----	Water flow rate - LPM Water temperature entering - degree C leaving - degree C Water pressure entering - Kg/Sq.cm leaving - Kg/Sq.cm

S.No.	Item		Test
5.	Condensers	-----	Water flow rate - LPM Water temperature leaving - degree C - degree C Water pressure leaving - Kg/Sq. cm - Kg/Sq.cm
6.	Pumps	-----	R.P.M Motor current - Amps Discharge pressure -Kg/Sq.cm Return pressure - Kg/Sq.cm
7.	Cooling	-----	Water entering - degree C leaving - degree C Wet bulb approach - degree C Fan motor current - Amps Fan motor voltage - Volts Fan motor RPM -
8.	Air handling units & Fan coil units	-----	Total air quantity across coil – CMH Coil face area - SqM Air temperatures entering (D.B) - degree C entering (W.B) - degree C leaving (D.B)-

degree C

leaving (W.B) - degree C

Water flow rate -
LPM Water
temperature
entering - degree C
leaving -
degree C Water pressure
entering - Kg/Sq.cm

leaving - Kg/Sq.cm

S.No.	Item	Test Results
9.	Fresh air intakes	----- Face area - SqM Air quantity - CMH
5.	Room conditions at the working plant (No. of readings shall be taken and averaged out)	----- Temperature D.B. - degree C W.B. - degree C
11.	Controls	----- Function of each control shall be tested and report furnished.

Notes :

A. TEST INSTRUMENTS

1. All instruments for testing shall be provided by the air conditioning contractor.
2. Thermometers used for measurements of temperature of water/ refrigerant shall have graduations of 0.1 degree C and shall be got calibrated from N.P.I., or any recognized test house before hand.
3. Thermometers used in the psychrometers shall have graduations of 0.2 degree C and shall be calibrated as above.
4. Pressure gauges shall also be got calibrated before hand from a recognized test house.
5. Orifice type flow meters shall be used for measuring flow rate through chillers.
6. Where flow rates vs. pressure drop curves for the heat exchangers of the same model as installed, certified by Consultants on the basis of tests conducted at manufacturer's works are produced, flow meters for measuring water flow rate through these may not be provided. Actual water flow shall in such a case, be computed with reference to these curves and the actual pressure drop measured at site.
7. Integrating type flow meters may be used for measuring water flow through the individual air handling units.
8. Air flow rate shall be measured in the supply duct using pitot tube as indicated in figures 3 and 4.

B. CAPACITY COMPUTATIONS

The contractor shall demonstrate performance of HVAC system and shall conclude summer as well as monsoon tests in line with the above procedure.

1. Air handling unit :
The capacity shall be computed from the air temperatures and air flow measurements. A tolerance of + 5% from the specified value shall be acceptable in the capacity so computed. Air quantity shall be measured in the supply duct and checked with the quantity specified in the schedule. A tolerance of +10% in the air quantity shall be acceptable. The enthalpy difference of air entering and leaving the coil shall be computed from air temperatures as recorded.
2. For the purpose of system capacity, the refrigeration tonnage obtained from the main refrigeration plant will be accepted.
3. If due to any reason, internal load mentioned in the tender specification is not available psychrometric computations for actual

load conditions will be done and the plant, if found satisfactory will be accepted.

APPROVED MAKES OF EQUIPMENT & MATERIALS

List of approved makes of different equipment/materials to be used in this project.

S. NO.	DETAILS OF EQUIPMENT & MATERIALS	Approved Make
EQUIPMENT		
3	Mechanical Coupling	Victaulic/ Tyco
4	Double Skin Air Handling Units & Fresh Air Treatment Units	Advantec/ Edgetech/ VTS/Systemair
5	Cooling Coils for AHUs & FATUs	Advantec/ Edgetech/ VTS/ Systemair
6	Heat Recovery Wheels (HRW)	Ecofresh/ Flaktwoods/ Ostberg
7	Fan Coil Units	Kubic /Midea/ Trane/ Edgetech/Bhutoria
8	Pump Sets:	
9	Constant Speed Primary CHW/ HW Pumps & CDW Pumps	Bell & Gosset (Xylem)/ Grundfos/ Armstrong
9.1	Secondary Variable speed Pumping System	Bell & Gosset (Xylem)/ Grundfos/ Armstrong
9.2	Variable Frequency Drives	
10	Cooling Towers	Bell/ Paharpur/ Advance/Floair-tech
11	Extract Fan Sections & Fan Filter Units	Zeco-Munters/ Edgetech/ VTS/ Advantek
12	Centrifugal Fans	Nicotra/ Kruger/ Greenheck
13	EC Plug Fans	EBM Papst/ Ziehl Abegg
15	Axial Flow Fans	Greenheck/ System Air/ Kruger

16	Jet Vent Fans	Greenheck/ System Air/ Kruger
17	Inline Fans/ Low Noise Mixed Flow Inline Fans	Kruger/ System Air/ Ostberg
18	Propeller Fans	Marathon/ Khaitan
19	CO Sensors	Honeywell/Elixir/ Omicron
20	V-Belts	Fenner India/ Dunlop
21	Finned Strip Heaters	Dasspass/ Neptronics
22	Air Washers	Zeco-Munters/ Zair/ VTS/ Advantec
23	Monobloc Pumps for Air Washers	Grundfos/ Armstrong/ KBL
24	Cellulose based Paper Fills	EcoCool/ Munters/ AMB Cool
25	Motors:	
25.1	High Efficiency Normal	ABB/Siemens/Crompton/Bharat Bijli
25.1	Fire Rated (Upto 250 deg C)	Crompton/CMS/Rotomotive/ Havells
26	Air Curtains	Euronics / Mitsubishi/ VTS/Zair
27	Dry Scrubbers	Trion/ AOM
28	Inertia Bases for Pumps	Resistoflex/ Easyflex/ Gerb
29	Hot Water (electric)	Rapidcool/ Emerald
30	Ductable/ Non-Ductable Split Packages	Daikin/ Toshiba/ Mitsubishi/Voltas/Bluestar/Career/Panasonic
31	Compressor for above units	Daikin/ Toshiba/ Mitsubishi/Voltas/Bluestar/Career/Panasonic
32	CHW based Hi-Wall/ Cassette Units	Kubic Midea/ trane/Sinko/Edgetech

33	Condensate drain pump for Hi-wall Units & FCUs	Aspen/ Equivalent Approved
34	Chemical Dosing System	Nalco/ Equivalent
35	Electronic Air Cleaners (EACs)	
	ESP with ACF	Honeywell/ Trion(JCI)/Elixir
36	CO/CO2 Sensors & Controller for demand control ventilation	Honeywell/ Greystone/ Omicron /Elixir
37	VAQ Station assembly	Conaire/ Omicron
38	Plate Heat Exchanger	Trantor/Alfa laval
39	RO Water System	Kent/Ion Exchange/Thermax/Aquagaurd
40	Heat Pump	Trane/York/carrier/Daikin/Kehems
41	Chiller Unit (Drinking Water)	Trane/York/carrier/Daikin/Kehems
PIPING		
1	Pipes (MS & GI)	
1.1	upto 300mm dia	Jindal (Hissar)/ Tata Steel/ QST/Jindal(Star)
1.2	above 300mm dia	Jindal (Hissar)/ Tata Steel/ QST/Jindal(Star)
1.3	Pre insulated Chilled water Pipe	Permapipe/Urecon/Sevenstar/Eurotube
2	Welding Rods	Esab/Adore-Bond/Advani
3	Wafer type Check Valves	Honeywell/ Advance/ C&R/ Audco
4	Wafer type Butterfly Valves	Honeywell/ Advance/ C&R/ Audco/Zoloto
5	Motorized Butterfly Valves	Honeywell/ Advance/ Siemens/ Danfauss/Belimo/Jonhson Control/Zoloto
6	Manual Balancing Valves	Honeywell/ Advance/ Audco/ Danfauss
7	Automatic Balancing Valves/PICV	Oventrop/ Danfoss/ Honeywell/Advance

	Valves	
8	Strainers	Honeywell/ Zoloto/ Advance
9	Ball Valves	Honeywell/ Advance/ Zoloto/Rapid Control/Emerald
10	Pair of Ball Valves with & without Strainers for FCUs	Honeywell/ Advance/Danfuss/Jihson Controls
11	Pressure Gauge for Water Line	H-Guru/Feibig/Omicron/
12	Thermometers for Water Line	H-Guru/Omicron/Feibig
13	Expansion Bellows	Resistoflex/ Easyflex/ Gerb
14	Flow Switch & DP Switch	Johnson Controls/ Honeywell/ Omicron
15	Automatic Purge Valves	Reflex/ Spirotech/ Rapidcool
16	Test Points	Rapidcool/ Oventrop/ Anergy
17	Suction Guides with Strainer	Emerald/ Rapidcool/ Anergy
18	Copper Pipes (Make should comply with VRF OEM approval also)	Rajco/ Mandev/ Mexflow/ RR Shramik
19	BTU Meters	Omicron/Kamstrupp/Honeywell/Elixir
20	Pressurization Unit with Built-in Degasser	Reflex/IMI Hydronics/ Spirotech/Flamco
21	Dirt Separator	Reflex/IMI Hydronics/ Spirotech/Flamco
22	Vacuum Degasser	Reflex/IMI Hydronics/ Spirotech/Flamco
23	Air Vents	Anergy/ Honeywell
AIR DISTRIBUTION		
1	GS Sheet	SAIL/ ISCO/ Tata Steel/ National/ Jindal

2	Factory Fabricated Ducts (Rectangular/Round/Elliptical)	Asawa/ Ductofab/ Dustech/ Zeco/Rolastar
3	PIR Ducts (Spiral/ Square)	Asawa/ P3/ Pal/ Aura
3	Flanges & Accessories for the above ducts	Asawa/ Ductofab/ Dustech/ Zeco
4	Wire Rope Suspension Arrangement	Gripple/ HILTI
7	Fine Filters/ Hepa Filters/ Activated Carbon Filters	Thermadyne/ Spectrum/ Anfilco/ SAGI Cofim
8	Pre-Filters	Thermadyne/ Spectrum/ Anfilco/ Aer Team
11	Extruded Aluminium Grilles & Diffusers	Dynacraft/Asawa/ Servex/Tristar
12	Plaque Diffusers	
13	Swirl Diffuseres	Asawa/Dynacraft/ Servex/Tristar
14	Jet Nozzles	Asawa/Dynacraft/ Servex/Tristar
15	Air Transfer Grilles/ Louvers	Asawa/Dynacraft/ Servex/Tristar
16	Fire & Smoke Dampers:	
16.1	Bare Dampers	Asawa/Ruskin/ greenheck
16.2	Actuators	Honeywell/ Johnson Control/Siemens (UL Actuators Only)
17	Sound Attenuators	Ruskin/ Dynacraft/ Trox
18	Intake Louvers	Asawa/Dynacraft/ Servex/Tristar
19	Duct Dampers	Asawa/Dynacraft/ Servex/Tristar
20	Motorized Volume Control Dampers:	

20.1	Bare Dampers	Asawa/Ruskin/Trox
20.2	Actuators	Siemens/ Honeywell/ Johnson Control
		(UL Actuators Only)
21	Dash fastners/ suspension accessories with anti-seismic feature	HILTI/ Fischer/ Canon
22	Pre-insulated Flexible Ducts	Atco/ Sphere/Asawa
23	Un-insulated Flexible ducts	Atco/ Sphere/Asawa
24	Spigots	Asawa/Dynacraft/ Servex/Tristar
25	Fire Retardant Canvass connections for ductwork	Resistoflex/ Easyflex/ Mapro/ Sphere
26	Fire Sealant	HILTI/ 3M/ Promat
29	Fire Retardant Coating on Ductwork	Flamebar/ Paramount-Polytreat/ Cischem
30	Anti-Corossion Coating on STP Ductwork	Paramount-Polytreat/ Cischem
INSULATION		
1	Fibre Glass	Ursa/ Saint Gobain/Kimmco
2	R P Tissue	Owens Corning/ Kimmco
3	Closed/ Open Cell Elastomeric Insulation material:	
3.1	Nitrile Rubber	Aerocell/ Aerofoam/Armaflex/Aerolam
3.2	EPDM	Aeroflex/ HT Armaflex
4	Adhesive for closed/ open cell	Pidilite/ Paramount-Polytreat/ Cischem

	insulation material	
5	Expanded Polystyrene	Beardsell/ Styrene Packing/Pioneer
6	Adhesive for Expanded Polystyrene	Unishield/ Polyshield
7	Aluminium Tape	3M/ Magic
8	Aluminium Foil	INDALCO/ BALCO
9	PUF Pipe Supports	Malanpur Entech/ Bestopuf/ Rinac
10	Polyester Membrane	Shelko/ Bituplus
11	External surface treatment of insulated surface of ductwork & piping to achieve mechanical strength and UV protection.	Paramount-Polytreat/ Polybond/ Cischem
ELECTRICAL		
1	MCC & Starter Panels	L&K/Adlec/Excel/Modern Switchgear/Neptune/Milestone
2	Air Circuit Breaker	Schneider/ Siemens/ ABB/ L&T
3	MCCB	Schneider / Siemens / Legrand
4	MCB	Schneider / Siemens / Legrand
5	Cables	Bonton/ Excel/ Rallison/Polycab/Grandlay/Gloster
6	Cable Glands	Commet/ Dowells/elixir
7	Cable Lugs	Commet/ Dowells
8	Cable Trays	KME/MEM/ profab/Excel
9	ELCB	Schneider / Siemens / Legrand

10	Changeover Switch	L&T/ HH Elcon/ Socomec/ HPL
11	Contactors	ABB/Schneider/Siemens
12	Overload Relay	ABB/Schneider/Siemens
13	Indicating Lamp/Push Button	Siemens/Vaishno/ Schneider
14	SFU/FSU	Siemens / L&T
15	HRC Fuses & fuse fittings	Siemens / L&T
16	Current Transformers	Kappa/AE/Procom
17	Rotary switches	Salzer/ L&T/ Kaycee
18	Toggle Switches	L&T/ Kaycee
19	Selector Switches	Salzer/ L&T/ Kaycee
20	Time Delay Relay	Schneider/ L&T
21	Ammeter/Voltmeter (Digital)	Schneider/ L&T/ Secure
22	Ammeter/Voltmeter (Analog)	AE/ Rishabh
23	Time Clock	L&T/ Schneider
24	KWH Meter (Digital Type)	Schneider/ Secure/ L&T
25	Under Voltage Relays	Procom/ C&S/ L&T
26	Over Voltage Relays	Procom/ C&S/ L&T
27	MS Conduits (ISI Marked)	AKG/BEC/ RMCon
28	PVC Conduits – FRLS	Diamond/BEC/Precision
29	XLPE Wires – FRLS (Halogen free)	Polycab/ Bonton/ EXCEL
30	Circuit Integrity Cables	Polycab/ Bonton/ EXCEL

31	Factory Fabricated Distribution Board	Legrand/ Schneider/ Hager
CONTROLS		
1	Pressure Independent Self Balancing type Control Valves with accessories	T&A/ Oventrop/ Honeywell/Advance
2	2-way/ 3-way Diverting Valves	Honeywell/ T&A/ Oventrop Controls/Advance
3	Modulating actuators	T&A/ Oventrop/ Honeywell
4	Thermostats	Honeywell/ Johnson Controls / Trane
5	Safety Thermostat for Heaters	Anergy Controls/ Staefa/ Honeywell
6	Dial Thermometer Capillary type	Tadington/ Equivalent
7	HP/LP/Cutout Switch	Danfoss/ Equivalent
8	Oil Pressure Safety Switch	Penn/ Danfoss
9	Refrigerant Solenoid Valves	Sporlan/ Alco
10	Expansion Valves	Sporlan/ Alco
11	Airstat	Rapidcool/ Anergy
12	Flow Switch/ Pressure Differential Switch	Omicron/Honeywell/Trane/ UTC
MODULAR SUPPORTS FOR SERVICES		
1	Base/Vertical Strut Channel 41x41	Fischer/ Caddy/ VDS
2	Seismic Connector 135 Deg.	Fischer/ Caddy/ VDS
3	M12 Slide Nut	Fischer/ Caddy/ VDS

4	M12x35mm Hex Bolt, HT	Fischer/ Caddy/ VDS
5	M12 Hex Nut	Fischer/ Caddy/ VDS
6	Threaded Rod	Fischer/ Caddy/ VDS
7	M12 Round Washer	Fischer/ Caddy/ VDS
8	Cross Connectors	Fischer/ Caddy/ VDS
9	Two Bolt Clamp 2-1/2"NB	Fischer/ Caddy/ VDS
10	4 Hole Wall Plate with Cross	Fischer/ Caddy/ VDS
11	Connector	Fischer/ Caddy/ VDS
12	Through Bolt Anchor M12x75	Fischer/ Caddy/ VDS
13	Base/Vertical Strut Channel 41x62x2.5	Fischer/ Caddy/ VDS
14	Base/Vertical Strut Channel 41x41x2.5	Fischer/ Caddy/ VDS
15	BIS Engineered Roof Top Support	Fischer/ Caddy/ VDS
16	BIS Strut Connectors 90° with RIB	Fischer/ Caddy/ VDS
17	Seismic Anchors	Fischer/ Caddy/ VDS
18	Seismic Bracing (Wire Rope)	Fischer/ Caddy/ VDS

Notes:

- Make of any other equipment not mentioned above will require approval from the Engineer In Charge before execution.
- Multiple makes for one equipment/ material shall not be acceptable.
- Successful bidders to produce relevant Test Certificates for various equipment/

materials.

LIST OF EQUIPMENT & ACCESSORIES WHICH CONTRACTOR HAS TO
BRING, KEEP AND MAINTAIN, AT HIS OWN COST, AT SITE DURING THE
CURRENCY OF THE CONTRACT IN GOOD CONDITION.

PLANT/EQUIPMENT		NUMBER
01.	Hydraulic Test Machine	4
02.	Floor mounted drill machine	2
03.	Hand drill machine with drill bits	6
04.	Hammer Drill machine with drill bits	2
05.	Lock forming machine for duct fabrication	2
06.	Hand held lock closing machine	2
07.	Electric Pittsburg Seamer for closing Pittsburg joints	2
08.	Electric Slitting shear for making cut outs	2
09.	Collar cutting machine	2
10.	Mechanized saw for cutting angles & channels	2
11.	Duct smoke test kit	2
12.	Thermometers	2
13.	Water line pressure testing kit	2
14.	For application of closed cell elastomeric insulation	
i.	1200 long steel scale	2
ii.	1200x900 size 40mm thick commercial ply board	2
iii.	Knives of following sizes	4
	Medium Knives 150mm – 200mm long	4
	Small Knives 100mm- 150 mm long	4
15.	50mm-100 brush for adhesive application	5
16.	Tripods with chain pulley blocks	4

17. Hoisting system for lifting the factory fabricated ducts
-

and any other equipment required for efficient execution of work within the stipulated period.

HVAC SERVICES SCHEDULE OF QUANTITIES

1. All equipment described hereafter shall be in accordance with the specifications.
2. All equipment shall be selected and installed for the lowest operating noise level.
3. Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components and warranty obligations for the individual equipment.
4. Installation of various equipment shall include all material and labour associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting & anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.
5. Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and sound power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.
6. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.
7. Testing and commissioning shall include furnishing all labour, materials, equipment, instruments and incidentals necessary for complete testing of each component as per the specifications & manufacturer's recommendations, submission of test results to the Consulting Engineer, obtaining their approval and submission of necessary completion documents & drawings.
8. All piping shall be installed conforming to the relevant Indian Standards, approved shop drawings and the specifications. All water recirculation piping shall be tested as per the specifications.
9. Piping installation shall include all costs towards supplying and fixing of pipes & fittings (elbows, tees, reducers) cutting, threading, joining, welding, soldering & affecting connections as required, providing non-hardening sealing material as well as rubber gaskets for screwed flanges, providing and installing adequate number of clamps, hangers, saddles, brackets, rawl plugs and other accessories for pipe supports, providing minor dressing of walls and floor, providing and installing pipe sleeves as required and treatment to pipes as per the specifications.
10. Exposed steel pipes shall be given two coats of approved paint as per the relevant Indian Standards for colour coding of pipes and direction of flow of fluid in the

- pipes shall be visibly marked with identifying arrows.
11. Valves, unions, strainers, drain, air valves, expansion joints, pressure guages and thermometers shall be provided in the various pipe lines as per the approved shop drawings and specifications.
 12. After completion of the installation, the entire piping system shall be tested for leak in accordance with the specifications.
 13. All ducts shall be fabricated and installed conforming to the relevant Indian Standards, approved shop drawings and the specifications.
 14. Duct installation shall include fabricating and installing the ducts, splitter dampers, turning vanes, distribution grids within the ducts in position extruded aluminium hardware fittings such as handles thunder bolts hinges, factory fabricated access door and providing , installing , MS hangers with dash fasteners, foam rubber insertions, nuts, bolts and screws as required. Making all joints air tight using rubber insertions in addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flow. All primer coated MS hangers, dampers, base frames etc. shall be painted with black enamel paint.
 15. All registers and diffusers shall be provided with a soft continuous rubber gaskets between their periphery and the surface on which these have to be mounted.
 16. MS registers and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved colour. Aluminium grilles and diffusers shall be fabricated out of extruded aluminium sections.
 17. After completion of the installation, the entire air distribution system shall be tested for leaks and balanced in accordance with the specifications.

18. **Mode of Measurement**

The mode of measurement for the various items, unless otherwise specified, shall be as follows :

18.1 **Ducting**

Payment for ducting shall be made on the basis of the external surface area of the ducting including all material and labour for installed duct.

The rates per SqM of inspection doors, dampers, turning major hardwares such thunder bolts, hinges, handles in extruded aluminium construction and any other item which will be required to complete the duct installation except external insulation and acoustic lining.

The external area shall be calculated by measuring the overall width and depth (including the corner joints) in the centre of the duct sections and overall length of each duct section from flange face incase of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

In case of taper pieces average width and depth will be worked out as follows :

W1 = width of small cross section

W2 = width of large cross section

D1 = depth of small cross section

D2 = depth of large cross section

Average width = $\frac{W1 + W2}{2}$

Average depth = $\frac{D1 + D2}{2}$

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.

For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.

For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth of flanges.

Duct measurements for calculation of area shall be taken before application of insulation.

For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.

18.2 Uninsulated Piping

Payment for uninsulated piping shall be made on the basis of linear measurement including all materials and labour for installed pipe. The linear rate per

meter/feet for each nominal diameter shall include all pipe fittings, flanges, unions, gaskets for joints, bolts and nuts, pipe supports and hangers, vibration isolation devices or suspenders, flexible connections and any other item required to complete the pipe installation except valves of any kind and strainers. the length of the pipe section with flanges shall be from flange face to flange face.

For fitting like bends, elbows, branches and tees etc. same principle of linear measurement as for pipe sections shall be adopted except for bends, the length of which shall be the average of the lengths of inner and outer periphery along the curvature.

18.3 Duct Insulation

This item is provided separately for various thickness and shall be paid for on area basis of uninsulated duct. The area of the duct to be insulated shall be measured before application of insulation.

18.4 Grilles & Diffusers

All extruded aluminium grilles and diffusers shall be paid on the basis of actual measurement at site. Diffusers shall be counted physically at site and accounted for. Area of linear grilles shall be derived based on width and linear length and paid for on actual area basis.

18.5 Exhaust Hoods

All kitchen exhaust hoods shall be measured and accounted for the area derived from plan dimensions.

18.6 Valves / Strainer

Payment will be made on unit basis.

19. All quantities indicated in this schedule are for Contractor's guidance only.
20. Appropriate troughs in the suspended ceiling be provided for terminating duct collars for diffusers & grilles by other agencies to achieve desired interior finishes.
21. Contractor to verify the static pressure of various air handling units in accordance with the approved for construction shop drawings.

केन्द्रीय लोक निर्माण विभाग

कार्यालय ज्ञापन

No. DG/MAN/410

ISSUED BY AUTHORITY OF DIRECTOR GENERAL, CPWD

NIRMAN BHAWAN, NEW DELHI

DATED: 22.10.2021

Subject: Addition of new Para 4.10.2 in CPWD Works Manual 2019 regarding testing charges to be borne by contractor.

It has been noticed that following provisions are sometimes being made in the NITs / Agreements by the NIT approving authorities:

"The cost of test shall be borne by contractor/ department in the manner as below:

- By the contractor, if the result shows that material does not conform to the relevant codes/ specification,
- By the department, if the results show that the material conforms to relevant codes/ specification."

It has been decided by the competent authority that testing charges shall be borne by the contractor in all cases. Accordingly following new para is added in CPWD Works Manual -2019.

Existing Provision	Modified Provision
4.10 Preparation of NIT	4.10 Preparation of NIT
4.10.2 No Provision	4.10.2 Testing charges to be borne by contractor
	Following provision shall be incorporated by the NIT approving authority in the NIT:
	All expenditure to be incurred for testing of samples e.g. packaging, sealing, transportation, loading, unloading etc. including testing charges shall be borne by the contractor. The NIT shall have list of approved laboratories for testing as approved by ADG / SDG.

This issues with the approval of competent authority.

(वी.पी. साहु) 22/10/2021

अधीक्षक अभियंता(सी.एंड एम.)

e-file 9116587

Issued from file No. CSQ/CM/16(1)/2021

प्रतिलिपि: सभी केलोनिवि तथा लोनिवि दिल्ली के अधिकारियों को आवश्यक सूचना एवं कार्यवाही हेतु (केलोनिवि वेबसाइट के माध्यम से).